NAVFAC MID- ATLANTIC

WORK ORDER NO. 1661828
1661829

CONTRACT NO. N40085-20-D-0034

P4638 AND P4639 AMBULATORY CARE CENTER REPLACEMENTS

At the

MARINE CORPS BASE (MCB), CAMP LEJEUNE, NC

Pkg 2, 65% DD Specifications

Division 12 - Division 33

PREPARED BY:

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Architectural:	RQ Construction, LLC	Mechanical:	SC Engineers
Civil:	RQ Construction, LLC	Electrical:	Coffman Engineers
Structural:	Lynch Mykins	Fire Protection:	Coffman Engineers
Landscape:	Simon Landscape	Interior Design:	RQ Construction, LLC
Life Safety:	Coffman Engineers	Geotechnical:	Cape Fear Engineering
Medical Equipment Planner:	Chesapeake Healthcare Planning	Sustainability:	Doo

Submitted By: Date: 04/21/2022

APPROVED BY:

Specifications:

For Commander, NAVFAC:
Date:

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ROLLER WINDOW SHADES
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/WCMA A100.1	(2018) American National Standard for Safety of Window Covering Products

ASTM INTERNATIONAL (ASTM)

ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UNDERWRITERS LABORATORIES (UL)

UL 2818	(2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Detailed Drawings~~; G[, [_____]]~~

Location Schedule~~; G[, [_____]]~~

SD-03 Product Data

Window Shades~~; G[, [_____]]~~

[Recycled Content for various fiber components; S

] SD-04 Samples

Window Shades; G[, [_____]]

SD-06 Test Reports

Flammability Requirements; G[, [_____]]

SD-07 Certificates

[Indoor Air Quality for roller window shades; S

] Qualifications

SD-10 Operation and Maintenance Data

Window Shades, Data Package 1; G[, [_____]]

SD-11 Closeout Submittals

Submit Data Package 1 for roller window shades, and Data Package 2 for electrical operators, in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

[1.3 CERTIFICATES

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Roller Window Shades

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) [Gold], SCS Global Services Indoor Advantage Gold or provide validation by other third-party program that products meet the requirements of this paragraph. Provide current product certification documentation from certification body.

]1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Installer's Qualifications

Installer trained and certified by the manufacturer with a minimum of ten years of experience in installing products comparable to those specified in this section.

1.4.2 Flammability Requirements

Passes in accordance with NFPA 701 small and large-scale vertical burn. Materials tested are identical to products proposed for use.

1.4.3 Electrical Requirements

NFPA Article 100 listed and labeled in accordance with UL 325 or other

~~testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components is not acceptable in lieu of system testing.~~

1.4.3 Anti-Microbial Requirements

'No Growth' per ASTM G21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 50 degrees F. Do not open containers until needed for installation unless verification inspection is required. Handle and store shades in accordance with manufacturer's recommendations.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of ~~[~~10~~]~~ ~~[_____]~~ years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 WINDOW SHADES

Submit drawings showing plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to work. Submit a location schedule showing location, size and quantity of shades. Include the use of same room designations as indicated on the drawings.

Provide product data composed of catalog cuts, brochures, and operating and maintenance instructions on each product to be used. Include styles, profiles and features.

Furnish samples of each type and color of roller shade fabric and roller shade channel. Provide shade material minimum 6 by 6 inches in size. Mark face of material to indicate interior faces.

Mock up: Install shade in area designated by Contracting Officer. Do not proceed with remaining work until the Contracting Officer approves workmanship and operation. Rework mock up as required to produce acceptable work. The approved shade can be used in the installation.

Submit fire resistance data, flame spread and smoke contribution data.

Provide roller tube that operates smoothly and of sufficient diameter and thickness to prevent excessive deflection. Provide brackets that are appropriate for ~~[inside][outside][ceiling]~~ mount as indicated in Contract Drawings. Provide shade cloth meeting the performance described in NFPA 701, small scale test. Treat steel features for corrosion resistance.

Provide Various Fiber Components with a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for

various fiber components.
~~[~~Provide certification of indoor air quality for roller window shades.~~]~~

2.1.1 Manufacturer's Qualifications

Obtain motor-controlled roller shades through one source from a single manufacturer with a minimum of twenty years of experience and minimum of three projects of similar scope and size in manufacturing products comparable to those specified in this section. Furnish manual and motorized shades produced by the same manufacturer to provide matching appearance.

2.1.2 Manually Operated Shades with Single Rollers

A6309- Provide mechoshade manual fascia, 3% open, single roller.

2.1.2.1 Chain-and-Clutch Operating Mechanisms

Provide continuous-loop bead chain and clutch that stops shade movement when bead chain is released; shade to be permanently adjusted and lubricated.

2.1.2.2 Bead Chains

Provide bead chain from #10 stainless steel rated to 90 lb. minimum breaking strength with pull chain tensioning device complying with ANSI/WCMA A100.1

a. Loop Length: ~~[~~Full length of roller shade~~][As indicated]~~.

b. Limit Stops: Allows shade to stop when chain is released. Provide limit stops to prevent shade from being raised or lowered too far.

c. Chain-Retainer Type: ~~[~~Clip, jamb mount~~][Chain tensioner, jamb mounted][Chain tensioner, sill mounted]~~.

~~[2.1.2.3 Crank-and-Gear Operating Mechanisms~~

~~Sealed gearbox drive system controlled by crank handle, [detachable][permanently mounted].~~

~~a. Crank-Handle Length: [Manufacturer's standard for height of shade][As indicated on drawings].~~

~~[b. Coupling system: Provide system to operate shades from single crank by coupling shade rollers together. System to consist of endcaps, plus couplings to connect rollers.~~

~~]]~~2.1.2.3 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade cloth for service.

a. Roller Drive-End Location: ~~[Right side of interior face of shade][Left side of interior face of shade][~~As indicated~~]~~.

b. Direction of Shade cloth Roll: {Regular, from back (exterior face) of roller}[Reverse, from front (interior face) of roller].

c. Shade cloth-to-Roller Attachment: {Manufacturer's standard method}[Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.2.4 Mounting Hardware

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.2.5 Shade Cloth

a. Shade Material: {Light-filtering fabric: Openness {1 percent}[3 percent_]{5 percent}[_____]}[Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar {enclosed in sealed pocket of shade band material}[exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.2.6 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

{ b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

} c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

{ d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

}[e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

~~][2.1.2.7 Room Darkening Shades~~

~~Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed and conform with the following:~~

~~a. Provide roller tube made of aluminum. Provide shop fabricated light traps consisting of a head box to house the roller shade, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.~~

~~b. Provide light trap made of sheet steel having a minimum thickness of 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.~~

~~c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].~~

~~d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.~~

~~]2.1.3 Manually Operated Shades with Dual Rollers~~

~~2.1.3.1 Chain-and-Clutch Operating Mechanisms~~

~~Provide continuous-loop bead chain and clutch that stops shade movement when bead chain is released; shade to be permanently adjusted and lubricated.~~

~~2.1.3.2 Bead Chains~~

~~Provide bead chain from #10 stainless steel rated to 90 lb. minimum breaking strength with pull chain tensioning device complying with ANSI/WCMA A100.1. Provide positive mechanical engagement of drive mechanism to shade roller tube. Center bead chain placement for right or left- hand operation.~~

~~a. Loop Length: [Full length of roller shade][As indicated].~~

~~b. Limit Stops: Allows shade to stop when chain is released. Provide limit stops to prevent shade from being raised or lowered too far.~~

~~c. Chain-Retainer Type: [Clip, jamb mount][Chain tensioner, jamb mounted][Chain tensioner, sill mounted].~~

~~[2.1.3.3 Crank-and-Gear Operating Mechanisms~~

~~Sealed gearbox drive system controlled by crank handle,~~

[detachable][permanently mounted].

a. Crank-Handle Length: [Manufacturer's standard for height of shade][As indicated].

[b. Coupling system: Provide system to operate shades from single crank by coupling shade rollers together. System to consist of endcaps, plus couplings to connect rollers.

]]2.1.3.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade bands for service.

a. Dual Shade-Roller Mounting Configuration: [Side by Side][Offset][_____].

b. Inside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings]. Direction of Shade cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Outside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated]. Direction of Shade cloth Roll: [Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller].

d. Shade cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.3.5 Mounting Hardware

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.3.6 Inside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.3.7 Outside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide

shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.3.8 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.3.9 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps, consisting of a head box to house the shade roller, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades

to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.

][2.1.4 Motor-Operated Shades with Single Rollers

Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2.1.4.1 Motors

Provide motors that are [hardwired, wired into the building electrical system and][plug-in to standard AC electrical outlets and] concealed from interior view. The position of the motor and electrical connection is [left][right] side of roller, based on the hand of the user facing the shade from inside, unless otherwise indicated [on drawing][in the ROLLER WINDOW SHADE PLACEMENT SCHEDULE]. Provide motors capable of operating at or below 44 dBA measured 3 feet from the center of the shade depending on the electronic drive unit selected; no audible clicks when motor starts and stop. Motors are [120V, 60 Hz][low voltage with Class 2 power supply].

2.1.4.2 Controls

Provide electric controls with NEMA ICS 6 Type 1 enclosure for [surface][recessed or flush] mounting. Controls are able to electronically set and reconfigure shade open and close limits, shade preset positions, system groups and system subgroups at the control without rewiring and without access to the Electronic Drive Unit. Provide wall control engraved with button, group, or scene description as indicated on the drawings.

[a. Key Pad: Three-position, switch-operated control station with open, close, and off functions. Provide two keys per station. Battery operated key pads are not allowed.

][b. Switches: Wall-switch-operated control station with open, close, and center off functions. Switch Positions: [Three][Five]. Switch Style: [Toggle][Rocker].

][c. Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.

][d. Individual/Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.

][e. Sun Sensor Control: Provide solar adaptive shading software that automatically adjusts motorized shades throughout the day in response to the changing position and intensity of the sun. Customized shade schedules are developed combining information about building location and facade orientation. Wireless mullion sensors to be provided for

cloudy-day override.

][f. Low Voltage Controls: Provide a digital system that includes a low-voltage interface to communicate with both wired and wireless inputs. Wireless controls to utilize radio frequency in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

][g. Provide a whole building shade control system that can be preprogrammed and reprogrammed to accomplish different operations for management flexibility.

][2.1.4.3 Timer Controls

Clock timer, [24-hour][seven-day][_____] programmable for regular events.

[a. Provide switches that are adjustable and interlocked with motor controls and set to automatically stop the shade at fully raised and fully lowered positions.[Low voltage switching is required.]

][b. Operating Function: [Stop and hold shade at any position][Stop and hold shade at open, midpoint, and closed positions][Stop and hold shade at 3 pre-determined positions including open, closed and user-programmed position][Stop and hold shade at 5 pre-determined position including open, closed, and 3 user-programmed positions][_____].

][c. Provide the following options: [Low voltage system][Group switching with integrating switch control].[Capable of interface with [audiovisual][multi-room][_____] control system][Capable of accepting input from building automation control system][Override switch][Power failure memory for the life of the systems which protects presets][_____].

]]2.1.4.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade cloth for service.

a. Roller Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings].

b. Direction of Shade Cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Shade Cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.4.5 Mounting Hardware

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.4.6 Shade Cloth

a. Shade Material: Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.4.7 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.4.8 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps consisting of a head box to house the roller shade, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray

paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.

]][2.1.5 Motor-Operated, with Dual Rollers

Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2.1.5.1 Motors

Provide motors that are [hardwired, wired into the building electrical system and][plug-in to standard AC electrical outlets and] concealed from interior view. The position of the motor and electrical connection is [left][right] side of roller, based on the hand of the user facing the shade from inside, unless otherwise indicated [on drawing][in the ROLLER WINDOW SHADE PLACEMENT SCHEDULE]. Provide motors capable of operating at or below 44 dBA measured 3 feet from the center of the shade depending on the electronic drive unit selected; no audible clicks when motor starts and stops. Motors are [120V, 60 Hz] [low voltage with Class 2 power supply].

2.1.5.2 Controls

Provide electric controls with NEMA ICS 6, Type 1 enclosure for [surface][recessed or flush] mounting. Controls are able to electronically set and reconfigure shade open and close limits, shade preset positions, system groups and system subgroups at the control without rewiring and without access to the Electronic Drive Unit. Provide wall control engraved with button, group, or scene description as indicated on the drawings.

[a. Key Pad: Three-position, switch-operated control station with open, close, and off functions. Provide two keys per station. Battery operated key pads are not allowed.

][b. Switches: Wall-switch-operated control station with open, close, and center off functions. Switch Positions: [Three][Five]. Switch Style: [Toggle][Rocker].

][c. Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.

][d. Individual/Group Control Station: Three-position, rocker-style,

wall-switch-operated control station with open, close, and center off functions for individual and group control.

][e. Sun Sensor Control: Provide solar adaptive shading software that automatically adjusts motorized shades throughout the day in response to the changing position and intensity of the sun. Customized shade schedules are developed combining information about building location and facade orientation. Wireless mullion sensors to be provided for cloudy-day override.

][f. Low Voltage Controls: Provide a digital system that includes a low-voltage interface to communicate with both wired and wireless inputs. Wireless controls to utilize radio frequency in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

][g. Provide a whole building shade control system that can be preprogrammed and reprogrammed to accomplish different operations for management flexibility.

]2.1.5.3 Timer Controls

Clock timer, [24-hour][seven-day][_____] programmable for regular events.

[a. Provide switches that are adjustable and interlocked with motor controls and set to automatically stop the shade at fully raised and fully lowered positions.[Low voltage switching is required.]

][b. Operating Function: [Stop and hold shade at any position][Stop and hold shade at open, midpoint, and closed positions][Stop and hold shade at 3 pre-determined positions including open, closed and user-programmed position][Stop and hold shade at 5 pre-determined position including open, closed, and 3 user-programmed positions][_____].

][c. Provide the following options: [Low voltage system][Group switching with integrating switch control].[Capable of interface with [audiovisual][multi-room][_____] control system][Capable of accepting input from building automation control system][Override switch][Power failure memory for the life of the systems which protects presets][_____].

]2.1.5.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade cloth for service.

a. Dual Shade Mounting Configuration: [Side by Side][Offset][_____].

b. Inside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings]. Direction of Shade Cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Outside Roller: Drive-End Location: [Right side of interior face of

shade][Left side of interior face of shade][As indicated on drawings]. Direction of Shade Band Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

d. Shade Cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.5.5 Sub Title

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.5.6 Inside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.5.7 Outside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.5.8 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide

pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.5.9 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps consisting of a head box to house the roller shade, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.

]]2.2 COLOR

Provide color, pattern and texture for metal trim and shade fabric [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.] [as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers. Colors to be approved by Government.]

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 ROLLER WINDOW SHADE PLACEMENT SCHEDULE

[All exterior windows include [_____].] [Provide window covering as follows:

~~Room Number/Name~~	~~Roller Window Shade Covering Type~~	~~Window Type/Size~~	~~Window Quantity~~
~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~

~~]~~

3.2 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Provide roller window shades, complete with necessary brackets, fittings, and hardware ~~[in accordance with paragraph ROLLER WINDOW SHADE PLACEMENT SCHEDULE]~~[as indicated~~]~~.

Perform installation in accordance with the approved detailed drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Provide and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.3 CLEAN-UP

Upon completion of the installation, clean window treatments and exposed components as recommended by manufacturer. Adjust window treatment for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure shades installed in recessed pockets can be removed without disturbing the pocket. The entire shade, when retracted, is contained inside the pocket. For shades installed outside the jambs and mullions, overlap each jamb and mullion 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

-- End of Section --

SECTION 12 31 00

MANUFACTURED METAL CASEWORK
11/14, CHG 2: 11/16

PART 1 GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

1.1.1 Pre-Installation Meeting

Within ~~[~~30~~]~~ ~~[_____]~~ calendar days ~~after~~prior to Pre-Installation Meeting ~~[date of award] [date of receipt by him of notice of award]~~, submit for the approval of the Contracting Officer ~~[six (6)] [_____]~~2 copies of outline drawings of all casework to be furnished under this contract, together with weights and overall dimensions, and required samples. Ensure drawings show the general arrangement and overall dimensions of the casework, details of any casework supports~~[~~.~~][, and provisions for electrical outlets.][, special provisions for external cables and cords.]~~ Submit the following for review and approval:

a. Fabrication Drawings

b. Installation Drawings

Submit installation drawings for metal cabinets. Include in drawings the location of cabinets, details of cabinet relationship and dimensional positions~~, and locations for roughing in plumbing, including sinks, faucets, strainers and cocks[, special electrical lines or conduits] [cables] [_____]~~.

Submit manufacturer's catalog data and certificates for the following items showing conformance with the referenced standards contained in this section:

a. Cabinets

b. Corrosion-Resistant Steel

~~[~~ c. Glass

~~]~~ ~~d. Adhesives~~

~~e. Filler Material~~

~~f. Fasteners~~

~~[g. Steel Sinks~~

~~][h. Service Fixtures~~

~~] i. Accessories and Hardware~~

~~j. Plastic Laminate~~

~~k. Countertops~~

Submit manufacturer's instructions for metal cabinet systems including

special provisions required to install equipment components and system packages. Include special notices detailing impedances, hazards and safety precautions.

Submit manufacturer's standard color charts for metal cabinets showing the manufacturer's recommended color and finish selections.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings~~[; G[, [____]]]~~

Installation Drawings
~~[; G[, [____]]]~~

SD-03 Product Data

Cabinets~~[; G[, [____]]]~~

Corrosion-Resistant Steel~~[; G[, [____]]]~~

~~[~~ Glass~~[; G[, [____]]]]~~

~~Adhesives[; G[, [____]]]~~

~~Filler Material[; G[, [____]]]~~

~~Fasteners[; G[, [____]]]~~

~~[~~ ~~Steel Sinks[; G[, [____]]]]~~

~~[~~ ~~Service Fixtures[; G[, [____]]]]~~

Accessories and Hardware~~[; G[, [____]]]~~

~~Plastic Laminate[; G[, [____]]]~~

~~Countertops[; G[, [____]]]~~

SD-04 Samples

~~Accessories and Hardware[; G[, [____]]][; G][; G, [____]]~~

Manufacturer's Standard Color Charts~~[~~; G~~[, [____]]]~~

~~SD-07 Certificates~~

~~Corrosion-Resistant Steel[; G[, [____]]]~~

~~Glass[; G[, [_____]]]~~

~~Adhesives[; G[, [_____]]]~~

~~Filler Material[; G[, [_____]]]~~

~~Fasteners[; G[, [_____]]]~~

~~Steel Sinks[; G[, [_____]]]~~

~~Service Fixtures[; G[, [_____]]]~~

~~Accessories and Hardware[; G[, [_____]]]~~

SD-08 Manufacturer's Instructions

Manufacturer's Instructions~~[; G[, [_____]]]~~

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle metal casework in a manner that prevents damage or disfigurement.

~~Provide temporary skids under units weighing more than [_____] pounds~~ Comply with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Provide metal casework, factory-fabricated and finished in the manufacturer's standard sizes and finishes of the type, design, and configuration indicated. ~~Construct casework as specified and meet the requirements of KCMA A161.1. Provide wall and base cabinet assemblies consisting of individual units joined into continuous sections. Accomplish fastenings to permit removal and replacement of individual units without affecting the remainder of the installation. Provide counters with watertight sink rim when indicated. Provide removable doors equipped with position stops to avoid accidental complete withdrawals. Fix or adjust shelves as indicated.~~

a. CW090: Provide floor standing storage cabinet approximately 95"H by 36"Wide by 16" Depth with five adjustable shelves, framed glass hinged doors, and sloping top. Also referred to as a framed glass hinged double door case.

b. CW100: Provide floor standing storage cabinet approximately 95"H by 36"Wide by 16" Depth with five adjustable shelves, framed glass hinged doors, and sloping top. Also referred to as a framed glass hinged double door case.

2.2 MATERIALS

Doors are constructed with 20 gauge interior and 18 gauge exterior panels filled with sound deadening material, a 14 gauge steel reinforcement is added at hinge locations and a 20 gauge vertical reinforcement channel is included in each door.~~Provide corrosion-resistant~~

~~steel conforming to ASTM A1008/A1008M, and ASTM A167, Type [302] [304] [316] Finish 4.~~

14 gauge corner reinforcement at all four front corners, all corners welded and ground smooth.

~~Provide glass conforming to ASTM C1036, Type I, Class 1, Quality q3, 1/4 inch thick, for unframed sliding glass doors; other glass is to conform to ASTM C1036, Type II, Class 1, Quality q8, 7/32 inch thick~~Doors are equipped with nylon roller catches; double doors with locks feature an elbow catch on the left door.

~~Use thermosetting urea-resin Type II Adhesives for application of plastic laminate conforming to ASTM D4690 as recommended by the manufacturer of the laminate. Use adhesive conforming to ASTM D4689 for wood members.~~20 gauge shelf is adjustable on 1/2" increments; shelves over 36" long have hat channel reinforcement.

a. Holes for shelf clips and Zinc-plated shelf support clip.

~~Provide filler material conforming to FS TT-F-336.~~14 gauge corner reinforcement at all four front corners, all corners welded and ground smooth.

~~Provide plastic laminate conforming to ANSI/NEMA LD 3, Style [_____], Type [_____], Grade [_____], Class [_____], Finish [_____]~~18 gage bottom and stainless strike plate.

~~Provide accessories and hardware conforming to the following requirements, as applicable:~~

~~Extension drawer slides: ANSI/BHMA A156.9, Type B85071~~

~~[Semiconcealed hinges: ANSI/BHMA A156.9, Type B81201, 1-1/2 inches]~~

~~[Full surface hinges: ANSI/BHMA A156.9, Type B81131, 1-1/2 inches]~~

~~[Knob pulls: ANSI/BHMA A156.9, 1-inch diameter, Type B12132]~~

~~[Bar type pulls: ANSI/BHMA A156.9, 4-inch overall length, Type B12012]~~

~~Locks, keying, and keys: As directed~~

~~Catches: Magnetic, 5-pound pull~~

~~Sliding door set:~~

~~Impregnated fiberboard track~~

~~Nylon glides~~

~~Provide Fasteners conforming to the following:~~

~~Screws: Complying with ANSI Standards, Group, Type and Class as applicable~~

~~Anchoring Devices: FS FF-S-325, Group, Type, and Class as applicable~~

~~Toggle bolts: FS FF-B-588, Type I, Class A, Style 2~~

Nuts: ASTM F594, corrosion-resistant steel

Bolts: ASTM A325, heavy, hexagon head bolts corrosion-resistant steel

Nuts: ASTM F836M, corrosion-resistant steel

Bolts: ASTM A325M, heavy, hexagon head bolts corrosion-resistant steel

Corrosion-resistant Steel Sinks:

[18-gauge corrosion-resistant steel, integral with corrosion-resistant steel countertop

][18-gauge corrosion-resistant steel, nonintegral, self-rimming

] Drain holes in center of bowl

Underside coated with 1/8-inch thick sound deadener

Die-form, seamless, raised edges at front and ends

Cove corners to 1/2-inch radius

Equip with strainers and tail pieces

Provide Service Fixtures conforming to the following requirements:

a. Provide fixtures in accordance with the water conservation policy as stated in the ICC IPC.

b. Faucets:

(1) Splashback mounted, cast brass, chrome plated, FS WW-P-541

(2) Deck mounted, cast brass, chrome plated, FS WW-P-541

c. Gas, air, and vacuum, distilled water, steam, and de-ionized water cocks: cast brass, chrome plated, ground key type

d. Drains, strainers, and taps: brass, chrome plated, FS WW-P-541

e. Index buttons: plastic, color codes in accordance with SEFA 7

f. Special items: provide nipples and locknuts with each fixture.

[Metal pretreatment coatings: FS TT-C-490, Type I

][Metal pretreatment coatings: FS TT-C-490, Type II

][Metal pretreatment coatings: FS TT-C-490, Type III

][Enamel: FS TT-E-491, Class 2

]2.3 STEEL CABINET FABRICATION

2.3.1 General

Provide wall and base cabinets fabricated from22-gauge, cold-rolled

furniture steel, except for backs of cabinets and backs of doors provide 24-gauge steel. Construct cabinets with no raw edges or exposed flanges, with welds being flush and ground smooth on all exposed surfaces. Provide concealed fasteners at all exposed exterior surfaces. Provide doors and drawer fronts with panelized double-wall construction, not less than 1/2-inch thick, with a sound-absorbing material adhered between the walls. Equip doors and drawers with rubber or plastic silencers and bumpers. Provide drawers with removable fronts, mounted on [metal guides] [renewable fiber guides] [plastic guides] and equipped with position stops for complete drawer withdrawal. Provide [fixed] [adjustable] shelving as indicated.

2.3.2 Workmanship

Align end panels, top rails, bottoms and vertical posts at intersections in same plane, without overlap. Grind exposed welds flush and smooth. Welding is to conform to AWS D1.1/D1.1M and AWS D1.3/D1.3M.

Additional casework construction requirements:

a. Welded assembly.

b. Fabricate with enclosed uprights or posts full height or width at front, include sides, backs, bottoms, soffits, ceilings under sloping tops, headers and rail, assembled to form an integral unit.

c. Form sides to make rabbeted stile 3/4 to 1-1/8 inch wide, closed by channel containing shelf adjustment slots.

d. Make bottom of wall units flush, double panel construction.

e. Make top and cross rails of "U" shaped channel.

f. Enclose all backs and bottoms in cabinets, including drawer units.

g. Provide finish panel on exposed cabinet backs.

h. Do not use screws and bolts in construction or assembly of casework, except to secure hardware, applied door stops, accessories, removable panels and where casework is required to fastened end to end or back to back.

i. Fabricate casework, except benches, and desks with finished end panels.

j. Close flush exposed soffits of wall hung shelving, knee spaces in counters, and toe spaces at bases.

k. In base units with sinks provide on piece, lowered backs.

l. In base units with doors provide removable backs.

m. Provide built-in raceways or tubular or channel shaped members of casework for installation of wiring and electric work. Mount junction boxes on rear of cabinets. Electric work is specified in electrical sections of specifications.

n. Provide reinforcing for hardware.

o. Size Dimensions:

(1) Used dimensions shown or specified within tolerances specified.

(2) Tolerance:

(a) Depth: 13-inches in lieu of 12 -inches, 18 inches in lieu of 16 -inches, except wall hung units above counter 21 inches to 24 inches in lieu of 22-inches.

(b) Width: Minus one inch.

(c) Height: 1-inch plus or minus for wall hung cabinets and counter mounted cabinets, excluding sloping tops. 1-inch plus for floor standing cabinets,excluding base and sloping tops. Full height cabinets shown back to back same height.

(d) Manufacturer's tolerance for the length, depth or height: Not to exceed 0.0625-inches

2.3.3 Minimum Thickness of Steel

	U. S. Standard Thickness GAUGE	(INCH)
Drawer fronts, backs, bodies, closure plates or scribe and filler strips less than 75 mm wide,filler strips less than 75 mm wide, sloping top, shelf reinforcement channel and shelves. Toe space or casework soffits and ceilings and ceilings under sloping tops.	20	0.035
Base pedestals, casework top sides, back, and bottom panels, closure scribe and filler strips 75 mm or more. Reinforcement for drawers with locks. Table legs, spreaders and stretchers, when fabricated of cold rolled tubing. Metal for desks; except legs and aprons. Door exterior and interior panels, flush or glazed. Cross rails of base units. Front bottom rails, back bottom rails; rails may be 1.49 mm 16 gauge thick. Uprights or posts. Top corner gussets.	18	0.047

	U. S. Standard Thickness GAUGE	(INCH)
Aprons, apron division, reinforcing gussets, table legs, desk legs and aprons, spreaders and stretchers when formed without welding. Toe base gussets, drawer slides, and other metal work. Front top rails and back rails except top back rails may be 1.2 mm 18 gauge thick.reinforcing gussets, table legs, desk legs and aprons, spreaders and stretchers when formed without welding. Toe base gussets, drawer slides, and other metal work. Front top rails and back rails except top back rails may be 1.2 mm 18 gauge thick.	16	0.059
Drawer runners door tracks	14	1.88
Base unit bottom corner gussets and leg sockets	12	0.104
Reinforcement for hinge reinforcement inside doors and cabinets	12	3

2.3.4 Cabinets

Provide cabinets with sheet steel fronts, backs, sides, tops, and bottoms.

Form sides with rabbeted stiles 1-1/8-inches wide, closed by welded channel containing embossed louvers spaced 1-1/2-incheson center, for adjustable shelves.

Provide cabinets that have a steel channel-shaped top rail, 18-gauge steel cross rails, and Z-shaped rear rail to engage 16-gauge steel hanging bracket.

At base cabinets, provide 1-1/2-inch long leveling screws for adjusting to floor variations that are accessible through plugged openings in bottom; install 14-gauge gussets to support the screws.

At base cabinets, provide removable backs, knee space panels, or access doors where piping occurs.

2.3.5 Doors

Provide doors that are double-pan construction with 5/8-inch thick telescoped inner pan into outer pan with exposed vertical edge formed into channel shape having returned lip over inner pan and offset to receive lip.

Coat panels with 1/8-inch thick asphaltic sound deadener.

Fasten reinforcement for hardware attachment to inner pan and conceal.

Fit hinged doors with pairs of hinges, knob pulls, locks, and bumpers.

Bevel inside edge of cutout in front panel of glass door.

Set glass in continuous rubber gasket between panels.

Equip sliding doors with tracks, guides, bumpers, and bar pulls.

Additional considerations for doors:

a. Hollow metal type, flush and glazed doors not less than 5/8 inch thick.

b. Fabricate flush metal doors of two panels formed into pans with corners welded and ground smooth. Provide flush doors with a sound deadening core.

c. Fabricate glazed metal doors with reinforced frame and construct either from one piece of steel, or have separate stiles and rails mitered and welded at corners, and welds ground smooth.

(1) Secure removable glazing members with screws to back of doors.

(2) Install glass in rubber or plastic glazing channels.

d. Provide sheet steel hinge reinforcement inside doors.

e. Sliding doors: Provide stops to prevent bypass.

f. Doors removable without use of tools except where equipped with locks.

2.3.6 Drawers

Provide drawer fronts that are double-pan construction with 5/8-inch thick telescoped inner pan into outer pan with exposed vertical edge formed into channel shape having return lip over inner pan and offset to receive lip. Weld drawer bodies to front through flanges on sides and bottom, and to back through flanges at rear.

Extend flanges outward or downward, top of side, and backrolled.

Cove corners to 1/2-inch radius.

Provide drawer accessories including slides, bar pulls, lock and stop devices.

Additional considerations for drawers:

a. Drawer fronts flush hollow metal type not less than 5/8-inch thick with sound deadening core. Fabricate of two panels formed into pans. Weld and grind smooth corners of drawer fronts.

b. Form bodies from one piece of steel, weld to drawer front.

c. Provide reinforcement for locks and provide rubber bumpers at both sides of drawer head to cushion closing.

d. Equip with roller suspension guides.

2.3.7 Shelves

[Fabricate shelves from sheet steel with front and rear edges flanged down 3/4-inch and hemmed back at 30 degrees to underside of shelf.
][Fabricate shelves from corrosion-resistant steel sheet with front and rear edges flanged down 3/4-inch and hemmed back at 30 degrees to underside of shelf.

] Support shelves with 16-gauge shelf clips inserted in slots in front stile and in form channel in back.

Notch flanges at sides to match and engage with embossments on side panels.

Additional considerations for shelves:

a. Capable of supporting an evenly distributed minimum load of (twenty-five pounds per square foot) without visible distortion.

b. Flange shelves down 3/4-inch on edges, with front and bearing edges flanged back 1/2 inch.

c. For shelves over 42-inches in length and over 12 inches in depth install 1-1/2 x 1/2 x 0.0359 inch thick sheet steel hat channel reinforcement welded to underside midway between front and back and extending full length of shelf.

d. Weld shelves to metal back and ends unless shown adjustable.

e. Provide means of positive locking shelf in position, and to permit adjustment without use of tools.

f. On pharmacy on sloping shelf provide 1/2-inch wide clear acrylic plastic raised edge, 1/8-inch thick, secured to front edge of shelf.

2.3.8 Dustcover Tops

Provide front face height of 1-inch.

Slope dustcover tops upward 30 degrees from front to back of cabinet. Equip dustcover tops for attaching from inside of cabinet.

Additional considerations for sloping tops:

a. Provide sloping tops for casework where shown.

b. Where ceilings interfere with installation of sloping tops. Provide filler plates as specified.

c. Omit sloping tops or filler plates whenever ceiling material is turned down and furred-in at face of casework.

d. Provide exposed ends of sloping tops with flush closures.

e. Fasten sloping tops with sheet metal screws inserted from cabinet interior; space fastener as recommended by manufacturer.

2.3.9 Finish

Prime and factory finish steel cabinets with two coats of synthetic

enamel, baking quality, conforming to FS TT-E-489, Class B. Provide colors as selected.

2.3.10 Welded Cabinets

Conform to KCMA A161.1, all welded construction.

[2.3.11 Doors and Drawer Fronts

Doors and Drawer Fronts may be as specified for wood cabinets in lieu of metal pan construction.

]2.3.12 Undercounter Table and Bench Frames

Requirements for undercounter table and bench frames:

a. Using welded construction.

b. Open frame type with aprons and legs when required.

c. Aprons:

(1) Channels shaped welded at corners, with leg sockets and reinforcing triangular corner gussets welded in corners; 12301-9.

(2) Pierce sockets to receive leg bolts and notch gussets to receive legs.

(3) Upper flange perforated or slotted to receive screws at 8-inch centers, and back channels when installed against wall. Sizes lots for 1/4-inch anchor bolts.

(4) Pierce aprons to receive drawer formation, rail at top of drawer opening. Install channel shaped apron division welded at ends, 30-inches apart to front and back aprons, or at each side of drawer.

(5) Fabricate metal components from sheet steel.

(6) Use 0.0598-inch thick sheet for gussets and channel aprons.

(7) Use 0.0478-inch thick sheet for other items.

(8) At knee space, provide exposed metal sides and metal closure plate for soffit. Where shown at knee space, provide exposed metal back secured with continuous angle closures at both side.

d. Legs:

(1) Cold rolled tubing or 0.0598-inch formed steel.

(2) Leveling-anchoring device at floor.

(3) Stud bolt at top for attachment to leg socket.

e. Leg Braces:

(1) Tables and benches not anchored to walls.

(2) Brace back against front legs near bottom with steel angle channel or tubular braces.

(3) Fasten braces together with steel straps.

f. Leg Shoes:

(1) Fit laboratory casework legs at bottom with either stainless steel, aluminum, or chromium plated brass shoes, not less than one inch in height.

(2) Fit other legs with a movable molded vinyl shoe 4 inches high and coved at bottom.

2.3.13 Closures and Filler Strips at Pipe Spaces

Requirements for closures and filler strips at pipe spaces:

a. Flat steel strips or plates.

b. Openings less than 8-inches wide: 0.047-inch thick.

c. Openings more than 8-inches wide 0.359-inches wide.

[2.4 MISCELLANEOUS CABINETS

[2.4.1 Combination Sink-and-Base Cabinet

A combination sink-and-base cabinet unit may be furnished in lieu of the base cabinet and inset sink indicated provided the combination unit affords facilities and space equal to those indicated and provided the combination unit matches the adjacent units in materials and construction. Provide sink, with matching drainboards, made of [corrosion-resistant steel] [porcelain-enamel steel] and equipped with a chromium-plated [swinging-spout faucet, chromium-plated water-control valves,] [automatic faucet] and chromium-plated cup strainer. Make joints between sink and drainboard and between drainboard and counter top watertight.

][2.4.2 Special Purpose Cabinets

Provide special-purpose cabinets, such as cabinets for eye-level oven units, countertop range units, and built-in refrigerators as indicated[on the drawings,] and of the same materials and construction as adjacent cabinets. Provide space adjacent to sink for a dishwasher, as indicated.

]]2.5 ACCESSORIES AND HARDWARE

Furnish accessories such as utility shelves and racks for extracts, condiments, and towels; bins for sugar and flour; breadboxes; and trays for cutlery and flatware as indicated.

Provide corrosion resistant hardware. Provide exposed hardware with a chromium-plated finish or a corrosion-resistant finish as approved. Paint semi-concealed hinges on cabinets where paint finish is required to match the cabinets. Equip doors with [bullet-type catches] [spring hinges] [magnetic-type catches]. Provide door and drawer pulls as indicated.

2.6 CABINETS

The work includes providing new factory-finished kitchen wall and base cabinets with:

[a. High pressure decorative laminate (HPDL)

][b. Granite countertops

][c. Marble countertops

][d. Synthetic resins countertops

][e. ffrp countertops

][f. Stainless steel countertops

][g. Tile countertops

][h. [_____] custom countertops

] Bathroom vanity cabinets [with HPDL countertops][to receive combination lavatory-countertops as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE].

Provide cabinets conforming to KCMA A161.1, and bear the "KCMA Certified Cabinet" seal of the Kitchen Cabinet Manufacturers Association. Provide Countertops that conform to NEMA LD 3.1 and requirements specified herein.

2.6.1 Cabinet Locks

Requirements for cabinet locks:

a. Where locks are shown.

b. Locked pair of hinged door over 36 inches high:

(1) ANSI/BHMA A156.5, similar to E0261, key one side.

(2) On active leaf use three-point locking device, consisting of two steel rods and lever controlled cam at lock, to operate by lever having lock cylinder housed therein.

(3) On inactive leaf use dummy lever of same design.

(4) Provide keeper holes for locking device rods and cam.

(5) Use two point locking device both doors of cabinet 6D similar to ANSI/BHMA A156.5, E0251, key one side.

c. Door and Drawer: ANSI/BHMA A156.11 cam locks.

(1) Drawer and Hinged Door up to 36-inches high: E07261. 05-03M 12301-11

(2) Pin-tumbler, cylinder type lock with not less than four pins. Disc tumbler lock "duo A" with brass working parts and case, as manufactured by Illinois Lock Company are acceptable.

(3) Sliding Door: E07161.

d. Key locks differently for each type casework and master key for each service, such as Nursing Units, Psychiatric, Administrative, Pharmacy.

(1) Key drug locker inner door different from outer door.

(2) Provide two keys per lock.

(3) Provide six master keys per service or Nursing Unit.

e. Marking of Locks and Keys:

(1) Name of manufacturer, or trademark which can readily be identified legibly marked on each lock and key change number marked on exposed face of lock.

(2) Key change numbers stamped on keys.

(3) Key change numbers to provide sufficient information for manufacturer to replace key.

2.6.2 Cabinet Hardware

Comply with ANSI/BHMA A156.9.

Requirements for cabinet hardware:

a. Door/Drawer Pulls: B02011.

(1) One for drawers up to 23-inches wide.

(2) Two for drawers over 23-inches wide.

(3) Sliding door flush pull, each door: B02201.

[b. Door in seismic zones: B03352.

(1) Do not provide thumb latch on doors equipped with three point locking device.

(2) Use lever operated two point latching device on paired doors over 36-inches high if three point locking or latching device is not used.

] c. Cabinet Door Catch:

(1) Install at bottom of wall cabinets, top of base cabinets and top and bottom of full height cabinet doors over 48-inches.

(2) Omit on doors with locks.

d. Drawer Slides:

(1) Use B05051 for drawers over 6-inches deep.

(2) Use B05052 for drawers 3 to 6-inches deep.

~~(3) Use B05053 for drawers less than 3-inches deep.~~

2.3 FINISH

2.3.1 Cabinet Finish

Provide cabinets with a factory-applied durable finish in accordance with KCMA A161.1 requirements and of a type standard with the manufacturer.

2.4 COLOR, TEXTURE, AND PATTERN

Provide color ~~[in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.] [as indicated on the drawings.] [~~as selected from manufacturers standard colors, and approved by Government.~~] [[_____.]~~ Color listed is not intended to limit the selection of equal colors from other manufacturers.~~]~~

~~[2.5 DISPENSING TRAYS AND BINS~~

~~Requirements for dispensing trays and bins:~~

~~a. Design trays and bins to fit cabinets where shown.~~

~~b. Fabricate of steel, polypropylene, fiberglass reinforced polyester resin, or other suitable material.~~

~~c. Lock securely in place without the use of tools.~~

~~d. Fit at angle to provide gravity feed where shown.~~

~~e. Dispensing Trays:~~

~~(1) Equip trays with two longitudinal dividers adjustable to three position.~~

~~(2) Approximate dimensions: 6-inches in width 3-inches (in depth, and length to suit cabinets depth furnished.~~

~~f. Dispensing Bins:~~

~~(1) Open front, except for retaining rim. 05-03M 12301-14~~

~~(2) Approximate dimensions: 6-inches in width, 5-inches in depth, and length to suit cabinets furnished.~~

~~][2.6 ELECTRICAL FIXTURES~~

~~Requirements for dispensing electrical fixtures:~~

~~a. Comply with requirements of DIVISION 26 ELECTRICAL specifications for fixtures, receptacles, wiring and junction boxes required for fixtures and receptacles, included with casework.~~

~~b. Suitable for use with electrical system specified and shown.~~

~~c. Factory install in casework.~~

~~][2.7 SUSPENSION SYSTEM FOR INTERCHANGEABLE CASEWORK~~

~~Requirements for dispensing suspension systems for interchangeable casework:~~

~~a. Provide a suspension system for independent suspension of interchangeable under-counter cabinets and of countertops. Provide for removal or exchange of under counter cabinets of various heights, widths and types, and for vertical adjustment of counter tops to heights indicated on drawings.~~

~~b. Suspension Frames: Fabricate from 1-1/4-inch square or x 1-1/2-inch rectangular, 0.104-inch 12 gauge steel tubing welded to form full rectangle. Provide integral, adjustable leveling device in steel leg with non marring foot cap.~~

~~c. Provide mounting channels and support frames which allow for pipe chases and service channels when required.~~

~~d. Provide cabinets with a .059-inch steel shaped form welded across the entire width of back to engage a continuous slot in a wall mounting channel. Provide final positive location and locking of case in position with two fastening devices through case stile at front.~~

~~e. Paint all construction materials that are exposed.~~

~~][2.8 WHEELED CARRIER~~

~~Provide a wheeled carrier to facilitate installation, removal, and transport of interchangeable cases as part of the interchangeable [laboratory]furniture system.~~

~~]~~PART 3 EXECUTION

3.1 INSTALLATION

Install casework as described in manufacturers installation drawings in accordance with design intent.

a. Level base cabinets by adjusting leveling screws.

b. Secure cases permanently to floor and wall construction, where applicable.

c. Secure wall cases in position with screws to blocking, where applicable.

~~d. Bolt adjoining cases together.~~

~~e~~d. Align doors, adjust hardware, and clean surfaces.

3.1.1 Coordination

Before installing casework, verify wall and floor surfaces covered by casework have been finished.

~~Verify location and size of mechanical and electrical services as required.~~

Verify reinforcement of walls and partitions for support and anchorage of

casework.

3.1.2 Fastenings and Anchorage

Do not anchor to wood ground strips.

~~Provide hat shape metal spacers where fasteners span gaps or spaces 05-03M-12301-16.~~Comply with Manufacturer's installation requirements.

~~Use 1/4-inch diameter toggle or expansion bolts, or other appropriate size and type fastening device for securing casework to walls or floor. Use expansion bolts shields having holding power beyond tensile and shear strength of bolt and breaking strength of bolt head.~~

~~Use 1/4-inch diameter hex bolts for securing cabinets together.~~

~~Use 1/4-inch by minimum 1-1/2-inch length lag bolt anchorage to wood blocking for concealed fasteners.~~

~~Use not less than No. 12 or 14 wood screws with not less than 1-1/2-inch penetration into wood blocking.~~

~~Space fastening devices 12-inches on center with minimum of three fasteners in 3 or 4-foot unit width.~~

~~Anchor floor mounted cabinets with a minimum of four bolts through corner gussets. Anchor bolts may be combined with or separate from leveling device.~~

~~Secure cabinets in alignment with hex bolts or other internal fastener devices removable from interior of cabinets without special tools. Do not use fastener devices which require removal of tops for access.~~

~~Where units abut end to end anchor together at top and bottom of sides at front and back. Where units are back to back anchor backs together at corners with hex bolts placed inconspicuously inside casework.~~

~~Where type, size, or spacing of fastenings is not shown or specified, show on shop drawings proposed fastenings and method of installation.~~

~~3.1.3~~

3.2 CLEANING

Remove crating and packing materials from premises. Wipe down surfaces to remove fingerprints and markings and leave in clean condition.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspection

Examine casework grounds and supports for adequate anchorage, foreign material, moisture, and unevenness that could prevent quality casework installation. Ensure that electrical and plumbing rough-ins for casework are complete. Do not proceed with installation until defects are corrected.

-- End of Section --

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SECTION 12 36 00

COUNTERTOPS
08/16, CHG 2: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.1	(2016) Wood Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A1008/A1008M	(2021) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM F594	(2009; R 2020) Standard Specification for Stainless Steel Nuts
ASTM F836M	(2020) Standard Specification for Style 1 Stainless Steel Metric Nuts (Metric)

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2018) International Plumbing Code

KITCHEN CABINET MANUFACTURERS ASSOCIATION (KCMA)

KCMA A161.1	(2017) Performance & Construction

	Standards for Kitchen and Vanity Cabinets
SCIENTIFIC CERTIFICATION SYSTEMS (SCS)	
SCS	SCS Global Services (SCS) Indoor Advantage
SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)	
SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications
U.S. GENERAL SERVICES ADMINISTRATION (GSA)	
FS FF-S-325	(Basic; Int Amd 3; Notices 3, 4) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
FS MM-L-736	(Rev D; Notice 1; Notice 2) Lumber; Hardwood
UNDERWRITERS LABORATORIES (UL)	
UL 2818	(2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication~~; G[, [____]]~~

Installation Drawings~~; G[, [____]]~~

SD-03 Product Data

~~Plywood; G[, [____]]~~

~~Hardwood; G[, [____]]~~

~~Granite; G[, [____]]~~

~~Marble; G[, [____]]~~

~~Synthetic Resin~~Modified Epoxy Resin~~; G[, [____]]~~

Stainless Steel~~; G[, [____]]~~

~~[~~ Recycled Content for Stainless Steel Countertops; S

~~]~~ ~~Tile; G[, [____]]~~

~~FRP; G[, [____]]~~

Adhesives; G[, [_____]]

Filler Material; G[, [_____]]

Particle Board; G[, [_____]]

[Recycled Content for Particleboard; S

] Turpentine; G[, [_____]]

Varnish; G[, [_____]]

Fasteners; G[, [_____]]

Stainless Steel Sinks; G[, [_____]]

Service Fixtures; G[, [_____]]

Joint Sealants; G[, [_____]]

Softwoods; G[, [_____]]

Plastic Laminate; G[, [_____]]

[Indoor Air Quality for Laminate and Wood Member Adhesives; S

][Indoor Air Quality for Mounting and Stone Adhesives; S

] Indoor Air Quality for Joint Sealants; S

SD-04 Samples

Countertop; G[, [_____]]

Backsplash; G[, [_____]]

Manufacturer's Standard Color Charts; G[, [_____]]

SD-07 Certificates

Certified Sustainably Harvested Wood; S

[Indoor Air Quality for Countertop Products; S

][Indoor Air Quality for Particleboard; S

] SD-08 Manufacturer's Instructions

Manufacturer's Instructions

1.3 CERTIFICATIONS

[1.3.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD-01-001[, ATFS STANDARDS, CSA Z809-08, SFI 2015-2019, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify

~~certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.~~

~~]~~1.3.1 Indoor Air Quality Certification

Submit required indoor air quality certifications in one submittal package.

~~[~~1.3.1.1 Countertop Products

Provide countertop products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

~~][1.3.1.2 Composite Wood, Wood Structural Panel and Agrifiber Products~~

~~For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Provide products certified to meet emissions requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.~~

~~]~~1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle countertops ~~[~~and backsplash~~]~~ in a manner that will prevent damage and disfigurement.

~~Provide temporary skids under units weighing more than [_____] pounds.~~

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide the manufacturer's standard type countertops or as indicated on the drawings. Accomplish fastenings to permit removal and replacement of individual countertops without affecting the remainder of the installation.

Submit manufacturer's instructions for countertops including special provisions required to install equipment components and system packages. Include all special notices detailing impedances, hazards and safety precautions.

Submit manufacturer's standard color charts for countertops showing the manufacturer's recommended color and finish selections.

Provide countertop products certified to meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for countertop products.

2.1.1 Design

Provide factory fabricated, prefinished ~~[wood] [marble]~~Modified Epoxy Resin and ~~[~~stainless steel~~]~~ ~~[_____]~~ countertops in the manufacturer's

standard sizes and finishes of the type, design, and configuration indicated. Provide countertops as specified and meet the requirements of KCMA A161.1. Accomplish fastenings to permit removal and replacement of individual units without affecting the remainder of the installation. Provide counters with watertight sink rim when indicated. ~~Include removable drawers equipped with position stops to avoid accidental complete withdrawals.~~

2.2 FABRICATION

2.2.1 Countertop And Backsplash

Provide countertops and backsplash of ~~[plywood] [wood] [particle board] [Granite][Marble][Synthetic resin~~CT060 Modified Epoxy Resin~~][~~ and CT050 Stainless steel~~][Tile][FRP][_____] covered with a [shop-applied plastic laminate] [stainless steel] [an integral stainless steel top without backing][according to ANSI A161.2]~~.

CT050- Stainless steel countertops(combination of heavy-gauge type No. 304 stainless steel) having a smooth satin finish and integral 4" backsplash/ curb. Usage in areas where excellent ease of cleaning, abrasion resistance, bacteria resistance, impact resistance, load capacity and moisture resistance, are of concern. Refer to Contract Drawings for location.

CT060-Modified Epoxy Resin and splash blocks: Tops and curbs shall be molded from a modified epoxy resin that has been especially compounded and cured to provide optimum physical and chemical resistance required for a heavy duty laboratory working surface. Impregnated stone and/or furane resins are not equal. Tops and curbs shall be a uniform mixture throughout, and shall not depend on a surface coating that can be readily removed by chemical or physical abuse. Tops and curbs shall be non-glaring matte finish and black in color. Tops shall be a thickness as required with a drip groove provided on underside of all sink top exposed edges. All edges shall have a slight radius. Curbs shall be bonded to the surface on the top to form a square water-tight joint. All joints in tops to be bonded with an approved epoxy cement and shall be smooth and water-tight. Counters with integral splash blocks shall have a junction with a 3/4” radius, except around columns and special cutouts, which will have a standard bonded curb. Refer to Contract Drawings for location.

~~[Provide a water-resistant type plywood, Grade B-D Douglas fir plywood, with a minimum thickness of 3/4-inch.[Provide [plywood] [hardwood] [Granite][Marble][Synthetic resin][Stainless steel] [Tile] [FRP] [_____] backsplash 3/4-inch thick by the height indicated[, according to ANSI A161.2].]~~

~~][Provide particle board with a minimum thickness of 3/4-inch. Build up edges and opening around sink rim with hardwood strips. Provide backsplash of similar construction, a minimum of 3/4-inch[_____]thick by the height indicated.~~

~~] Provide steel no lighter than 22-gage stainless steel for backed construction and not lighter than 18-gage stainless steel for integral construction. Reinforce steel tops on edges and around sink-rim opening. Provide counters of one-piece construction; where stainless steel sink bowls are provided, weld and polish smooth all joints. Make joints between sink, countertop, and backsplash watertight. Provide backsplash of the same material as countertop and form with square edges, and height~~

as indicated.

Provide continuous sheet laminate of the longest length practicable and of the design and color selected. Provide joints in the surface sheeting that are tight and flush, and held to a practical minimum number.

Edging and trim:

a. For plastic-laminate-covered countertops and backsplash, provide edging and trim consisting of:

(1) Strips of laminate cut and fitted to exposed edges with contact adhesive

(2) Stainless steel molding applied to exposed edges and at the intersection of the top and backsplash with a concealed fastening system

(3) For stainless steel countertops and backsplash, form the edging and trim as an integral part of the top.

Provide sink rims when required which are the standard products of a manufacturer regularly producing this type of equipment, fabricated from stainless steel of the size necessary to receive the sinks. Refer to Div 22 Plumbing Sections for sink types and installation requirements.

[Include chopping block of the size and in the location indicated on the drawings, [portable type, of solid edge-grain clear [maple] [_____], minimum 3/4-inch thick, sized to fit on a suitable rack for storage][stationery type or built-up, edge-grain clear [maple] [_____], minimum 1-1/2-inches thick, installed in a countertop].

]2.2.1.1 High-Pressure Laminated Plastic Clad Countertops

Provide clad countertop and backsplash of[3/4-inch thick plywood] [or][3/4-inch thick, 44 pound density particle board core], [post formed cove type] [or] [fully formed type]. [Provide single unit cove type unit with self-edging and plastic laminate coved at the juncture of the countertop and backsplash.] [Provide fully formed type or square edge unit with shaped edges using wood nose molding at counter edge, including a separate backsplash not less than 3-1/2-inch high.] Provide edging and trim that consists of plastic laminate cut and fitted to all exposed edges. Supply end splashes constructed of 3/4-inch plywood or 3/4-inch thick, 44 pound density particle board core. Provide continuous sheets of longest lengths practicable. Make all joints in surface sheeting tight and flush. When the countertop and backsplash are two separate units, use GP50 plastic laminate. When the countertop and backsplash are one unit, use PF42 plastic laminate. Provide plastic laminate conforming to the requirements of ANSI/NEMA LD 3, with contact type plastic laminate adhesive applied to both surfaces. For fully formed and cove type countertops, the post-forming plastic laminate cannot be bent to a radius smaller than the limit recommended by the plastic manufacturer.

2.2.1.2 Solid Polymer Countertops

Provide countertop and backsplash [with integral [sink] [and] [lavatory]] [of sheet material for sink/lavatory cutout]; as shown, with [1/2] [3/4] [_____]-inch material thickness, cast, and filled nonporous solid surfacing composed of acrylic polymer, mineral fillers, and pigments.

~~Repair superficial damage, a depth of no more than 0.010-inch, by sanding or polishing. Use material conforming to the following performance requirements:~~

~~a. Tensile Strength; 4100 psi, when tested in accordance with ASTM D638.~~

~~b. Hardness; Barcol Impressor 50 when tested in accordance with ASTM D2583.~~

~~c. Flammability; rated Class I with a flame spread of 25 maximum and a smoke developed of 100 maximum when tested in accordance with ASTM E84.~~

~~d. Boiling water resistance; no effect when tested in accordance with ANSI/NEMA LD 3.~~

~~e. High temperature; no effect when tested in accordance with ANSI/NEMA LD 3.~~

~~f. Liquid absorption; 0.06 percent maximum (24 hours) when tested in accordance with ASTM D570.~~

~~g. Sanitation; National Sanitation Foundation approval for food contact in accordance with Standard 51 and approval for food area applications.~~

~~h. Impact resistance; no failure for ball drop when tested in accordance with ANSI/NEMA LD 3.~~

~~2.2.1.3 Solid Polyester Resin Cultured Marble Countertops~~

~~Provide countertop and backsplash [with integral [sink] [and] [lavatory]] [of sheet material for sink/lavatory cutout]; as shown. Use material of [1/2] [3/4] [_____]-inch thickness minimum, cast, and filled nonporous solid surfacing composed of polyester resin crushed marble, glass frit, mineral fillers and pigments. Material is to comply with IAPMO Z124.3 and the following performance requirement; Flammability: Class I, flame spread of 25 maximum, smoke developed of 100 maximum when tested in accordance with ASTM E84.~~

2.2.2 Color, Texture, and Pattern

Select color ~~[in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.] [~~as indicated on the drawings.~~] [from manufacturers standard colors.] [_____]~~ Color listed is not intended to limit the selection of equal colors from other manufacturers.

2.3 MATERIALS

~~[~~ Provide stainless steel conforming to ASTM A1008/A1008M and ASTM A167, Type ~~[302] [~~ 304~~] [316]~~ Finish 4. ~~[~~Stainless steel countertops and backsplashes must contain a minimum of ~~[40~~5~~][_____]~~ percent recycled content. Provide data identifying percentage of recycled content for stainless steel countertops.~~]~~

~~][~~Provide ~~[Douglas-fir] [_____]~~ plywood conforming to ICC IPC, exterior type, fully waterproof bond.

~~]~~ ~~Use thermosetting urea-resin Type II Adhesives for application of plastic laminate conforming to ASTM D4690 as recommended by the manufacturer of the laminate. Use adhesive for wood members conforming to ASTM D4689. Provide laminate and wood member adhesives meeting either emissions~~

~~requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for laminate and wood member adhesives.~~

~~Use filler material conforming to MPI 91.~~

~~[~~ Provide hardwood conforming to FS MM-L-736, standard hardwood lumber, S2S, and hardwood plywood conforming to ICC IPC.

~~[Wood materials must contain a minimum of [50][_____] percent certified sustainably harvested wood. Provide documentation that certified sustainably harvested wood is used and identify percentage.]~~

~~][Provide particle board conforming to CPA A208.1, Type 1, Grade M or medium density. Particleboard must contain a minimum of [50][_____] percent recycled content. Provide data identifying percentage of recycled content for particleboard. Particle board products must contain no added urea-formaldehyde resins. Provide certification of indoor air quality for particleboard.~~
~~]~~

~~Provide plastic laminate conforming to ANSI/NEMA LD 3, Style [_____], Type [_____], Grade [_____], Class [_____], Finish [_____].~~

~~Provide softwoods conforming to Voluntary Product Standard PS-20.~~

~~Provide turpentine conforming to ASTM D13.~~

~~Provide varnish conforming to MPI 28.~~

Provide fasteners conforming to the following:

a. Screws: ASME B18.6.1, Group, Type and Class as applicable

b. Anchoring Devices: FS FF-S-325, Group, Type, and Class as applicable

c. Toggle Bolts:

(1) Wings are two sheet-metal parts of "U" or channel shape. The wings are pivoted either on trunnion nuts or pins and are held normally in open position by a spring or springs placed inside the wing groove.

(2) Wing pivots are integral with the trunnion nuts used with the machine screw or threaded stud. Ensure the nut engages not less than two full threads of its screw or stud except in toggle bolts where the wing parts close on the bolt and lock it while being tightened, in which case one full thread engagement is permissible. The trunnion nuts are inserted in place with the pivots passed through the eyes in the wings.

d. Nuts: ASTM F594, stainless steel

e. Bolts: ASTM A325, heavy, hexagon head bolts stainless steel

f. Nuts: ASTM F836M, stainless steel

g. Bolts: ASTM A325M, heavy, hexagon head bolts stainless steel

~~Stainless Steel Sinks:~~

~~[a. 18-gage stainless steel, integral with corrosion-resistant steel countertop~~

~~][b. 18-gage stainless steel, nonintegral, self-rimming~~

~~] c. Drain holes in center of bowl~~

~~d. Underside coated with 1/8-inch thick sound deadener~~

~~e. Die-form, seamless, raised edges at front and ends~~

~~f. Cove corners to 1/2-inch radius~~

~~g. Equip with strainers and tail pieces~~

~~Sound deadening: Conform to CID A-A-59295.~~

~~Provide service fixtures conforming to the following requirements:~~

~~a. Fixtures: In accordance with the water conservation policy as stated in the Standard Plumbing Codes, Appendix J.~~

~~b. Faucets: Splashback mounted, cast brass, chrome plated, FS WW-P-541~~

~~c. Faucets: Deck mounted, cast brass, chrome plated, FS WW-P-541~~

~~d. Gas, air, and vacuum, distilled water, steam, and de-ionized water cocks: Cast brass, chrome plated, ground key type~~

~~e. Drains, strainers, and taps: Brass, chrome plated, FS WW-P-541~~

~~f. Index buttons: Plastic, color codes in accordance with SEFA 7~~

~~g. Special items: Nipples and locknuts with each fixture will be as directed.~~

~~[h. Metal pretreatment coatings: FS TT-C-490, Type I~~

~~][i. Metal pretreatment coatings: FS TT-C-490, Type II~~

~~][j. Metal pretreatment coatings: FS TT-C-490, Type III~~

~~][k. Enamel: Baked enamel~~

~~]~~2.4 MIXES

2.4.1 Adhesives

Provide mounting and stone adhesives meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for mounting and stone adhesives.

2.4.1.1 Mounting Adhesives

Provide structural-grade silicone or epoxy adhesives of type recommended

by manufacturer for application and conditions of use.

Provide spacers, if required, of type recommended by adhesive manufacturer.

~~2.4.1.2 Stone Adhesive~~

~~Provide epoxy or polyester adhesive of type recommend by manufacturer for application and conditions of use.~~

~~If adhesive will be visible in finished work, tint adhesive to match surfacing.~~

2.4.2 Joint Sealants

Use clear silicone sealant of type recommended by manufacturer for application and conditions of use. Provide joint sealant products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for joint sealants.

~~Provide anti-bacterial type in [[toilet][and][bath] rooms,][food preparation areas,][and][_____].~~

PART 3 EXECUTION

3.1 INSTALLATION

Inspect material for defects prior to installation. Ensure materials throughout bear labels with the same batch number. Visually inspect materials used for adjacent pieces to assure acceptable color match. Inspect in lighting conditions similar to those on the project. Repair or replace damaged materials.

Install countertops plumb with cabinetry level to within 1/16-inch in 10-feet. Level base cabinets by adjusting leveling screws. Scribe and fit scribe strips to irregularities of adjacent surfaces. Gap openings exceeding 0.025-inch are not acceptable.

~~Secure countertops to cabinetry and wall construction using[1/4-inch diameter masonry anchors][_____], spaced[30-inches][_____] maximum on center.~~

Submit installation drawings for countertops. Ensure drawings include location of cabinets, details of cabinets related and dimensional positions, and locations for roughing in plumbing, including sinks, faucets, strainers and cocks.

3.1.1 Preliminary Installation and Adjustment

Install materials in accordance to manufacturer's recommendations. Lift and place to avoid breakage.

Position materials to verify that materials are correctly sized and prepared. Make necessary adjustments.

If jobsite cutting, grinding, or polishing is required, use water-cooled tools. Protect jobsite and surfaces against dust and water. Perform work away from installation site if possible.

[Gypsum drywall back walls [which are not [fire][or][acoustically] rated] may be routed up to half the thickness of the drywall to allow countertop to fit.

]Shim countertop drainage [adjacent to sinks][and][where drainage is required], slightly to insure positive drainage.

]3.1.2 Surfacing

3.1.2.1 Laminated Plastic Surfacing

Laminate plastic sheeting to faces and exposed edges of particle board at 20 pounds per square inch and 185 degrees F.

Apply backing sheet to concealed faces.

3.1.2.2 Stainless Steel Surfacing

Form counters and work surfaces of 16-gage sheets with exposed edges returned.

Use hat-shaped channels, 16-gage, for reinforcement, spaced 30-inches on center.

Equip surfaces with wood strips under edges for fastening to cabinets.

Cove internal corners to 1/2-inch radius.

Coat underside with 1/8-inch thick sound deadener.

Electrically weld all joints, grind smooth, and polish to match adjacent finish.

[3.1.2.3 Wood Countertop Finish

Provide factory applied [stained wood] [clear coated natural finish] [or] [HPDL] finish [as indicated] on all internal and external surfaces.

[a. Stained Wood Finish

[As selected from manufacturer's standard finishes] [As indicated]. Internal surfaces need to receive at least one coat of finish material.

][b. HPDL Finish

Pattern and color: [As selected from manufacturer's standard finishes][As indicated].

]]3.1.3 Permanent Installation

After verifying fit, remove quartz surfacing from position, clean substrates of dust and contamination, and clean quartz surfacing back side and joints with solvent.

Apply sufficient quantity of mounting adhesive in accordance with adhesive manufacturer's recommendations to provide permanent, secure installation.

Spacing of mounting adhesive will not exceed:

a. Horizontal Surfaces: [_____]-inch on center

b. Vertical Surfaces: [_____]-inch on center; provide temporary shims until adhesive cures.

[Fasteners][Grout][Hardware]: [_____]

Install surfacing plumb, level, and square and flat to within 1/6-inch in 10-feet.

3.1.4 Joints

Ensure joints between adjacent pieces of quartz surfacing are:

a. Flush, tight fitting, level, and neat.

b. Securely joined with stone adhesive. Fill joints level with quartz surfacing.

Clamp or brace quartz surfacing in position until adhesive sets.

Seal joints [between backsplashes and countertops][and][around [tub][and][shower] enclosures] with silicone sealer.

3.2 FIELD QUALITY CONTROL

Examine casework grounds and supports for adequate anchorage, foreign material, moisture, and unevenness that could prevent quality casework installation.

Ensure that electrical and plumbing rough-ins for casework are complete. Do not proceed with installation until defects are corrected.

3.3 ADJUSTING AND CLEANING

3.3.1 Solvent

Use a product recommended by adhesive manufacturer to clean surface of quartz surfacing to assure adhesion of adhesives [and sealants].

3.3.2 Cleaning Agents

Use non-abrasive, soft-scrub type kitchen cleaners.

3.3.3 Cleaning

On completion of cabinet installation, touch up marred or abraded finished surfaces. Remove crating and packing materials from premises. Wipe down surfaces to remove fingerprints and markings and leave in clean condition.

-- End of Section --

SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2020) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D2047	(2017) Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
ASTM E648	(2019a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUSTAINABILITY REPORTING

Materials in this technical specification may increase contract compliance with sustainability requirements.

1.2.1 EPA Comprehensive Procurement Guidelines

See Section 01 33 29 SUSTAINABILITY REPORTING for requirements associated with EPA-designated products.

~~1.2.2 USDA Biobased~~

~~See Section 01 33 29 SUSTAINABILITY REPORTING for requirements associated with USDA Biobased products.~~

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings~~; G[, [____]]~~

Detail Drawings~~; G[, [____]]~~

~~Custom Graphics Drawings; G[, [____]]~~

SD-03 Product Data

Entrance Floor Mats and Frames~~; G[, [____]]~~

Adhesives and Concrete Primers~~; G[, [____]]~~

SD-04 Samples

Entrance Floor Mats and Frames; G~~[, [____]]~~

~~Custom Graphics; G[, [____]]~~

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Protection, Maintenance, and Repair Information

1.4 QUALITY CONTROL

Comply with 36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines for installed entrance floor mats and frames. Ensure that entrance floor mats and frames are slip-resistant in accordance with ASTM D2047, with a minimum 0.60 coefficient of friction, for accessible routes and are structurally capable of withstanding a ~~[uniform floor load of 300 lb/sq ft][~~wheel load of 350 lb/wheel~~]~~. Ensure that flammability is in accordance with ASTM E648, Class 1, Critical Radiant Flux, minimum 0.45 watts/square meter. ~~.~~

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in their original packages or containers bearing labels clearly identifying the manufacturer, brand name, and quality or grade.

Store materials in their original unbroken packages or containers in the area in which they will be installed. Unwrap, inspect, and place mats at indicated locations. Remove all excess packing materials.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

2.1.1 Entrance Floor Mats and Frames

Submit the manufacturer's catalog data. Submit samples of assembled sections of floor mats showing corners, intersections, and other details

of construction. Submit samples of ~~custom graphics,~~ exposed floor mats, frame finishes and accessories. Provide surface mounted metal floor mat system with carpet inserts. Provide carpet inserts complying with UFC 4-510-01 Appendix B TARR Rating. Per UFC 4-510-01Carpet Tile must meet TARR (Texture Appearance Retention Rating) classification ratings based on location areas where it is being used. Reference the Carpet and Rug Institute (CRI) Fact Sheet for more information. For entrance areas TARR Classification shall be equal or larger than 3.5.

~~2.1.1.1 Resilient-Link Mats~~

~~Provide [rubber][vinyl][rubber-tire] resilient-link mats, [3/8][7/16] inch thick with [galvanized-spring][stainless] steel wire link rods. Ensure that nosing is vulcanized and [beveled for surface installation extending approximately 2 inches around the perimeter][square for recess or mats butted one to another]. Provide mats with steel-reinforced end trim that is [close-weave with link openings of 1/16 inch by 1/2 inch][open-weave with link openings of 1 1/2 inches by 1/2 inch].~~

~~2.1.1.2 [Rubber][Vinyl] Mats~~

~~Provide mats [1/4][3/8][1/16][_____] inches thick with [square edges for recessed installations][beveled edges for surface applications]. Provide mats with [solid sheet (no perforations) style] [perforated style, 1/4-inch diameter on standard spacing] [perforated style, 3/16 inch by 3/4 inch on standard spacing][standard pyramid design with knob back][standard wide-wale corrugated][hi-rib, narrow-wale corrugated] top profile and [low-rib, narrow-wale corrugated][standard knob-base][flat-base] bottom surface. Ensure that mats are made of a nonslip prime-quality compound free of calendaring and curing defects, and resistant to weather aging and ozone in normal concentrations.~~

~~2.1.1.3 Coco Mats~~

~~Provide coco brush mats made of high-quality coir yarn from coconut husk fibers. Secure mats with a heavy-duty vinyl backing, woven tightly together and securely bound around the perimeter with matching coir yarn rope. Overall thickness is [5/8 inch][3/4 inch][1 inch][1 1/4 inches].~~

~~2.1.1.4 Recycled Rubber Tire [Tiles][Mats]~~

~~Provide recycled rubber tire [tiles] [mats] that are made from recycled truck, bus and aircraft tires, with sidewall cords and are buffed to a chenille finish. Ensure that the [tiles] [mats] are bonded to a woven flexible backing to form 3/8- to 7/16- inch-thick[12-inch -wide tiles][12-inch-wide rolls up to 25 feet long].~~

~~2.1.1.5 Carpet-Type Mats~~

~~Provide a [nylon][polypropylene][olefin][polyester][____] carpet bonded to a 1/8-inch to 1/4-inch-thick, flexible vinyl backing to form mats that are [3/8][7/16] inch thick with nonraveling edges.~~

~~2.1.1.6 Loop Filament Mats~~

~~Provide loop filament vinyl material [3/8][1/2] inch thick, with [solid vinyl sheet] [foam sheet] backing. Ensure that chemical agents are built into the backing to reduce fungus and mildew.~~

~~2.1.1.7 Roll-Up Mats~~

~~Provide roll-up mats with [mill finish] [[clear][bronze]] [black] [anodized] [_____] aluminum tread rails spaced a maximum 2 inches on center and running counter to the traffic flow. Ensure that the mats must allow debris to fall to subfloor. Ensure that tread rails are connected by [aluminum] [vinyl] hinges and include [an aluminum] [a vinyl] edge around the perimeter and a continuous vinyl cushion.~~

~~Provide [recessed] [surface] mats mounted with [carpet consisting of nylon or polypropylene carpet fibers fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Carpet has antistatic and antistain treatments] [carpet/bristle filament mix] [vinyl] [abrasive tape] [poured abrasive] [recycled rubber] [serrated aluminum] [_____] inserts.~~

~~2.1.1.8 Floor Grids~~

~~Provide a floor grid consisting of a series of [aluminum][bronze] tread rails spaced [1 1/2] [_____] inches on center and running counter to the traffic flow. Ensure that floor grids allow debris to fall to the subfloor. Provide a [drain pan] [trench drain] [_____] deep. Rest grid assemblies on a continuous vinyl cushion mounted to each continuous foot at [_____] on center. [Ensure that pits are [_____] deep and rest on a continuous vinyl cushion with additional support members [_____] on center, including adjustable support legs.] [Provide a drain pan to include a drain and a stainless-steel strainer.] For a [stainless-steel grid, provide satin-finished stainless-steel rails [_____] apart, electronically welded joints, and a stainless-steel frame [_____] deep.] Provide all anchors, fasteners, accessories, and other parts required for a complete installation.~~

2.1.1.1 Frames and Inserts

~~[Provide surface-mounted frames that have a tapered flexible vinyl edge at least [2][1 1/2] inches wide, with welded corners and attached to the mat at all four edges.] [Ensure that surface-mounted frames are tapered, at least [2][1 1/2] inches wide, screwed into an opening in the floor to create an opening for the mat to sit in.]~~ [Provide recessed or surface mounted frames in extruded aluminum Alloy 6061-T6 or Alloy 6063-T5 ASTM B221~~.~~. Provide surface mounted metal floor mat system. The frame depth shall vary from 1/4" to 1/2" tapered. The frame inserts shall be carpet, Refer to Contract Drawings for type, pattern, and size. Ensure that the frame depth accommodates the mat and system specified.~~]~~ Frame color is ~~[~~mill finish~~] [clear] [black] [[light] [medium] [dark] bronze] [_____]~~. Ensure that edge-frame members are fabricated in single lengths or with the fewest pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins. Ensure that any concealed surfaces of aluminum frames that contact cementous material are coated with the manufacturer's standard protective coating. Ensure that frames include accessories and devices required for a complete installation. ~~.~~

~~2.1.1.2 Tread Insert Options~~

~~Provide tread inserts consisting of [carpet composed of solution-dyed nylon or polypropylene carpet fibers fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths; carpet has antistatic and antistain treatments. Ensure that pile weight~~

~~is a minimum 30 ounces per square yard] [carpet/bristle filament mix] [vinyl] [abrasive tape] [poured abrasive] [recycled rubber] [serrated aluminum] [_____].~~

2.1.2 Adhesives and Concrete Primers

Provide adhesives and concrete primers, where required, according to the manufacturer's recommendations.

~~2.1.3 Graphics~~

~~Clearly illustrate details in drawing of custom graphic [emblem] [logo][design].~~

2.1.3 Color and Size

Ensure that color is in accordance with ~~[Section 09 06 00 SCHEDULES FOR FINISHES]~~[the drawings~~]~~[~~_____~~]. Ensure that the size of mat is ~~[_____]~~[as indicated~~]~~.

PART 3 EXECUTION

3.1 EXAMINATION

Comply with the manufacturer's requirements for substrates and floor conditions affecting installation of floor mats and frames. Ensure that all unsatisfactory conditions have been corrected before installation.

3.2 INSTALLATION

Submit detail drawings, ~~and custom graphics drawings~~ as required. Provide installation drawings. Provide the manufacturer's protection, maintenance, and repair information.

Install floor mats and frames according to manufacturer's instructions. Set mat tops at the height recommended by the manufacturer for the most effective cleaning action. Provide clearance between bottoms of doors and tops of mats. ~~[~~Coordinate recess frame installation with concrete construction to ensure that frame anchorage is correct and that the base is level and flat. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.~~]~~

-- End of Section --

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SECTION 12 93 00

SITE FURNISHINGS
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2014) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1064/A1064M	(2017) Standard Specification for

	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM C94/C94M	(2018) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2018) Standard Specification for Portland Cement
ASTM D3451	(2006; R 2017) Standard Guide for Testing Coating Powders and Powder Coatings

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for ~~[~~Contractor Quality Control approval.~~]~~ ~~[information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section ~~01 33 29~~01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

~~SD-02 Shop Drawings~~

~~Benches and Chairs; G~~

~~Tables; G~~

~~Shelters; G~~

~~Bicycle Racks; G~~

~~Planters; G~~

~~Bollards; G~~

~~Tree Grates; G~~

~~Assembly Instruction Drawings~~

SD-03 Product Data

Benches~~ and Chairs~~

~~Tables~~

Shelters

Bicycle Racks
Planters
Bollards
Tree Grates

Recycled Content for steel components; S

Recycled Content for aluminum components; S

Recycled Content for HDPE components; S
Waste Receptacles Recycling Receptacles

SD-04 Samples

Finish; G

SD-06 Test Reports

Testing

SD-07 Certificates

Primer Certificate

Powder Coatings Certificate
Certified Sustainably Harvested lumber; S]

[Certified Sustainably Harvested wood for wood seats and table tops; S]

[Certified Sustainably Harvested wood for wood benches and chairs; S]

[Certified Sustainably Harvested wood for wood containers; S]

[Certified Sustainably Harvested wood for wood shelters; S]

[Certified Sustainably Harvested wood for wood tables; S]

1.3 CERTIFICATIONS

1.3.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-08, SFI 2015-2019, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Provide current product certification documentation from certification body. Submit copies of invoices bearing certification numbers.

1.3 QUALITY ASSURANCE

Qualify welders in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

~~1.3.1 Fabrication Drawings~~

~~Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.~~

1.3.1 Installation Drawings

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation.

1.3.2 Assembly Instruction Drawings

Submit assembly instruction drawings showing layout(s), connections, bolting and anchoring details in accordance with manufacturer's standards. Submit drawings showing scaled details of proposed site furnishings, elevations for each type of site furnishing; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction.

1.3.3 Primer Certificate

Submit a certificate from the manufacturer stating that the primer conforms to requirements of SSPC Paint 25.

1.3.4 Powder Coatings Certificate

Submit a certificate from the manufacturer stating that the powder coat conforms to ASTM D3451.

1.4 DELIVERY, STORAGE, AND HANDLING

Ship items knocked-down (KD) ready for site assembly. Packaged components must be complete including all accessories and hardware. Materials must be delivered, handled, and stored in accordance with the manufacturer's recommendations. Site furnishings must be inspected upon arrival at the job site for conformity to specifications and quality in accordance with paragraph MATERIALS. Protect from corrosion, staining, and other types of damage. Store items in designated area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of such products. The materials provided shall be of a type with proven satisfactory usage for at least 2 years.

2.1.1 Metals

Metallic materials and products must conform to Section 08 31 00 ACCESS DOORS AND PANELS. Furnish metal components with factory drilled holes and

free of excess weld and spatter. Metal components with holes that will not be filled by hardware or hidden by other components will be rejected. Structural steel products must conform to ASTM A36/A36M, ASTM A500/A500M and ASTM A501/A501M. Provide Steel Components with a minimum of 70 percent recycled content. Provide data identifying percentage of recycled content for steel components.

~~2.1.2 Structural Tubing~~

~~ASTM A500/A500M~~

2.1.2 Steel Pipe and Fittings

Steel pipe must conform to ASTM A53/A53M, Type E or S, Grade B; standard malleable iron fittings must conform to ASTM A47/A47M.

~~2.1.3 Gray Cast Iron~~

~~Gray cast iron must conform to ASTM A48/A48M Class 35 or better. Provide castings manufactured true to pattern and component parts that fit together in a satisfactory manner. Castings must be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. Smooth castings must be well-cleaned by sand or shot blasting.~~

2.1.3 Aluminum Products

Provide Aluminum Components with a minimum of 50 percent total recycled content. Provide data identifying percentage of recycled content for aluminum components

2.1.4 Cast Aluminum

Cast aluminum must conform to ASTM B26/B26M and ASTM B108/B108M. Provide castings manufactured true to pattern and component parts that fit together in a satisfactory manner. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. Smooth castings must be well-cleaned by sand or shot blasting.

~~2.1.5 Aluminum Alloy Products~~

~~Conform to ASTM B209 for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.~~

2.1.5 Anchors and Hardware

Provide anchors, where necessary, for fastening site furnishings securely in place and in accordance with approved manufacturer's instructions. Anchoring devices that may be used, when no anchors are otherwise specified or indicated, include anchor bolts, slotted inserts, expansion shields for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; and lag bolts and screws for wood. Anchor bolts must conform to ASTM A307. Hardware must be ~~[stainless steel] [brass] [zinc-plated][zinc-chromate plated] [or] [~~galvanized steel~~]~~ in accordance with ASTM A153/A153M and compatible with the material to which applied. All exposed hardware must match in color and finish. Mounting hardware must be concealed, recessed, and plugged.

~~2.1.5.1 Threaded Inserts and Expansion Anchors~~

~~Provide inserts recessed not less than [2.5] [_____] inches into concrete or masonry. Pullout [198] [_____] pounds in concrete with f'c of 3,000 psi, as tested in accordance with ASTM E488/E488M. Expansion shields must conform to CID A-A-1925, group II, type 4, class 1. Provide embedment required by manufacturer.~~

~~2.1.5.2 Lag Screws and Bolts~~

~~ASME B18.2.1, type and grade best suited for the purpose.~~

~~2.1.5.3 Toggle Bolts~~

~~ASME B18.2.1.~~

~~2.1.5.4 Bolts, Nuts, Studs and Rivets~~

~~ASME B18.2.2 or ASTM A307.~~

~~2.1.5.5 Power Driven Fasteners~~

~~Follow safety provisions of ASSP A10.3.~~

~~2.1.5.6 Screws~~

~~ASME B18.2.1, ASME B18.6.2, and ASME B18.6.3.~~

~~2.1.5.7 Washers~~

~~Provide plain washers to conform to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.1.~~

~~2.1.6 Ounce Metals~~

~~Bronze, copper, and other ounce metals must conform to ASTM B62.~~

2.1.6 Concrete

Ready-mixed concrete must conform to ASTM C94/C94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Portland cement must conform to ASTM C150/C150M. Cast-in-place concrete materials and products must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE. ~~Precast concrete material and products must conform to Section 03 45 33 PRECAST[PRESTRESSED] STRUCTURAL CONCRETE.~~ Reinforcing steel must conform to ASTM A615/A615M. Welded wire fabric must conform to ASTM A1064/A1064M.

~~2.1.7 Masonry~~

~~Masonry material and products must conform to Section 04 20 00 UNIT MASONRY~~

~~2.1.8 Tempered Glass~~

~~ASTM C1048, Kind FT (fully tempered), condition A (uncoated), Type 1 (transparent, Quality q3, [1/4] [_____] inch thick, [clear] [bronze] [_____] in color.~~

2.1.9 Plastics

Provide High Density Polyethylene (HDPE) Components with a minimum of 90 percent total recycled content. Provide data identifying percentage of recycled content for HDPE components. Recycled materials must be constructed or manufactured with a maximum 1/4 inch deflection or creep in any member in conformance with ASTM D2990. Provide panels and components molded of ultraviolet (UV) and color stabilized polyethylene, with minimum 1/4 inch wall thickness; exposed edges must be smoothed, rounded, and free of burrs and points; and the material must be resistant to fading, cracking, fogging, and shattering. The material must be non-toxic and have no discernible contaminates such as paper, foil, or wood. The material must contain no more than 3 percent air voids and be resistant to deformation from solar radiation heat gain. Recycled materials to include plastic lumber will not be used as structural components of site furnishings. Submit a report of site furnishing parts consisting of recycled materials. Product specification data, providing test information for deflection and creep in accordance with ASTM D2990 for site furnishings which use plastic lumber as a component, must be submitted. Provide data for comparison of deflection and creep measurements to other comparable materials.

2.1.9.1 Extruded Acrylic Sheet

ASTM D4802 [Type I, regular] [Type II, heat resistant] [1/4] [_____] inch thick, [clear] [_____] in color.

2.1.9.2 Cast Acrylic Sheet

ASTM D4802, Item A, [Type I, Heat resistant and ultraviolet light absorbing] [Type II, heat resistant], 1/4 inch thick, [clear] [bronze] [_____] in color.

2.1.10 Lumber

Provide premium grade wood free of knots; boards with eased edges and ends; and wood components with factory drilled holes. Components with holes that will not be filled by hardware or hidden by other components will be rejected. Wood products must be selected to withstand the climatic conditions of the region in which the site is located.

[Provide certified sustainably harvested lumber.]

Lumber grades must meet manufacturers standards of the grading rules under which they are manufactured. Where no standards exist the following must be the minimum acceptable grades for species used.

a. WWPA G-5 grading rules, [Douglas Fir] [Western Cedars],[Choice & Btr,] [Select or A & Btr.] in accordance with special western red cedar rules.

b. WCLIB 17 standard grading rules, [Douglas Fir] [Western Cedars], A & Btr.

c. SPIB 1003 grading rules, Southern Pine, C & Btr.

d. NHLA Rules standard specification, Cypress, C-Select.

e. RIS Grade Use standard specifications, Redwood, [Clear] [Clear All Heart].

f. NHLA Rules rules, [Cypress] [Teak], [B Finish] [Select or Btr.].

2.1.10.1 Moisture Content

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery must be in accordance with manufacturers standard. If no manufacturer's standard exists, then moisture content must be based on requirements for the product, grade and intended use.

2.1.10.2 Treatment

Wood that is not naturally rot and insect resistant must be treated in accordance with AWPA U1, as applicable, and inspected in accordance with AWPA M2. Provide treatment of wood in accordance with ASTM F1487.

2.1.10.3 Wood Seats and Table Tops

Clear teak, maple, oak, Jarrah, Ipe or other suitable hardwood, not less than 1-5/8 inches thick with rounded edges.

[Provide certified sustainably harvested wood for wood seats and table tops.]

2.1.11 Fiberglass

Fiberglass must consist of at least 3 laminations of chopped glass fibers impregnated with polyester resin, with colors and textures molded into all exposed surfaces so that colors resist fading. Fiberglass must be resistant to cleaners, fertilizers, high power spray and salt.

2.2 PRETREATMENT, PRIMING AND PAINTING

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. [On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.]

2.2.1 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.2 Aluminum Surfaces

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2 COATINGS AND FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing must conform to ASTM A123/A123M,

~~ASTM A153/A153M or ASTM A653/A653M, as applicable. Tailings and sharp protrusions formed as a result of the hot-dip process must be removed and exposed edges burnished. Galvanize anchor bolts, grating fasteners, washers and parts or devices necessary for proper installation, unless otherwise indicated.~~

~~2.2.2 Polyester Powder~~

~~Powder-coated surfaces must receive electrostatic zinc coating prior to painting. Powder coating must be electrostatically applied and oven cured. Polyester powder coating must be resistant to ultraviolet (UV) light.~~

~~2.2.3 Polyvinyl-Chloride (PVC)~~

~~PVC coating must be primed with a clear acrylic thermosetting solution. The primed parts must be preheated prior to dipping. The liquid polyvinyl chloride must be ultraviolet (UV) stabilized and mold-resistant. The coated parts must be cured. The coating must be a minimum 2/25 inches thick plus or minus 0.020 inches and must have an 85 durometer hardness with a slip-resistant finish.~~

2.2.1 Finish

Finish must be as specified by the manufacturer or as indicated. ~~Exposed surfaces and edges must be rounded, polished, or sanded.~~ Finish must be non-toxic, non-glare, and resistant to corrosion. ~~Exposed surfaces must be smooth and splinter-free exposed surfaces.~~ Submit one~~[two] [_____]~~ set~~s~~ of color data for each furnishing displaying manufacturer's color selections and finishes, and identifying those colors and finishes proposed for use.

~~2.2.1.1 Wood Sealants~~

~~Exposed wood surfaces must have, as a minimum, two shop coats of paint, varnish, sealer, or other approved preservative. Sealants must seal all applied surfaces from air.~~

2.2.1.1 Paint

Paint must be factory applied with a minimum of 2 coats. Paint must be weather-resistant and resistant to cracking, peeling and fading.

2.2.1.2 Color

Color ~~of site furnishing components must be in accordance with Section 09 06 00 SCHEDULES FOR FINISHES~~to be selected by DOR and approved by the Government.

2.3 SITE STANDARDS

Site furnishings must be furnished with the dimensions and requirements indicated. ~~Site furnishings placed in children's outdoor play areas must meet the safety requirements of ASTM F1487 for entrapment; sharp points, edges, and protrusions; entanglement; pinch, crush, and shear points. Site furnishings to be included in children's outdoor play areas must be free from sharp vertical edges and any protruding elements and designed with a minimum radius of 1/2 inch on all vertical edges; this includes, but is not limited to, seat walls, containment curbs and planters. Where~~

practical, horizontal edges exposed to children's activities must be rounded.

2.4 BENCHES AND CHAIRS

Provide benches as indicated on plans Furnish benches and chairs with no sharp edges or protruding hardware.

a. Height: The height above finished grade or specified surface must be between 18-20 inches and level.

b. Seat: The seat surface must be pitched or slotted to shed water; the seat depth must be between 12-18 inches and pitched down at the back at a 0-5 degree angle. Seat must have a minimum width of 24 inches per person, and must overhang the support base by a minimum of 4 inches for heel space and to facilitate rising from a seating position.

c. Back Rest: When back rests are required, the height must be between 15-18 inches from the top of the seat and the connection must be at a 90-110 degree angle to the seat.

d. Arm Rest: When arm rests are required, a minimum of 6 inches height from the seat and a minimum arm rest width of 1-1/2 inches must be provided.

e. Weight Limit: Seats must support a minimum 300 lbs for each person they are designed to accommodate.

[2.4.1 Precast Units

Design precast units in accordance with manufacturer's standards, size as indicated. Finish and color as indicated selected from manufacturer's standards.

[2.4.1.1 Glass Fiber Reinforced Concrete (GFRC) Units

Provide glass fiber reinforced concrete (GFRC) units at locations indicated on the drawings. Comply with PCI MNL-128 recommended practice for glass fiber reinforced concrete, including Appendix G, Polymer Modified Glass Fiber Reinforced Concrete Panels.

a. Design precast benches to sustain a live load of not less than 200 pounds per square foot.

b. Provide ASTM C150/C150M cement, use only one brand and type of cement throughout project.

c. Provide alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete, minimum three percent glass fiber content.

d. Provide clear silica sand aggregate passing No. 16 sieve; washed, dried and free from deleterious materials. Provide type with successful history of uses in GFRC fabrication standard with the manufacturer.

e. Provide 3000 psi concrete, 28 day minimum compressive strength with approximately 120 pcf density; shell thickness of 3/8 to 5/8 inch.

f. Provide manufacturer's standard acrylic thermoplastic copolymer admixture.

g. Provide factory finished units standard with the manufacturer; texture and color as selected.

(1) Provide white or grey cement consistent with final finish.

(2) Provide ASTM C33/C33M (less gradation) facing aggregates, clean, hard, durable, inert and free of staining and deleterious materials; as required to match approved samples.

(3) Provide color meeting ASTM C979/C979M, pure, non-fading mineral oxides, maximum ten percent cement weight; as required to match approved samples without impairing strength of GFRC.

(4) Apply finish meeting ASTM D4060 waterborne crosslinked acrylic 49.5 +/- two percent solids by weight providing 1000 cycles per 0.001 inch resistance to abrasion.

h. Prefabricate units within following maximum fabrication tolerances.

(1) Dimension: Plus or minus 1/8 inch in any direction, noncumulative.

(2) Material Thickness: Plus 1/4 inch and minus 0-inch.

(3) Total Unit Thickness: Plus 1/4 inch and minus 1/8 inch.

(4) Insert Locations: Plus or minus 1/4 inch.

][2.4.1.2 Precast Concrete/Cast Stone Units

Provide reinforced precast concrete units consisting of a mixture of cement, aggregates and mineral colors suitable for exterior use, located as indicated. Design benches to sustain a live load of not less than 200 pounds per square foot.

2.4.1.2.1 Portland Cement

ASTM C150/C150M Type I II or III

2.4.1.2.2 Aggregate

ASTM C33/C33M, maximum size 3/4 inch

2.4.1.2.3 Reinforcing Steel

ASTM A615/A615M

2.4.1.2.4 Galvanized Wire Mesh

ASTM A1064/A1064M

2.4.1.2.5 Integral Color

ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

2.4.1.2.6 Concrete Strength

Provide minimum 5000 psi 28 day compressive strength concrete, maximum five percent absorption.

2.4.1.2.7 Admixture

ASTM C260/C260M for air-entraining

]][2.4.2 Wood Units

Provide manufacturer's standard wood units with wood, metal, fiberglass or concrete pedestals as indicated. Provide fasteners and accessories required for onsite assembly. Kiln dry and pressure treat wood components to manufacturer's standards. Pre-treat metal components and provide manufacturer's standard primer and powder coat finish complying with ASTM D3451, color as selected. Provide fiberglass non-fading gel coat color as indicated. Provide manufacturer's standard exposed aggregate or sandblasted finish and protection coating on concrete pedestals.

[Provide certified sustainably harvested wood for wood benches and chairs.]

a. Design wood benches to sustain a live load of not less than 200 pounds per square foot.

b. Provide kiln dried, surfaced four sides (S4S), clear all sides wood slats of species and sizes indicated.

(1) Species: [Teakwood] [Marine Teak] [Clear All Heart Redwood] [Red Cedar] [Alaska Yellow Cedar] [Clear Douglas Fir] [Ipe] [Mahogany] [Purple Heart].

(2) Nominal wood slat sizes: 1 by 2-1/2 inch [1 by 3 inch] [2 by 3 inch] [2 by 4 inch]. Top and bottom rail may be larger in size and configuration for comfort of seating.

2.4.2.1 Support Pedestals

Provide [cast iron] [cast aluminum] [steel] [wood] [concrete] [fiberglass] support pedestals in accordance with manufacturer's standard.

2.4.2.1.1 Cast Grey Iron

ASTM A48/A48M Class 30 or recycled cast grey iron ASTM A48/A48M Class 25

2.4.2.1.2 Cast Aluminum

ASTM B26/B26M or ASTM B108/B108M as applicable

2.4.2.1.3 Steel

ASTM A653/A653M

2.4.2.1.4 Wood

Match in species, grade, grain, color and finish of the wood slats.

~~2.4.2.1.5 Concrete~~

~~Concrete must be of the same quality and finish as specified for precast concrete.~~

~~2.4.2.1.6 Fiberglass~~

~~Design fiberglass pedestals to support the loads imposed in design of bench. Color as approved.~~

~~[2.4.2.2 Steel Arms~~

~~Provide 3/8 inch thick by 3 inch wide steel bench arms conforming to ASTM A653/A653M.~~

~~]][2.4.3 Fiberglass Benches~~

~~Provide reinforced fiberglass benches molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins, minimum thickness of 1/8 inch and reinforced in accordance with manufacturer's standard practice.~~

~~a. Design bench to sustain a live load of not less than 200 pounds per square foot.~~

~~b. Provide manufacturer's finish, 12-15 mil color impregnated polyester gel coat, of color as selected from manufacturer's standard colors and finishes, [smooth matte] [orange peel] [polished granite].~~

~~]2.4.4 Steel Units~~

~~[2.4.4.1 Perforated Steel~~

~~Provide [14 gage] [16 gage] perforated steel sheet, electrostatically coated with two component polyester enamel.~~

~~a. Design bench to sustain a live load of not less than 200 pounds per square foot.~~

~~[b. Provide 3/8 inch thick by 4 inch wide hot rolled steel pedestals conforming to ASTM A653/A653M.]~~

~~[c. Provide 1-1/2 inch O.D. ASTM A53/A53M schedule 40 steel pipe pedestals.]~~

~~][2.4.4.2 All-Welded Wire~~

~~Provide all-welded wire construction of 9 gage, 11 gage wire with 1/2 inch clear spacing and 5/16 inch wire with 2 1/2 inch spacing.~~

~~a. Design benches to sustain a live load of not less than 200 pounds per square foot.~~

~~b. Provide one inch O.D. by 18 gage [1-1/2 inch O.D. by 16 gage] galvanized tubing for bench frames.~~

~~[c. Provide 1-1/2 inch O.D. by 11 gage galvanized tubing for armrest.]~~

~~d. Provide cadmium or zinc plated hardware; nuts, bolts, screws, and lock~~

washers with a clean chromate finish.

]2.4.5 Aluminum Units

[AA DAF45] [AAMA 611]. Provide [extruded] [formed] aluminum benches in accordance with manufacturers standard, with [dark] [medium] [light] bronze [clear anodized] [black anodized] [acrylic paint] [powder coat] finish, color as selected from manufacturer's standards.

a. Design benches to sustain a live load of not less than 200 pounds per square foot.

b. Provide manufacturer's standard [cast grey iron] [cast aluminum] [steel] [precast concrete] [fiberglass] pedestals.

2.4.6 Accessories

Provide manufacturer's standard materials and accessories as required for assembly of units and as indicated on the assembly drawings. Provide unexposed aluminum, stainless steel or steel plates, angles and supports as required for complete assembly. Separate dissimilar materials to prevent electrolytic action.

2.4.7 Fasteners

Provide concealed fasteners except where specifically approved; types as required for specific usage.

2.4.8 Anchoring Brackets

Provide 1/4 inch zinc plated steel angle anchoring brackets, 1-7/8 inch wide by 2 inches deep by 2-1/2 inches high [1-7/8 inch wide by 3-1/2 inch deep by 6 inch high], pre-drilled for bolting benches to substrate.

2.5 BICYCLE RACKS

Design bicycle racks (stanchions) in accordance with manufacturer's standards and to meet design conditions indicated. Locate as shown on the drawings. Provide powder coat finish in color as selected from manufacturer's standards. Racks must accommodate locking devices and secure, as a minimum, one wheel and part of the frame simultaneously. The spacing between racks must be a minimum of 24 inches.

[2.5.1 Metal Pipe Bicycle Racks

Provide ASTM A53/A53M schedule 40 steel pipe bicycle racks in configuration and of [4-1/2] [_____] inch pipe size. Type of mounting, bicycle rack capacity and height above the ground as shown on the drawings.

][2.5.2 Precast Concrete Bicycle Rack

Provide one-piece precast concrete bicycle rack base with embedded galvanized metal hitching loops. Design bicycle rack with wheel notches for bike support and wheel locking device.

]2.6 BOLLARDS

Provide reinforced concrete bollards [12] [18] inch [square] [round], height as indicated, suitable for ground mount installation. Provide

~~exposed aggregate or sandblast finish as indicated; manufacturer's standard clear acrylic sealer. Submit manufacturer's descriptive data and catalog cuts.~~

~~2.6.1 Portland Cement~~

~~ASTM C150/C150M Type I II or III~~

~~2.6.2 Aggregate~~

~~ASTM C33/C33M, maximum size 3/4 inch~~

~~2.6.3 Reinforcing Steel~~

~~ASTM A615/A615M~~

~~2.6.4 Integral Color~~

~~ASTM C979/C979M, pure mineral oxide, limeproof and non-fading~~

~~2.6.5 Concrete Strength~~

~~5000 psi, 28 day minimum compressive strength~~

~~2.6.6 Admixture~~

~~ASTM C260/C260M for air-entraining~~

2.6 PLANTERS ~~[~~WASTE RECEPTACLES RECEPTACLES~~]~~ ~~[ASH RECEPTACLES]~~

~~[~~Provide for waste receptacles as indicated on plans ~~[spun aluminum] [reinforced fiberglass] [flat] [domed] tops and removable semi-rigid plastic liner insert.] [Provide top-mounted ash trays for ash receptacles.] Waste receptacles must be furnished with weather protection, odor containment, and insect/animal-proofing. Container size must be [as directed] [_____]~~.

~~2.6.1 Height~~

~~Trash and litter deposit openings must be between 30-40 inches above the ground.~~

~~2.6.2 Liners~~

~~Trash and litter receptacles must be furnished with [disposable inner-linings] [removable/reusable inner containers]. Self-dumping type designs to include hinged bottom, top or sides will be rejected.~~

~~2.6.3 Anchors~~

~~Trash and litter receptacles that can be anchored to resist overturning by typical use, high winds, or animals must be furnished and anchored in accordance with the manufacturer's recommendations.~~

~~2.6.4 Openings~~

~~Openings for trash and litter insertion must be a minimum of 4 inches in~~

diameter. Edges of the openings must be crimped, rounded and smoothed.

2.6.5 Ash Receptacles

Provide ash receptacles with a fire-proof metal bowl or screen or sand-filled containers for ash containment. Ash receptacles must have a minimum diameter of 8 inches; ash containers must have a fire-proof metal bowl or screen and must be easily removable for cleaning.

2.6.6 Planter Size

The planter size must be determined according to the spacial root requirements at 2/3 maturity size of the designated plant material, in conformance with Section 32 93 00 EXTERIOR PLANTS.

2.6.7 Drainage

Drainage for the planter must be as follows: a minimum of one drainage hole in the base of each planter and a minimum 1/8 inch space, in 2 locations, between the base of the planter and the supporting surface.

2.6.8 Base

The planter base must be capable of supporting the weight of the planter filled with both the designated plant material and fully saturated soil. The planter must not crack, overturn, or sink below the existing grade. Planters must allow for relocation.

2.7 SHELTERS

AISC 360. Provide prefabricated shelter systems to meet design conditions indicated. Shelter design must conform to all applicable State and Local Building Codes and must meet manufacturer's standards of construction and materials. Shelter systems must be [preglazed] pre-drilled and pre-cut, shipped with all hardware and accessories necessary for complete field assembly.

2.7.1 Framing Systems

Framing system; columns, rafters, ridge, purlins and other structural framing members must be [aluminum] [steel] [wood] as indicated. Manufacturer must provide shop drawings and calculations prepared by a structural engineer.

[2.7.1.1 Aluminum

Extruded aluminum alloy tubing must conform to ASTM B429/B429M 6063-T5 or 3003-H14, dark [medium] [light] bronze [black] [clear anodized] [powder coat] finish. Framing sizes and configurations must be as required for size of structure indicated meeting manufacturer's standards and applicable building codes.

][2.7.1.2 Steel

Structural steel must conform to ASTM A36/A36M or ASTM A500/A500M, 36,000 psi yield strength and 58,000 psi tensile strength, factory finished with rust inhibited primer and powder coat conforming to ASTM D3451. Framing sizes and configurations must be as required for size of structure indicated meeting manufacturer's standard and applicable building codes.

~~][2.7.1.3 Wood~~

~~Wood framing system must consist of surfaced four sides (S4S), #2 grade southern yellow pine [_____] solid timber columns with eased edges, pressure treated against decay, fungi and insect infestation, surfaced four sides (S4S), #1 grade, southern pine, [_____] glue-laminated columns manufactured in accordance with ANSI/AITC A190.1 and AITC certified glue-laminated structural grade southern yellow pine [_____] beams, rafters and purlins, factory sealed and individually wrapped for protection during shipment. Factory stain all wood members prior to shipment.~~

~~[Provide certified sustainably harvested wood for wood shelters.]~~

~~]2.7.2 Roof Panels [Decking]~~

~~Provide manufacturer's standard [molded acrylic translucent roof panel] [standing seam metal roof panel] [wood decking] [V-beam aluminum roof panels] [FRP roof panels] [_____] roof panels as indicated. Materials must be factory finished and shipped with all necessary fasteners and accessories as required for complete site assembly.~~

~~2.7.3 Glazing~~

~~Factory installed in separate structural window frames, gasketed and glazed in accordance with manufacturer's standard, interchangeable, glazing system. Provide [1/4 inch acrylic sheet] [1/4 inch tempered glass] [1/4 inch polycarbonate plastic sheet] [1/4 inch mar-resistant polycarbonate plastic sheet], [clear] [_____] color.~~

~~2.8 TABLES~~

~~Picnic tables must be furnished with attached benches that have no backrests. Table's exposed edges and corners must be rounded, eased or chamfered.~~

~~2.8.1 Height~~

~~Between 29-48 inches from the finished grade to the lowest surface of the top, or as noted.~~

~~2.8.2 Clearance~~

~~A minimum vertical clearance of 9 inches between the seat top and the bottom edge of the table top must be provided. A minimum of 18 inches of leg space under tables, measured from the inside edge of the seat top to the nearest table support, must be provided. A minimum of 18 inches from the end of the table top to the nearest support leg must be provided.~~

~~2.8.3 Top~~

~~Table top surfaces must not contain recesses that might hold water or food particles. The table top width must be a minimum of 18 inches when utilized from one side only, and a minimum of 36 inches when utilized from two sides. The table top length must be a minimum of 24 inches per person.~~

2.8.4 Wheelchair Access

A minimum clear space of 29 inches from the finished grade to the underside of the table must be provided for persons with disability to be able to pull a wheelchair beneath the table top at the end of the table; the minimum clear width must be 34 inches.

2.8.5 Precast Concrete Tables

Provide reinforced precast concrete tables with smooth tops; minimum 4500 psi concrete, 28 day minimum compressive strength, consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish with clear acrylic coating.

a. Portland cement: ASTM C150/C150M, gray, Type I.

b. Aggregate: ASTM C33/C33M, washed No. 8 limestone and sand.

c. Galvanized wire mesh: 14 gage, 2 by 2 inch.

d. Welded wire fabric: ASTM A1064/A1064M

e. Reinforcing steel: ASTM A615/A615M

f. Integral color: ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

g. Admixture: ASTM C260/C260M for air-entraining.

2.8.6 Fiberglass Tables

Provide reinforced fiberglass table tops molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins, minimum thickness of 1/4 inch with 12-15 mil thickness color impregnated polyester gel coat, color as selected.

a. Steel pedestal base: ASTM A53/A53M Schedule 40 steel pipe, [1-1/2] [1-5/8] [2-3/8] inch O.D.

b. Mounting: Type as indicated.

c. Metal finish: Powder coating conforming to ASTM D3451 testing.

2.8.7 Perforated Steel Tables

Provide 14 gage [16 gage] perforated steel sheet table tops with solid metal edges in accordance with manufacturer's standard. Weld tops to base as required for frame support.

a. Steel pedestal base: ASTM A53/A53M Schedule 40 steel pipe, 2-3/8 inch O.D.

b. Mounting: Type as indicated.

c. Hardware: Zinc or cadmium plated nuts, bolts, screws, and lock washers.

d. Metal finish: Powder coating conforming to ASTM D3451 testing.

2.8.8 [Wood Tables

Provide manufacturer's standard wood tables with wood [metal] [_____] bases as indicated. Provide fasteners and accessories required for onsite assembly. Kiln dry and pressure treat wood components to manufacturer's standard, maximum 19 percent moisture content. [Pre-treat metal components and provide manufacturer's standard primer and powder coat finish complying with ASTM D3451, color as selected].

[Provide certified sustainably harvested wood for wood tables.]

a. Design wood tables to sustain a live load of not less than 200 pounds per square foot.

b. Provide kiln dried, surfaced four sides (S4S), clear all sides wood slats of species and sizes indicated.

(1) Species: [Teakwood] [Marine Teak] [Clear All Heart Redwood] [Red Cedar] [Alaska Yellow Cedar] [Clear Douglas Fir] [Ipe] [Mahogany] [Purple Heart].

(2) Nominal wood slat sizes: 1 by 2-1/2 inch [1 by 3 inch] [2 by 3 inch] [2 by 4 inch].

c. Design bases of the materials listed below to support the loads imposed in the design of the tables.

d. Wood Support: Match in species, grade, grain, color and finish of the wood slats.

[e. Steel Support: ASTM A653/A653M].

[f. Cast Grey Iron Support: ASTM A48/A48M, Class 30 or recycled cast grey iron ASTM A48/A48M, Class 25.]

[g. Cast Aluminum Support: ASTM B26/B26M or ASTM B108/B108M as applicable.]]

2.9 [TREE GRATES

Provide [cast aluminum] [cast iron] [cast bronze] [punched steel] [stainless steel] tree grates in [round] [square] model of sizes indicated on the drawings. Furnish complete with angle steel frames with finish to match tree grates.

]PART 3 EXECUTION

3.1 CHILDREN'S PLAY AREAS

Install the site furnishings outside the play structure use zone in accordance with ASTM F1487. Verify and mark the locations of the use zone. These zones are to be free from obstacles and hard surfaces. When child accessibility requirements are to be met, child anthropometric dimensions must be used and not adult anthropometric dimensions.

3.1 INSTALLATION

Verify that finished grades and other operations affecting mounting

surfaces have been completed prior to the installation of site furnishings. Site furnishings must be installed plumb and true, at locations indicated, in accordance with the approved manufacturer's instructions.

3.1.1 Assembly and Erection of Components

New parts must be acquired from the manufacturer; substitute parts will not be accepted unless approved by the manufacturer. When the inspection of parts has been completed, the site furnishings must be assembled and anchored according to manufacturer's instructions or as indicated. When site furnishings are assembled at the site, assembly must not interfere with other operations or pedestrian and vehicular circulation.

3.1.2 Anchorage, Fastenings, and Connections

Furnish metal work, mounting bolts or hardware in ample time for securing into concrete or masonry as the work progresses. Provide anchorage where necessary for fastening furniture or furnishings securely in place. Provide, for anchorage not otherwise specified or indicated, slotted inserts, expansion shields, and power-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish the fastenings to which they are applied. Conceal fastenings where practicable.

~~3.2 WELDING~~

~~Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.~~

3.2 TESTING

Test each site furnishing to ascertain a secure and correct installation. A correct installation must be according to the manufacturer's recommendations and by the following procedure: Measure the physical dimensions and clearance of each installed site furnishing for compliance with manufacturer's recommendations and as indicated. Site furnishings which do not comply must be reinstalled. Fasteners and anchors determined to be non-compliant must be replaced. Submit a written report describing the results of the testing and a report of post-installation test results.

3.3 FINISHES

~~3.3.1 Field Finishes~~

~~Where indicated, field finishes must be applied in accordance with Section 09 90 00 PAINTS AND COATINGS. Where dissimilar metals are in contact, protect surfaces with a coat conforming to SSPC Paint 25 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.~~

3.3.1 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint

conforming to ASTM A780/A780M or by the application of stick or thick paste material specifically designed for repair of galvanizing, as approved by the Contracting Officer. Clean areas to be repaired and remove the slag from the welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread the molten material uniformly over surfaces to be coated and wipe the excess material off.

~~3.4 BOLLARDS~~

~~Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement.~~

3.4 BICYCLE RACKS

Affix to base structure by flanges anchored to concrete or other existing masonry by expansion shields. Provide Series 300 stainless steel bolts to anchor aluminum alloy flanges, of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metals or concrete, give the contact surface a heavy coating of bituminous paint.

3.5 ~~SHELTERS~~WASTE, RECYCLING RECEPTACLES

~~Secure to the adjacent construction with the clip angles attached to the concrete. Secure to concrete with not less than two 1/2 inch diameter expansion bolts.~~Install per manufacturers specifications.

~~3.5.1 Glazing~~

~~Factory install windows into separate structural frame. Miter corners and connect internally by extruded aluminum corner keys or screw bosses with tamper-proof stainless steel screws. Provide continuous gasketing around windows set to metal frames. Provide 1/2 to 3/4 inch deep pocket for polycarbonate glazing. Fully gasket and frame in independent interchangeable factory assembled units. Affix to shelter frame with 3/16 inch mustow head aluminum rivets at approximately13-1/4 inches on centers for full 360 degrees, rivet from inside of shelter.~~

~~3.5.2 Roof~~

~~Provide manufacturer's standard roof system including facia [gutter] assembly, ensuring a weather-tight seal and installation.~~

3.6 RESTORATION AND CLEAN UP

When the installation has been completed, clean up and protect the site. Existing areas that have been damaged from the installation operation must be restored to original condition at Contractor's expense.

3.6.1 Clean Up

The site must be cleaned of all materials associated with the installation. Site furnishing surfaces must be cleaned of dirt, stains, filings, and other blemishes occurring from shipment and installation. Cleaning methods and agents must be according to manufacturer's instructions or as indicated.

3.6.2 Protection

The area must be protected as required or directed by providing barricades and signage. Signage must be in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE.

3.6.3 Disposal of Materials

Excess and waste material must be removed and disposed off Government property ~~[_____]~~.

3.7 RE-INSTALLATION

Where re-installation is required, the following must be accomplished:

a. Re-install the product as specified. Material acquisition of replacement parts is the responsibility of the Contractor. Provide replacement materials that are new and supplied by the original manufacturer to match.

b. Damage caused by the failed installation must be repaired.

-- End of Section --

SECTION 14 24 23

HYDRAULIC PASSENGER ELEVATORS
05/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2021 19) Safety Code for Elevators and Escalators
ASME A17.2	(2020) Guide for Inspection of Elevators, Escalators, and Moving Walks Includes Inspection Procedures for Electric Traction and Winding Drum Elevators, Hydraulic Elevators, and Escalators and Moving Walks
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2018) International Building Code

NATIONAL ELEVATOR INDUSTRY, INC. (NEII)

NEII-1	(2000; R thru 2017) Building

	Transportation Standards and Guidelines, including the Performance Standards Matrix for New Elevator Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace
NFPA 72	(2019; TIA 19-1; ERTA 1 2019; TIA 21-1; ERTA 1 2021) National Fire Alarm and Signaling Code
NFPA 101	(2021) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017, with Change 2, 2019) Operations and Maintenance: Electrical Safety

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Elevator System; G~~[, [_____]]~~

Elevator Components; G~~[, [_____]]~~

Elevator Machine; G~~[, [_____]]~~

Elevator Controller; G~~[, [_____]]~~

Wiring Diagrams; G~~[, [_____]]~~

SD-03 Product Data

Elevator and Accessories~~[~~; G~~[, [_____]]]~~

Elevator Components~~[~~; G~~[, [_____]]]~~

Data Sheets[; G[, [_____]]]

Elevator Microprocessor Controller; G[, [_____]]

SD-05 Design Data

Emergency Power Systems

Heat Loads

Reaction Loads

SD-07 Certificates

Elevator Parts and Components Price Lists; G[, [_____]]

Warranty

Endorsement Letter

Welders' Qualifications

Elevator Controller Certification; G[, [_____]]

SD-10 Operation and Maintenance Data

Elevator, Data Package 4; G[, [_____]]

Maintenance Control Program (MCP); G[, [_____]]

Software and Documentation; G[, [_____]]

Submit in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY ELECTRONIC OPERATION AND MAINTENANCE SUPPORT INFORMATION (eOMSI).

1.2.1 Shop Drawing Requirements

Provide assembly and arrangement of elevators, accessories, and elevator components. Show location of elevator machine in elevator machine room (MR) or machinery space (MS). Show location of elevator controller in elevator machine room or elevator control room (CR). Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, and other layout information and clearance dimensions.

1.2.2 Product Data Requirements

Provide manufacturers' product data for all elevator components, including but not limited to the following: elevator controller, hydraulic pump unit, hydraulic pump and motor, hydraulic cylinder, hydraulic piping and fittings, car and hall fixture buttons and switches, cab and machine room or control room communication devices, door operator, door protection system, car roller guides, and buffers. For data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening. Provide controller manufacturer's published procedures for performance of each and all testing required by ASME A17.1/CSA B44.

1.2.3 Design Data

1.2.3.1 Reaction Loads

Provide calculations by registered professional engineer for reaction loads imposed on building by elevator system. Demonstrate calculations complying with ASME A17.1/CSA B44

1.2.3.2 Heat Loads

Provide calculations from elevator manufacturer, or by registered professional engineer, for total anticipated heat loads generated by all of the elevator equipment.

1.2.3.3 Emergency Power Systems

Where the facility does have an emergency power system, confirm the elevators that will be connected to the emergency power system. Confirm the complete emergency power system and sequence of operation for all elevators, including operation of the elevator lobby manual selection switch. Provide wiring diagrams for building emergency power interface with elevator controls. For elevators not supplied by an emergency power system, provide manufacturers' product data for auxiliary power systems.

1.2.4 Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of field welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work

1.2.5 Maintenance Control Program (MCP)

For each elevator, prepare and provide a written Maintenance Control Program (MCP) that complies with ASME A17.1/CSA B44 Section 8.6, including written documentation that details the test procedures for each and every test that is required to be performed by ASME A17.1/CSA B44. Assemble all MCP documentation, and supporting technical attachments, in a single MCP package and provide in both electronic and hard copy. Assemble entire hard copy MCP in 3-ring binders. For each elevator provided, the MCP must include only documentation and instruction that apply to the elevator specified.

For each elevator, provide an additional, separate binder that includes all maintenance, repair, replacement, call back, and other records required by ASME A17.1/CSA B44. The records binder must be kept in the elevator mechanical room, maintained by elevator maintenance and service personnel, and be available at all times to authorized personnel.

Provide detailed information regarding emergency service procedures and elevator installation company personnel contact information. Provide a listing of all tools to be provided to the Contracting Officer as components of the elevator system.

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide a designed and engineered elevator system by an elevator

contractor regularly engaged in the installation of elevator systems. Provide elevator components manufactured by companies regularly engaged in the manufacture of elevator components. Utilize only licensed and certified elevator personnel for the installation, adjusting, testing, and servicing of the elevators.

1.3.1.1 Elevator Contractor's Elevator Technicians

For elevator installations in the United States, including United States territories, perform all elevator related work under the direct guidance of a state certified elevator technician with a minimum of three years of experience in the installation of elevator systems of the type and complexity specified in the contract documents. Provide an endorsement letter from the elevator manufacturer, certifying that the elevator specialist is qualified. All elevator technicians must carry a current certification issued by one of the following organizations:

a. National Association of Elevator Contractors (NAEC)

b. National Elevator Industry Education Program (NEIEP)

1.3.2 Manufacturers' Technical Support

Provide elevator components from manufacturers that provide factory training and online and live telephone elevator technical support to any elevator installation, service, and maintenance contractor. Provide elevator components from manufacturers that guarantee accessibility to all replacement and repair parts and components to any elevator installation, service, and maintenance contractor. Use only elevator component manufacturers that provide current published price lists for all elevator parts and components.

1.3.3 Operation and Maintenance Data

Assemble all shop drawing and product data material into O&M Data Packages in accordance with Article SUBMITTALS. Provide two complete O&M Data Packages in hard copy and two complete electronic O&M data packages on separate CDs, in PDF format. Provide all O&M Data Packages to Contracting Officer. Include controller diagnostic documentation and software as required under Article CONTROL EQUIPMENT.

1.3.4 Wiring Diagrams

Provide complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems. Provide one set (11 inch by 17 inch minimum size) of wiring diagrams, with individual sheets laminated in plastic and assembled in binder, to be stored in the machine room or control room cabinet. Provide one additional hard copy set and two complete electronic sets on separate CDs, in PDF format. Provide all wiring diagram sets to the Contracting Officer. Coded diagrams are not acceptable unless fully identified.

1.3.5 Machine Room/Control Room Cabinet

For storage of O&M Data Packages and Wiring Diagrams, provide locking metal cabinet with a minimum size of 20 inch W by 12 inch D by 30 inch H. Cabinet must be sized large enough to accommodate all O&M Data and hardware required in paragraphs OPERATION AND MAINTENANCE DATA and WIRING DIAGRAMS. Secure cabinet to machine room or control room wall.

1.4 NEW INSTALLATION SERVICE

Provide elevator warranty service in accordance with the manufacturer's maintenance plan, warranty requirements and applicable safety codes, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel. Provide [Monthly][Bi-weekly] services to include repairs, adjustments, greasing, oiling, and cleaning. Provide service log in elevator machine room or control room and update [Monthly][Bi-weekly], throughout the one-year warranty period.

Provide 24-hour emergency service, with [one hour][two hour] on-site response time, during this period without additional cost to the Government.

1.4.1 Periodic Elevator Certification Inspection and Testing

Provide elevator mechanic to support [NAVFAC]QEI Certified Elevator Inspector in the periodic six-month and the annual Category 1 elevator certification inspection and testing. Perform Category 1 inspection and testing no greater than 30 days prior to the end of the warranty period. Perform all elevator certification testing in the presence of QEI Certified Elevator Inspector.

In conjunction with the testing noted above, test systems for Emergency Power Operation, Earthquake Emergency Operation, and Hospital Emergency Commandeering Service Operation, as applicable. Schedule so that testing does not interfere with building operations.

1.5 FIRE PROTECTION SYSTEM

Coordinate interface between building fire protection system and elevator controls.

Additional fire protection requirements are located in: [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE;] [Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE;] [Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE;] [Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE;] [Section 28 31 02.00 20 FIRE ALARM REPORTING SYSTEMS - DIGITAL COMMUNICATORS;] [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION;] [_____] and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5.1 Fire Alarm Initiating Devices

Fire alarm initiating devices are specified in [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE] [Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE] [Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE] [Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE] [_____], including conduit and wiring from each detector to fire protection addressable modules in elevator machine room or control room.

1.5.2 Fire Sprinklers

Provide fire sprinklers in accordance with all applicable safety codes and with [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION][_____].

Provide shutoff valve, check valve, and non-adjustable, zero time-delay flow switch, in each sprinkler line immediately outside of each machine room, control room, and hoistway, as applicable. Provide inspectors' test valve for periodic testing of flow switch and shunt trip disconnect.

Pipe sprinkler piping serving these spaces in a series manner with no laterals. Locate inspectors' test connection at the end of pipe runs such that operation of the test connection will purge air from system piping.

1.5.3 Shunt Trip Disconnect

Provide flow switches specified in paragraph FIRE SPRINKLERS to comply with ASME A17.1/CSA B44 and NFPA 72 for shunt trip of the main line power supply. For each elevator, provide control wiring connecting the flow switch to a shunt trip equipped circuit breaker located in the elevator machine room or control room. Upon flow of water, flow switch will instantaneously cause opening of the shunt-trip circuit breaker and remove power from the elevator. Flow switch must also send a signal to fire alarm control panel to indicate water flow condition.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein. Provide elevator system that meets or exceeds the NEII-1 Ride Quality Performance Standards Matrix (RQPSM). Comply with the RQPSM "Intermediate Performance" criteria. Provide a minimum of one elevator sized to comply with the International Building Code (IBC) medical stretcher requirement and also designed to vertically transport the largest movable equipment or furniture used on the project.

Provide and install elevators in accordance with 36 CFR 1191 - ABAAS, ICC IBC, IEEE C62.41, NFPA 70 and NFPA 101 requirements.

2.1.1 Elevator Design Parameters

2.1.1.1 Elevator No.~~[_____]~~E1 - Emergency Medical Service Accessibility (EMSA)

Provide elevator(s) with minimum size and arrangement to accommodate an ambulance stretcher 24-inch by 84-inch with not less than 5-inch radius corners, in the open, horizontal position.

a. Type: ~~[In-Ground Direct Plunger] [~~Holeless~~]~~

b. Rated load: ~~3500~~4500 lb.

c. Rated Speed: ~~[125][~~150~~]~~ fpm

d. Car Door Type: ~~Single~~2-speed side slide.

e. Car Door Opening Width: 3 ft.-6 in. minimum, or ~~[_____]~~4'0".

2.1.1.2 Elevator No.~~[_____]~~E1 - Larger Capacity (Pallet-Sized) Loading

a. Type: ~~[In-Ground Direct Plunger] [~~Holeless~~]~~

b. Rated load: ~~[~~4000~~][4500][_____]~~ lb.

c. Rated Speed: ~~[125][~~150~~]~~ fpm

d. Car Door Type: Single-speed ~~center opening~~side-slide, horizontally sliding.

e. Car Door Opening Width: ~~[~~4 ft.-0 in.~~][4 ft.-6 in.]~~

~~2.1.1.3 Elevator No.[_____] - Non-EMSA Elevator~~

~~a. Type: [In-Ground Direct Plunger] [Holeless]~~

~~b. Rated load: 2500 lb.~~

~~c. Rated Speed: [125][150] fpm~~

~~d. Car Door Type: Single speed [side slide][center opening].~~

~~e. Car Door Opening Width: 3 ft.-6 in. minimum, or [_____].~~

2.1.2 Cab Enclosure and Hoistway Entrance Assemblies

Provide finishes ~~[~~as indicated in Contract Drawings and ~~.][~~as listed below:

a. Floor; ~~[carpet][vinyl composition tile][vinyl sheet tile][_____]~~Refer to Contract Drawings.

b. Walls; ~~[~~prefinished steel~~][laminated plastic on plywood][stainless steel][_____]~~. Provide each cab wall with equally spaced and equally sized wall panels. All wall panel fasteners must be concealed.

Wall trim; ~~[prefinished steel][~~stainless steel~~][_____]~~.

Accessories; Provide hand rails on full length of back wall and side walls of elevator cab.

c. Car doors, car door returns, and wall reveals; ~~[prefinished steel panels][~~stainless steel~~][_____]~~.

d. Ceilings; ~~[supported][~~prefinished steel panels~~][anodized aluminum][eggcrate][_____]~~.

Ceiling frame; ~~[prefinished steel][~~stainless steel~~][anodized aluminum][_____]~~.

e. Hoistway Entrance Assembly Material and Finishes; ~~[prefinished steel][~~ stainless steel~~][_____].~~

2.2 ELEVATOR OPERATION

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

~~[~~2.2.1 Single, Two-Stop, Automatic Operation

Provide Single Two-Stop Automatic Operation.

~~][2.2.2 Selective Collective Automatic Operation~~

~~Provide Selective Collective Automatic Operation.~~

~~][2.2.3 Duplex Selective Collective Automatic Operation~~

~~Provide Duplex Selective Collective Automatic Operation. If a car is taken out of service or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to the other car functioning as a single car Selective Collective elevator until the out-of-service car is returned to the system.~~

~~][2.2.4 Group Automatic Operation~~

~~Provide Group Automatic Operation. If a car is taken out of service, or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to another car until out-of-service car is returned to the system.~~

~~]~~2.3 SPECIAL OPERATION AND CONTROL

Provide the following special operations and control systems.

2.3.1 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

2.3.2 Firefighters' Emergency Operation (FEO)

Provide FEO equipment and signaling devices. The designated level for the FEO Phase I key operated switch is the ~~[~~ground~~][_____]~~ floor. In the FEO Phase I fixture, provide FEO Operating Instructions.

2.3.2.1 Firefighters' Emergency Operation (FEO) Key Box

Provide flush mounted, locking, FEO Key Box of a minimum size of 5 inch W by 9 inch H by 1.5 inch D. Install at a height of 6 feet above floor level and directly above the FEO Phase I key switch. Provide box equipped with lock that uses the FEO K1 key.

2.3.3 Hoistway Access Operation

Provide hoistway access operation with switches at top and bottom terminal landings. Locate switch 6 feet above floor level, within 12 inches of elevator hoistway entrance frame or with the ferrule exposed when located in the elevator entrance frame.

2.3.4 In-Car Inspection Operation

Provide In-Car Inspection Operation.

2.3.5 Independent Service

Provide exposed key-operated switch in car operating panel to enable

independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service. For duplex or group operation, if one car is removed from group another car will respond to its hall calls.

~~2.3.6 Selective Door Operation~~

~~For elevator with one or more rear openings at same level as front opening, provide full-selective operation with car and door operating buttons clearly marked for front and rear openings, front and rear car button for each such floor, and front and rear "DOOR OPEN" and "DOOR CLOSE" buttons. Only door for which the button was operated opens or closes.~~

~~[~~2.3.6 Elevator Emergency Power Operation

Provide elevator emergency power operation for ~~[~~the~~all~~ elevator~~s~~] ~~[elevator 1,2,3...]~~. Coordinate power supply and control wiring to accomplish initiation and operation of elevators on emergency power.

~~][2.3.7 Elevator Auxiliary Power Operating System~~

~~Provide elevator auxiliary power operating system for [all elevators] [elevator 1,2,3...].~~

~~][~~2.3.7 Hospital Emergency Commandeering Service (HECS)

Provide Hospital Emergency Commandeering Service.

~~]~~2.4 ELEVATOR DRIVE SYSTEM

Provide hydraulic elevator drive system, including pump unit, piping, cylinder/plunger assembly, and associated equipment, which will operate at a maximum working pressure of 500 psi or less. Provide complete elevator system that meets or exceeds the NEII-1 Ride Quality Standard, including elevator ride quality and noise levels in car and in elevator machine room and machinery space.

2.4.1 Hydraulic Pump Unit

Provide self-contained pump unit, including oil-hydraulic elevator pump, electric motor, suction-line oil strainer, and structural steel outer base with tank supports and isolation pads. Provide oil tank capacity for full plunger displacement plus at least 10 gallons. Provide means to maintain oil temperature between 100 and 130 degrees F regardless of ambient temperature. Limit acoustic output in elevator machine room and machinery space to 80 dbA.

2.4.1.1 Pump Motor

Provide intermittent-duty pump motor rated at 120 starts/hour. Provide motor that is sized so that the motor amperage does not exceed the motor data tag amperage in any operating condition, exclusive of acceleration and deceleration. Provide minimum of one mega ohm insulation resistance between conductors and motor frame. Provide motor and pump nameplate and data tags permanently mounted on the outside of the pump unit frame, with all data viewable without the use of mirrors or other tools.

2.4.2 Hydraulic Controls and Equipment

Provide control valve, overspeed safety valve, blowout-proof muffler, and hydraulic pump discharge strainer in the hydraulic oil supply line. Provide two 1/4 turn, ball valve type manual shutoff valves. Provide one in the elevator hoistway pit and one in the elevator machine room or machinery space.

2.4.2.1 Hydraulic Control Valve

Provide constant-velocity, down-speed regulated, control valve. Down-speed regulated control valve allows the car to travel at the same speed in the down direction, regardless of the load on the elevator. In addition, the hydraulic control valve must have built-in adjustment capability to operate the elevator at 140 percent of rated speed to facilitate periodic testing of the overspeed safety valve.

2.4.2.2 Hydraulic Overspeed Safety Valve

Provide overspeed safety valve in hydraulic oil supply line, directly adjacent to the hydraulic cylinder. Provide threaded pipe connections between the hydraulic cylinder and the overspeed valve. Provide valve equipped with manufacturer's manual shutoff feature. Overspeed valve must not be equipped with a manual or automatic lowering feature. Provide adjustable valve with means to seal adjustment after inspection and testing by certified elevator inspector.

2.4.3 Hydraulic Piping and Accessories

Provide ASTM A53/A53M or ASTM A106/A106M, Schedule 80, black steel piping with ASME B16.9 or ASME B16.11 fittings for supply piping. Extend schedule 80 piping from the pump control valve body, inside the pump unit, to the hydraulic cylinder in the hoistway. Provide welded or threaded forged pipe fittings for all fittings and components of the hydraulic oil supply line. ~~[For in-ground direct plunger cylinders, provide dielectric union or isolation couplings at each end of the hydraulic oil supply line.]~~Provide hangers or supports for all piping and components.

2.4.3.1 Containment of Hydraulic Oil Supply Line

Protect all portions of hydraulic oil supply line that are installed below ground, including portions encapsulated in concrete or covered by construction, with continuous, Schedule 80, PVC. Inside diameter of PVC must be 3 inches larger than the outside diameter of the hydraulic oil supply line pipe and couplings.

2.4.4 Hydraulic Elevator Type

Provide a ~~[in-ground direct plunger] [~~holeless~~]~~ direct plunger type hydraulic elevator. Elevators with telescopic or inverted cylinder-plungers are not acceptable and may not be used. Rope hydraulic elevator design is not acceptable and may not be used.

2.4.4.1 Cylinder-Plunger (Jack) Unit

Provide a single-stage plunger of seamless steel construction. Provide cylinder with self-stabilizing mount that will support and hold cylinder plumb without the need for stabilization means at the bottom of the cylinder. Provide a threaded, 1/4 inch bleeder valve at the top of the

cylinder, just below packing gland.

~~[2.4.5 Cylinder Well System~~

~~For direct plunger, in-ground type hydraulic elevator, provide a dry, sealed cylinder well system.~~

~~2.4.5.1 Well Casing~~

~~Locate and drill well for the cylinder well system. Line well with steel casing, minimum 1/4 inch wall with welded 1/2 inch steel bottom. Set casing plumb.~~

~~2.4.5.2 PVC or HDPE Liner~~

~~Provide Schedule 80 PVC or HDPE liner with bottom cap and couplings; joints sealed watertight using pipe manufacturer's recommended adhesive or heat welding methods. Provide liner inside diameter not less than 3 inches larger than elevator cylinder maximum outside diameter. Liner may be provided as a cylinder manufacture's applied liner or as a separate component. For separate liner, set liner plumb in well casing, located for cylinder installation. Provide dry, salt-free sand below and around liner to top of well casing.~~

~~2.4.5.3 Cylinder Installation~~

~~Remove all moisture from inside of liner. Install cylinder plumb, inside liner. Provide a 1/4 inch copper evacuation tube inside the liner. The bottom of the evacuation tube must be within 6 inch of the bottom of the liner. Top of evacuation tube must extend at least 6 inch above pit floor. Provide top of test tube with removable cap to exclude foreign matter. Provide air inlet pressure fitting in top of liner and accessible in pit, for performance of air pressure test. Secure Liner/Cylinder Assembly as recommended by cylinder manufacturer.~~

~~2.4.5.4 Cylinder Liner Moisture Sensor System~~

~~Provide moisture and oil sensors inside the cylinder liner for detection of oil and water at the bottom of the cylinder liner. Provide sensor monitoring system that will actuate audible and visual alarms and identify the presence of water and identify the presence of oil inside the liner.~~

~~2.4.5.5 Seal Top of Well Casing~~

~~Upon successful test and certification of Liner/Cylinder assembly, seal gap between steel well casing and liner with foam insert strong enough to retain and support final grouting. Provide 3000 psi grout to a minimum of 4 inch thickness and level top of final grouting with pit floor.~~

~~]~~2.5 CONTROL EQUIPMENT

Enclose all elevator control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with ventilation louvers and removable or hinged doors. Mount cabinets at a height of 10 inches above machine room or control room finish floor.

2.5.1 Motor Control Equipment

Provide elevator motor control with electronic, soft-start motor starter.

2.5.2 Elevator Microprocessor Controller

For each individual elevator controller, and for each group controller, provide a microprocessor controller that complies with the following paragraphs. Provide controller(s) package that includes all hardware and software required for the installation, maintenance, and service of the elevator, in its' entirety. Provide verification of technical support service that the controller manufacturer provides to any licensed elevator installation, service, and maintenance company.

Provide an elevator controller from a manufacturer that provides comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that manufacturer has provided for a minimum period of one year prior to contract award date.

The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. All components, parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable. The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

Provide verification of telephone and internet based technical support service that the elevator controller manufacturer provides to any licensed elevator installation, service, and maintenance company at an industry competitive price. The service must include live telephone based technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and related elevator components. The service must be available during standard working hours.

Provide an elevator controller that is designed to automatically reestablish normal elevator operation following any temporary loss of power, regardless of duration.

2.5.2.1 Elevator Controller Interface Cabinet

For each individual elevator microprocessor controller, provide a separate elevator control cabinet with an integrated human interface system. For group elevator installations, a single cabinet and interface system with full access to each elevator controller may be utilized. The separate controller interface cabinet must be supplied by the elevator controller manufacturer and include a minimum 12 inch wide keyboard and a minimum 10 inch monitor. The elevator controller interface cabinet must comply with arc-flash protection requirements of NFPA 70E and UFC 3-560-01.

2.5.2.1.1 Elevator Microprocessor Human Interface

The interface system must provide complete elevator controller interface capability and must include the elevator controller manufacturer's comprehensive package of installation and diagnostic software. The microprocessor interface system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of each elevator and for the elevator group. All software programming must be

stored in non-volatile memory. The elevator controller fault log must provide non-volatile memory fault log storage of all faults, trouble calls, and fault history for a minimum of one year and the ability to download or print the fault log. The controller interface must also provide the capability to display and diagnose trouble calls, faults, and shutdowns. Expiring software, degrading operation, and "key" access controls are not acceptable.

2.5.2.2 Software and Documentation

Provide three copies of the manufacturer's maintenance and service diagnostic software, with complete software documentation, that will enable the same level of unrestricted access to all controllers of the same make and model, regardless of the installation date or location. Provide signed certification, from the manufacturer's corporate headquarters, that guarantees that the microprocessor software and access system will not terminate the unlimited and unrestricted access at any future date.

2.5.2.3 Elevator Controller Certification

For elevator installations in the United States, including United States territories, provide an elevator microprocessor controller that has a current certificate of safety code compliance issued by the Technical Standards and Safety Authority (TSSA), Toronto, Canada.

2.6 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

For all panels and fixtures, provide identical and uniform panel and fixture design, material, finish, and components for all elevators. For all panels and fixtures, legibly and indelibly identify all buttons, devices, and all operating positions for each device. Use engraving and backfilling, or photo etching, for button and device designations. Do not use attached signs. Provide elevator manufacturers' standard grade for all key switches unless otherwise specified. All illuminating panels and fixture components must utilize LED lighting for energy efficiency.

2.6.1 Car and Hall Buttons

For all cab and landing fixture buttons, provide industry-standard, vandal resistant push buttons with positive-stop assembly design. Buttons must be minimum 3/4 inch diameter, satin-finish stainless steel, with illuminating LED halo.

2.6.2 Passenger Car-Operating Panel

Provide each car with ~~[~~one~~]~~ ~~[two]~~ car operating panel~~[s]~~ that contains operation controls and communication devices. Provide exposed, flush mounted buttons for the controls identified in subparagraph PASSENGER CONTROLS. Provide a lockable service cabinet for the controls listed in subparagraph SERVICE CONTROLS. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

2.6.2.1 Passenger Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Illuminating car-call buttons identified to correspond to landings

served by the elevator.

b. "DOOR OPEN" and "DOOR CLOSE" buttons. For front and rear openings at the same floor, include the identification "F" and "R" for each opening.

c. Red, illuminating "ALARM" button.

d. Key-operated "Independent Service" switch.

e. "Help" communication device to include communication between elevator cab and elevator machine room or control room.

[f. Key-operated "HOSPITAL EMERGENCY COMMANDEERING SERVICE" switch.

]2.6.2.2 Service Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Provide a key-operated, three-position switch for "In car Inspection Operation" and "Hoistway Access". The center switch position will provide normal, automatic operation.

b. "Car Light" switch.

c. "Car Fan" switch with two speed settings identified.

d. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

2.6.2.3 Certificate Window

Provide a minimum 4 inch wide by 6 inch high certificate window for elevator inspection certificate. Locate window in the Service Controls door of the Car Operating Panel.

2.6.2.4 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device must have a sound pressure rating between 80 and 90 dBA at 10 ft. Provide battery backup power capable of operating the audible signaling device for at least one hour.

2.6.3 Elevator In-Car Position Indicators

For all elevators, provide illuminating position indicator in the Car Operating Panel.

2.6.4 Elevator In-Car Direction Indicators

For 2-stop elevator installations, provide visual direction indicators and audible car arrival signal in the elevator car door jamb, in accordance with ABA Standards. Visual indicators must be visible from the hall call fixture.

2.6.5 Hall Call Landing Fixtures

Provide a hall call fixture adjacent to each elevator. Provide a single push-button for terminal landings and dual push-buttons, up and down, at intermediate landings.

2.6.5.1 Designated Landing Hall Call Fixture

2.6.5.1.1 Location of COMMUNICATION MEANS FAILURE (CMF) Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator CMF audible and illuminating signal, and reset switch, in the FEO Designated Landing hall call fixture. ~~Mount the signal and reset switch at a minimum of 7 inches above the "UP" hall call button.~~

2.6.5.1.2 COMMUNICATION MEANS FAILURE (CMF) Visual and Audible Signal Operation

Provide a CMF visual and audible signal system that conforms to ASME A17.1/CSA B44. Provide continuous verification of operability of the telephone line and immediate activation of audible and visual signals when verification means determines that the telephone line is not functioning. Provide illumination of visual signal at one second intervals. Provide a minimum of 65 dBA audible signal at 30 second intervals.

2.6.5.1.3 Firefighters' Emergency Operation Phase I Switch and Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator Firefighters' Emergency Operation Phase I switch and illuminating visual signal in the FEO Designated Landing hall call fixture. Provide FEO Phase I visual signal that is designed with intermittent, flashing, illumination when actuated by the machine room, control room, or hoistway fire alarm initiating device. ~~Locate FEO Phase I key switch above the CMF visual signal with a minimum of 6 inches vertical between the centerlines of the CMF signal and the FEO Phase I key switch.~~ Locate FEO Phase I visual signal directly above the Phase I switch. In addition, locate Elevator Corridor Call Station Pictograph at top of hall call fixture.

2.6.6 Elevator Car Position and Direction Indicators and Car Arrival Signal

For elevator installations with three or more stops, provide a separate hall landing fixture that includes the visual elevator position indicator, visual direction indicators, and audible car arrival signal, in accordance with ABA Standards.

2.6.7 Designated Landing Elevator Identification Fixture

For duplex and group elevator installations, provide a separate elevator identification fixture for each elevator, with identification engraved and backfilled with a contrasting color. Number elevators from left to right, as seen during primary approach from building main entrance to elevator lobby. For multiple elevator groups, begin numbering with group that is closest to the building main entrance.

2.6.8 Emergency or Standby Power

When emergency or standby power is provided for elevator operation, provide an elevator emergency power visual indicator that conforms to

ASME A17.1/CSA B44. Locate the visual signal in the Firefighters Emergency Operation fixture for each simplex elevator and for each elevator group. When an emergency power selector switch is required, provide switch in a separate, flush mounted fixture located at the designated level, in view of all elevator entrances.

2.7 CAR DOOR EQUIPMENT

2.7.1 Car Door Operator

Provide elevator door operator equipment and circuitry that is designed and installed as discreet communication. Serial communication must not be used for this system.

2.7.2 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height and width of the door opening. Provide door nudging operation.

2.8 PASSENGER ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Roller Guides

Provide coil-spring loaded roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames.

2.8.2 Car Enclosure Wall Panels, Return Panels, Doors, Entrance Columns, and Transom

Provide 14 Gauge minimum ~~[prefinished steel]~~[stainless steel~~]~~ cab wall panels and entrance components. Use same material and finish for all hoistway and car entrance assemblies. Apply sound-deadening material on exterior of all cab wall panels.

2.8.3 Car Enclosure Top

Provide reinforced, 12 gauge minimum steel car enclosure top. Provide hinged emergency exit with lock that complies with the seismic risk zone 2 or greater design requirements of ASME A17.1/CSA B44. Locate emergency exit hinge towards the rear of the elevator cab. Design and configure the elevator cab interior ceiling to provide convenient and unobstructed access to, and use of, emergency exit from inside the elevator cab.

2.8.4 Car Door

Provide 16 gauge minimum ~~[prefinished steel]~~[stainless steel~~]~~ car doors of sandwich construction with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading and one at trailing door edge with guides in the sill groove their entire length of travel.

2.8.5 Car Entrance Sill

Provide one piece cast nickel silver, stainless steel, or white bronze entrance sill(s). Set sills level and flush with floor finish. Use same material for hoistway and car entrance sills.

2.8.6 Cab Finish Floor

Provide cab finish floor with top of finish floor flush with the cab sill.

2.8.7 Car Fan

Provide 2-speed fan for car enclosure forced ventilation. Fan must be mounted in the car enclosure top.

2.8.8 Car Lighting

Utilize LED lighting for elevator car interior illumination. Provide a minimum of 10 foot-candles, measured at all areas of the car enclosure floor. Provide automatic car lighting operation that will turn off car lights after 3 minutes of inactivity. Car lights must automatically turn on upon actuation of an elevator car or hall call.

2.8.9 Car Protection Pads and Hooks

Provide fire retardant, hanging car protection pads that provide protection for all car interior wall panels. Provide permanently installed studs in car that are designed for hanging the car protection pads in the car.

2.9 PASSENGER ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating. Use same material and finish for all hoistway and car entrance assemblies.

2.9.1 Hoistway Entrance Frames

Provide 14 gage minimum ~~[prefinished carbon sheet steel][~~stainless steel~~]~~ hoistway entrance frames. Solidly grout uprights of entrance ways to height of 5 feet.

2.9.2 Hoistway Entrance Sills

Provide one-piece cast nickel silver, stainless steel, or white bronze entrance sills. Set top of landing sill flush with top of finish floor. Solidly grout under full length of sill. Use same material for all hoistway and car entrance sills.

2.9.3 Hoistway Entrance Doors

Provide ~~[hollow metal][~~stainless steel~~]~~ non-vision construction hoistway entrance doors with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading edge and one at trailing edge with guides in the sill groove the entire length of door travel. Use same material and finish for all hoistway and car entrance assemblies.

2.9.4 Hoistway Entrance Door Track Dust Covers

Provide sheet metal hoistway door track dust covers at each landing. Dust covers must cover top and hoistway side of door locks and door roller tracks, and extend the full width of the door track and associated hardware. Dust cover sections will not exceed 3 feet in length.

2.10 HOISTWAY EQUIPMENT

2.10.1 Car Guide Rails and Fastenings

Provide T-section type guide rails for car. Paint rail shanks with one coat of black enamel.

~~2.10.2 Pit Equipment and Support Channels~~

~~Provide rail-to-rail pit channels to serve as mounting surface for main guide rails [, hydraulic cylinder]and car buffers. Method of installation of channels, brackets and buffer mounts must be such that pit waterproofing is not punctured.~~

2.10.2 Pit "STOP" Switch

Provide push-to-stop/pull-to-run type pit "STOP" switch.

2.10.3 Traveling Cables

Suspend traveling cables by means of self-tightening webbed devices or internal suspension members.

2.10.4 Hoistway Pit Ladder

Provide continuous horizontal rungs for the full height of the pit ladder.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with DOD design criteria, contract specifications, manufacturer's instructions, NEII-1 Building Transportation Standards and Guidelines, and all applicable building and safety code requirements.

3.1.1 Structural Members and Finish Materials

Do not cut or alter structural members. Do not alter finish materials from manufacturer's original design. Restore any damaged or defaced work to original condition.

3.1.2 Miscellaneous Requirements

Provide recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work and spot paint.

3.2 FIELD QUALITY CONTROL

The Contractor will provide and utilize a third-party licensed and certified Qualified Elevator Inspector (QEI) to conduct elevator pre-acceptance inspection and testing. The QEI must perform inspections and witness tests to ensure that the installation conforms to all applicable safety codes and contract requirements. The QEI will be directly employed by the Contractor and independent of the elevator contractor.

Upon completion, the QEI must provide written test data for all ASME A17.1/CSA B44 Acceptance Tests and written certification that the elevator is complete and ready for final Acceptance Inspection, Testing, and Commissioning.

3.3 ACCEPTANCE INSPECTION, TESTING AND COMMISSIONING

When elevator system installation is complete and ready for final inspection, notify Contracting Officer that elevator system is ready for Acceptance Inspection, Testing, and Commissioning. Provide QEI certification specified in Article FIELD QUALITY CONTROL.

[Contracting Officer will obtain services of Naval Facilities Engineering Command (NAVFAC) QEI Certified Elevator Inspector. NAVFAC QEI will utilize the applicable NAVFAC Elevator Acceptance Inspection Form to record the results of inspection and testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the NAVFAC QEI will sign a copy of the completed forms and provide the signed copy to the Contracting Officer or representative. Within 2 weeks of the inspection, the QEI will also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, NAVFAC Certified Elevator Inspector will complete, sign and post form NAVFACENGCOM 9-11014/23(Rev.9-2009), Elevator Inspection Certificate.

][~~Contracting Officer will obtain the services of a third-party QEI Certified Elevator Inspector. The QEI must utilize an Elevator Acceptance Inspection Form to record the results of inspection and all testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the QEI must sign a copy of the completed forms and provide to the Contracting Officer. Within 2 weeks of the inspection, the QEI must also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, the QEI will complete, sign, and provide a certificate of compliance with ASME A17.1/CSA B44.~~

]### 3.3.1 Acceptance Inspection Support

Prime and Elevator Contractors must provide inspection support and perform all required tests, in order to demonstrate proper operation of each elevator system and to prove that each system complies with contract requirements and all applicable building and safety codes. Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All inspection and testing must be conducted in the presence of the Qualified Elevator Inspector (QEI).

If the elevator does not comply with all contract and safety code requirements on the initial Acceptance Inspection and Test, the Contractor is responsible for all costs involved with re-inspection and re-testing required as a result of contractor delays and discrepancies discovered during inspection and testing.

3.3.2 Testing Materials and Instruments

Furnish all testing materials and instruments necessary for Acceptance Inspection, Testing and Commissioning. At a minimum, include calibrated

test weights, tachometer, accelerometer, hydraulic pressure gauge, 600-volt mega ohm meter, volt meter and ammeter, infrared temperature gauge, door pressure gage, dynamometer, and 20 foot tape measure.

3.3.3 Field Tests

3.3.3.1 Endurance Tests

Test each elevator for a period of one hour continuous, automatic operation, with specified rated load in the elevator cab. During the one hour test, stop car at each floor, in both directions of travel, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise and Motor Amperes must be met throughout the duration of the Endurance Test. Restart the one hour test period from the beginning, following any shutdown or failure.

3.3.3.2 Speed Tests

Determine actual speed of each elevator, in both directions of travel, with rated load and with no load in elevator car. Make Speed tests at the beginning and at the end of the Endurance test. Determine speed by tachometer reading or accelerometer, excluding accelerating and slow-down zones. Under all conditions, minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.3.3.3 Leveling Tests

Test elevator car leveling operation and provide a leveling accuracy equal to or less than 1/8 inch at each floor with no load in car, and with rated load in car, in both directions of travel. Determine leveling accuracy at the beginning and at the end of the endurance tests.

3.3.3.4 Temperature Rise Tests

Determine temperature rise of elevator pump motor and hydraulic fluid during one-hour full-load test run. Under these conditions, maximum temperature rise must not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

3.3.3.5 Motor Ampere Tests

At beginning and end of Endurance test, measure and record motor amperage in both directions of travel and in both no-load and rated load conditions.

3.3.3.6 Elevator Performance and Ride Quality Testing

Evaluate elevator performance to ensure compliance with specification requirements related to the NEII-1 Performance Standards Matrix for New Elevator Installations.

3.3.3.7 Hydraulic Safety Valve (Automatic Shutoff Valve) Tests

In order to ensure consistent performance, regardless of hydraulic oil temperature, test the Hydraulic Safety Valve twice. Test once before the one-hour endurance test and once immediately after the one-hour test. For elevator certification, safety valve must perform to code in both tests.

3.3.3.8 Hydraulic Pressure Tests

Check the hydraulic static pressure and rated-speed operating pressure at the hydraulic control valve, under both no load and rated load conditions.

~~3.3.3.9 Pressure Test of Liner/Cylinder Assembly~~

~~Perform 20 psig pressure test of the completed and installed liner/cylinder assembly. Test liner/cylinder assembly as a sealed unit. Provide safety relief valve set to relieve at 20 psig; 4.5 inch diameter dial pressure gage scaled for 0 to 50 psig and calibrated to 0.5 percent accuracy; and an air pressure admission throttle and shutoff valve. For safety, pressure test must only be performed when liner and cylinder are fully inserted and assembled in the well casing. Perform the test from remote location outside of the elevator pit. Perform test in the presence of, and witnessed by, a Certified Elevator Inspector.~~

-- End of Section --

SECTION 21 13 13

WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

~~AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)~~ASME INTERNATIONAL (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2016) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M14	(2015) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2021; with Change 6, 2021) Fire Protection Engineering for Facilities

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2019; Errata 19-1; Errata 19-2; TIA 19-1; TIA 19-2; TIA 19-3; TIA 19-4; Errata 19-3; Errata 20-4; TIA 19-5; TIA 19-6) Standard for the Installation of Sprinkler Systems
~~NFPA 13R~~	~~(2022) Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies~~
~~NFPA 15~~	~~(2022) Standard for Water Spray Fixed Systems for Fire Protection~~
NFPA 24	(2022) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 291	(2016) Recommended Practice for Fire Flow Testing and Marking of Hydrants

NFPA 1963 (2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7 (2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL 199 (2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service

UL 262 (2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service

UL 312 (2010; Reprint Mar 2018) UL Standard for Safety Check Valves for Fire-Protection Service

UL 405 (2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices

UL 668 (2004; Reprint Jul 2016) UL Standard for Safety Hose Valves for Fire-Protection Service

UL Fire Prot Dir (2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide wet pipe ~~[~~sprinkler~~][water spray]~~ system(s) in ~~[~~all areas of the building~~][areas indicated on the drawings] [_____]~~. Except as modified herein, the system must meet the requirements of NFPA 13~~[NFPA 13R][~~ and ~~][NFPA 15]~~ UFC 3-600-01. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

1.2.1.1 Basis for Calculations

A waterflow test was performed on ~~[~~12-14-2021~~DATE]~~ at ~~[LOCATION]~~the P4638 site with the pressure hydrant off D st. between 7th and 8th street and the flow hydrant on 7th st and D st and resulted in a static pressure of ~~[~~56~~_____~~ psi~~]~~ with a residual pressure of ~~[~~54~~_____~~ psi~~]~~ while flowing ~~[_____~~ 1,020 gpm~~]~~. The waterflow test for the P4639 site was also performed on 12-14-2021 with the pressure hydrant North of M446 by Pavillion and the flow hydrant South of M446 by Pond and resulted in a static pressure of 60 psi with a residual pressure of 54 psi while flowing 880 gpm. Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be

based on flow test noted in this paragraph~~, unless [verified by the NAVFAC[_____] Fire Protection Engineer and] approved by Contracting Officer.~~. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping~~, [and [_____] for existing underground piping].[Hydraulic calculations must be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.] [The minimum residual pressure in a service lateral (lead-in) at the [design flow rate][150 percent of the fire pump rated flow] must be 20 psi at [the inlet to the backflow preventer][the suction side of the fire pump]]~~.

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or ~~[~~12 psi for reduced pressure ~~][8 psi for double check]~~ backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.1.3 Design Criteria

Hydraulically design the system ~~to discharge a minimum density [of [_____] gpm/square foot over the hydraulically most demanding [_____] square feet of floor area][~~as indicated on the drawings~~]~~. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13 and UFC 3-600-01. Add an allowance for exterior hose streams ~~of [_____] gpm to the sprinkler system demand [~~at the fire hydrant shown on the drawings closest to the point where the water service enters the building~~] [at the point of connection to the existing water system]~~.~~[An allowance for interior hose stations of [_____] gpm must be added to the sprinkler system demand.]~~

1.2.2 Sprinkler Coverage

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the ~~[~~building~~][area noted on the Contract drawings]~~. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13. ~~Exceptions are as follows:~~

~~a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.~~

~~b. Facilities that are designed in accordance with NFPA 13R.~~

1.2.3 Qualified Fire Protection Engineer (QFPE)

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government ~~[~~and final Government ~~]~~functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[for Contractor Quality Control approval.][~~for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.~~]~~ Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for

completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G~~[, [_____]]~~

Sprinkler System Designer; G~~[, [_____]]~~

Sprinkler System Installer; G~~[, [_____]]~~

SD-02 Shop Drawings

Shop Drawing; ~~G[, [_____]]~~

SD-03 Product Data

Pipe; ~~G[, [_____]]~~

Fittings; ~~G[, [_____]]~~

Valves, including gate, check, butterfly, and globe; ~~G[, [_____]]~~

~~Alarm Valves; G[, [_____]]~~

Relief Valves; ~~G[, [_____]]~~

Sprinklers ; ~~G[, [_____]]~~

Pipe Hangers and Supports ; ~~G[, [_____]]~~

Sprinkler Alarm Switch; ~~G[, [_____]]~~

Valve Supervisory (Tamper) Switch; ~~G[, [_____]]~~

Fire Department Connection; ~~G[, [_____]]~~

Backflow Prevention Assembly; ~~G[, [_____]]~~

Air Vent; ~~G[, [_____]]~~

Hose Valve; ~~G[, [_____]]~~

~~[~~ ~~Seismic Bracing; G[, [_____]]~~

~~]~~ Nameplates; ~~G[, [_____]]~~

SD-05 Design Data

~~[~~ ~~Seismic Bracing; G[, [_____]]~~

~~Load calculations for sizing of seismic bracing~~

~~]~~ Hydraulic Calculations; ~~G[, [_____]]~~

SD-06 Test Reports

Test Procedures; G~~[, [_____]]~~

SD-07 Certificates

Verification of Compliant Installation; G~~[, [_____]]~~

Request for Government Final Test; G~~[, [_____]]~~

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G~~[, [_____]]~~

Spare Parts Data; G~~[, [_____]]~~

SD-11 Closeout Submittals

As-built drawings

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

Within 36 days of contract award but no less than ~~[~~14 days~~][_____]~~ prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.4.1.1 Shop Drawing

~~[~~Provide~~_____]~~ copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than ~~[ISO A1][ANSI D]~~[the Contract Drawings~~]~~. Each set of drawings must include the following:

a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

b. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, and other details required to clearly describe the proposed arrangement.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler

above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

e. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

f. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

g. Details of each type of riser assembly, pipe hanger, [sway bracing for earthquake protection,]and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

h. Details of each type of pipe hanger[, seismic bracing/restraint] and related components.

[i. Include fire pump curve with shop drawings and hydraulic calculations.

]1.4.1.2 Product Data

[Provide_____] copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.4.1.3 Hydraulic Calculations

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings.[Calculations must include isometric diagram indicating hydraulic nodes and pipe segments.][Include fire pump curve with submittal.]

1.4.1.4 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide [six][_____] manuals[and one pdf version on electronic media]. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.[Each service organization submitted must be capable of providing [4][_____]-hour on-site response to a service call on an emergency basis.]

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after

1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.4.2 Qualifications

1.4.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level ~~[~~III~~][IV]~~ Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.4.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item or equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.6 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of material. Material and equipment must be standard products of a manufacturer regularly engaged in the manufacture of the products for at least ~~[~~2~~][_____]~~ years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address,

type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than ~~[~~175~~][250]~~ psi.

2.2 UNDERGROUND PIPING COMPONENTS

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is ~~[4 inches][~~6 inches~~]~~. ~~Piping more than 5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.~~ A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve~~[~~ and Indicator Posts~~]~~

Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262.~~[Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.]~~

~~[2.2.4 Valve Boxes~~

~~Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes must be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter must be 5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 10 mils.~~

~~]~~2.2.4 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

~~[~~Steel pipe must be minimum Schedule 40 for sizes 2 inches and less; and minimum Schedule 10 for sizes larger than 2 inches.~~]~~~~[Steel pipe must be Schedule 40 only.]~~ Steel piping with wall thickness less than Schedule 40 must not be threaded. ~~[Grooved pipe must be cut-grooved.]~~

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound.~~[Saddle tees using rubber gasketed fittings are permitted only when connecting to existing piping for additions or modifications. Saddle tees must use a connection method that completely wraps around the pipe.]~~ Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 175 psi service and the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 2 inches and larger. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thick, and full face or self-centering flat ring type.

~~[2.3.2 Copper Tube Components~~

~~2.3.2.1 Copper Tube~~

~~Copper tube must conform to ASTM B88, Types L and M.~~

~~2.3.2.2 Copper Fittings and Joints~~

~~Cast copper alloy solder-joint pressure fittings must conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.~~

~~][2.3.3 Plastic Piping Components~~

~~2.3.3.1 Plastic Pipe~~

~~Plastic pipe must be chlorinated polyvinyl chloride (CPVC) conforming to ASTM F442/F442M, 175 psi rating and listed for use in wet pipe sprinkler systems.~~

~~2.3.3.2 Plastic Fittings~~

~~Plastic fittings must be chlorinated polyvinyl chloride (CPVC) and listed for use in wet pipe sprinkler systems.~~

~~]~~2.3.2 Flexible Sprinkler Hose

~~[The use of flexible hose is [~~not ~~]~~permitted.~~][Flexible sprinkler hose must comply with UL 2443 and FM 1637.]~~

2.3.3 Pipe Hangers and Supports

Provide galvanized pipe hangers~~[, supports and seismic bracing][and supports]~~ in accordance with NFPA 13.~~[Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category ["D"]["_____"]]~~.

2.3.4 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.4.1 Control Valve

Manually operated sprinkler control/gate valve must be~~[outside stem and yoke (OS&Y) type][or][butterfly type][~~ as indicated on the drawings~~]~~ and must be listed.

2.3.4.2 Check Valves

Check valves must comply with UL 312. Check valves 4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 6 inches.

2.3.4.3 Hose Valve

Valve must comply with UL 668.

2.3.5 ~~[Alarm][~~Riser Check~~]~~ Valves

~~[~~Provide riser check valve, pressure gauges and main drain. ~~][Provide variable pressure type alarm check valve, standard trim piping, pressure gauges, bypass, retarding chamber, testing valves, and main drain, and other components as required for a fully operational system. Alarm valves must comply with UL 193.]~~

2.4 ALARM INITIATING AND SUPERVISORY DEVICES

2.4.1 Sprinkler Alarm Switch

Vane ~~or pressure-type~~ flow switch(es). ~~[~~Connection of switch must be by the fire alarm installer~~]~~. ~~[~~Vane type alarm actuating devices must have mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and must instantly recycle. ~~][~~Flow switches for elevator power shunt must not have a retard feature.~~]~~

2.4.2 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

~~[~~2.5 BACKFLOW PREVENTION ASSEMBLY

~~[Reduced-pressure principle][~~Double-check~~]~~ valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.5.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain.

~~]~~2.6 FIRE DEPARTMENT CONNECTION

Fire department connection must be ~~[freestanding][~~projecting~~][flush]~~ (if not wall mounted) or flush (if wall mounted) type with cast-brass body, matching ~~[~~wall~~]~~ escutcheon lettered "Auto Spkr" with a ~~[~~polished-brass ~~][chromium-plated]~~ finish. ~~[~~The connection must have individual self-closing clappers, caps with drip drains and chains.~~]~~ Female inlets must have ~~[2-1/2-inch][4-inch][~~5-inch~~][_____]~~ diameter Storz connection on a 30 degree galvanized elbow pointed down towards the FDC per base standards. ~~[~~American National Fire Hose Connection Screw Threads (NH) per NFPA 1963~~] [Storz][_____]~~. Comply with UL 405.

2.7 SPRINKLERS

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only.

2.7.1 Pendent Sprinkler

Pendent sprinkler must be~~[recessed][~~ quick-response~~][dry pendent]~~ type with nominal K-factor ~~of [5.6][8.0][11.2][_____]~~ as required by UFC 3-600-01 and NFPA 13. Pendent sprinklers must have a ~~[polished chrome][stainless steel][white polyester][_____]~~ finish as indicated on the drawings. Assembly must include an integral escutcheon.

2.7.2 Upright Sprinkler

Upright sprinkler must be ~~[brass][chrome-plated][stainless steel][white polyester] [~~ quick-response type~~][_____]~~ and have a nominal K-factor ~~of [5.6][8.0][11.2][_____]~~as required by UFC 3-600-01 and NFPA 13.

2.7.3 Sidewall Sprinkler

Sidewall sprinkler must be the ~~[~~quick-response~~][standard-response] [recessed][dry sidewall]~~ type. Sidewall sprinkler must have a nominal K-factor as required by UFC 3-600-01 and NFPA 13.~~of [5.6][8.0][11.2][_____].~~ Sidewall sprinkler must have a ~~[brass][polished-chrome][stainless steel][white polyester][_____]~~ finish as indicated on the drawings.

~~[~~2.7.4 Concealed Sprinkler

Concealed sprinkler must be ~~[chrome-plated][stainless steel][white polyester] [~~quick-response type~~][_____]~~ and have a nominal K-factor ~~of [5.6][8.0][11.2][_____]~~as required by UFC 3-600-01 and NFPA 13.~~.~~ Coverplate must be ~~[chrome][~~white~~][_____]~~. Provide in all areas with finished ceilings.

~~][2.7.5 Residential Sprinkler~~

~~Residential sprinkler must be [recessed pendent][pendent][sidewall] type with nominal K-factor of [4.2][5.6]. Residential sprinkler must have a [polished-chrome][white polyester][_____] finish. Sprinkler must comply with UL 1626.~~

~~[~~2.7.5 Corrosion-Resistant Sprinkler

Corrosion-resistant sprinkler must be the ~~[~~upright~~]~~ or ~~[~~pendent~~]~~ type installed in locations as indicated. Corrosion-resistant coatings must be factory-applied by the sprinkler manufacturer.

~~][~~2.7.6 Dry Sprinkler Assembly

~~Dry sprinkler assembly must be of the[pendent][sidewall][45-degree] type as indicated. Assembly must include an integral escutcheon. Maximum length must not exceed maximum indicated in its listing. Sprinkler must have a [polished chrome][polyester coating][white enamel] finish.~~

~~][2.7.7 Control Mode Specific Application Sprinkler~~

~~Control mode specific application sprinkler must be of the [pendent][upright][dry sidewall] type as indicated. Sprinkler must be specifically listed for high-piled storage only. Sprinkler must have a [polished chrome][rough brass] finish.~~

~~][2.7.8 ESFR Sprinkler~~

~~ESFR sprinkler must be [pendent][upright] and comply with UL 1767. Nominal K-factor must be [_____].~~

~~][2.7.9 Intermediate Level Rack Sprinkler~~

~~Intermediate level rack sprinkler must be of the [upright][pendent] type with nominal K-factor of [5.6][8.0]. The sprinkler must be equipped with a deflector plate to shield the fusible element from water discharged above it.~~

~~]~~2.8 ACCESSORIES

2.8.1 Sprinkler Cabinet

Provide spare sprinklers in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.8.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.8.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.8.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located ~~[_____][~~within 7 feet of the floor~~]~~ and ~~[~~as indicated~~]~~.

2.8.5 Relief Valve

Relief valves must be listed and installed at the riser in accordance with NFPA 13.

2.8.6 Air Vent

Air vents must be of the automatic type and piped to drain to the building exterior.

2.8.7 Identification Sign

Valve identification sign must be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative a condition that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.~~[Installation of in-rack sprinklers must comply with applicable provisions of NFPA 13.]~~ Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) that are concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the

contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be ~~[3][_____] feet or the frost line, whichever is deeper~~1 foot below the frost line. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. ~~Piping more than 5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.~~

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

Seismic restraint is ~~[~~not ~~]~~required.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Pendent Sprinklers

a. Drop nipples to pendent sprinklers must consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (plus or minus 2 inches).~~[~~

~~e. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.][~~

~~f. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.][~~

~~g~~e. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 12 inches for steel pipe~~ and 6 inches for copper tube~~.~~]~~

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel,

ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

~~d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.~~

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Unless otherwise indicated, the test connection must consist of 1-inch pipe connected ~~[~~to the remote branch line~~]~~ or ~~[~~at the riser as a combination test and drain valve~~]~~; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

~~Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.~~

Install backflow preventers so that the bottom of the assembly is a minimum of 6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than

[_____]24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than [_____]6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 6 inches above grade/finished floor and away from walls.

[3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing.

]3.4.12 Drains

a. Main drain piping must be provided to discharge [at a safe point outside the building, no more than 2 feet above finished grade]][at the location indicated]][or]to the sanitary sewer]. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted [on the exterior wall approximately 3 feet above finished grade][adjacent to and on the sprinkler system side of the backflow preventer]. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75-inch in height and visible from the floor.[Provide properly lettered and approved metal sign to elevator flow switch stating the circuits' voltage, and identify the switch as an "Elevator Power Shunt Flow Switch".]

3.5 ELECTRICAL

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.~~{~~ Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.~~}~~

3.6 PAINTING

Color code mark piping ~~{~~red~~}[as specified in Section 09 90 00 PAINTS AND COATINGS]~~.

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level ~~{~~ III~~}[or][IV]~~ Fire Sprinkler Technician, and the representative of the installing company,~~{~~ and reviewed by the QFPE~~} [60][_____] days prior to performing system tests~~. Detailed test procedures must list all components of the installed system. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13). The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13. The Contractor ~~{~~and QFPE~~}~~ must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the ~~{_____}[~~Designated Fire Protection Engineer (DFPE)~~}[Contracting Officers Designated Representative (COR)]~~. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections

to the ~~[~~building fire alarm system~~][installation fire alarm reporting system]~~ have been completed and tested to confirm communications are fully functional. Submit request for test at least ~~[~~15~~][_____]~~ calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

~~[~~b. The contractor's Qualified Fire Protection Engineer (QFPE).~~]~~

c. Marked-up red line drawings of the system as actually installed.

Government Final Tests will be witnessed by the ~~[_____], [~~Designated Fire Protection Engineer~~][Contracting Officer][~~, Qualified Fire Protection Engineer (QFPE)~~]~~. At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.8.1 Underground Piping

3.8.1.1 Flushing

Underground piping must be flushed at a minimum of 10 fps in accordance with NFPA 24.

3.8.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

3.8.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.8.3 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

~~[~~ a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings.~~]~~ ~~[Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation][AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]~~

b. Provide operating and maintenance (O&M) instructions.

3.10 ONSITE TRAINING

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of ~~[_____]~~[8~~4~~] hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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SECTION 22 00 70

PLUMBING FOR HEALTHCARE FACILITIES
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.3/CSA 4.3	(2019) Gas-Fired Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous
ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2015) Scheme for the Identification of Piping Systems
ASME A112.1.2	(2012; R 2017) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.6.1M	(1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2019) Standard for Floor and Trench Drains
ASME A112.14.1	(2003; R 2017) Backwater Valves
ASME A112.18.1	(2018) Plumbing Supply Fittings
ASME A112.19.2/CSA B45.1	(2018; ERTA 2018) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.3/CSA B45.4	(2017; Errata 2017) Stainless Steel Plumbing Fixtures
ASME A112.36.2M	(1991; R 2017) Cleanouts

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.34	(2017) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2018) Power Piping
ASME B31.5	(2020) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME CSD-1	(2016) Control and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2016) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1010	(2004) Performance Requirements for Water Hammer Arresters (ANSI approved 2004)
ASSE 1011	(2004; Errata 2004) Performance Requirements for Hose Connection Vacuum Breakers (ANSI approved 2004)
ASSE 1012	(2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)
ASSE 1013	(2011) Performance Requirements for Reduced Pressure Principle Backflow

	Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)
ASSE 1018	(2001) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002
ASSE 1019	(2011; R 2016) Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies
ASSE 1037	(2015; R 2020) Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures
ASSE 1070	(2015) Performance Requirements for Water Temperature Limiting Devices
ASSE 1071	(2012) Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2010; Addenda 2011) Hypochlorites
AWWA B301	(2010) Liquid Chlorine
AWWA C203	(2008) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(2015) Grooved and Shouldered Joints
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C652	(2019) Disinfection of Water-Storage Facilities
AWWA D100	(2011) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

AWS B2.1/B2.1M	(2014; Errata 2015) Specification for Welding Procedure and Performance Qualification
AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A74	(20207) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	(2018) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A193/A193M	(2019) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A515/A515M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A888	(2020) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B370	(2012; R 2019) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1053	(2000; R 2010) Standard Specification for

	Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2729	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D2846/D2846M	(2019) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2007; R 2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3311	(2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM D4586/D4586M	(2007; E 2012; R 2012) Asphalt Roof Cement, Asbestos-Free
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers

ASTM F402 (2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

ASTM F477 (2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASTM F656 (2010) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

ASTM F1290 (2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings

ASTM F1412 (2016) Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems

ASTM F2618 (2019) Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301 (2018) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

CISPI 310 (2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (2016; 14/17) Copper Tube Handbook

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual (10th Edition) Manual of Cross-Connection Control

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO Z124.5 (2013; E 2013; R 2018) Plastic Toilet Seats

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 COMM (2017) Standard And Commentary Accessible and Usable Buildings and Facilities

ICC IPC (2018) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2014) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017; Errata 1 2017) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NACE INTERNATIONAL (NACE)

NACE SP0169	(2013) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2018) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA Z535.1	(2017) Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2018) National Fuel Gas Code
NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2019) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2019) Drinking Water System Components - Health Effects
NSF/ANSI 372	(2016) Drinking Water System Components - Lead Content

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2009) Hose Clamp Specifications

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 430	Energy Conservation Program for Consumer Products
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
40 CFR 50.12	National Primary and Secondary Ambient Air Quality Standards for Lead

UNDERWRITERS LABORATORIES (UL)

UL 508	(2018) UL Standard for Safety Industrial Control Equipment
UL 778	(2016; Reprint Jan 2019) UL Standard for Safety Motor-Operated Water Pumps
UL 1951	(2011; Reprint Aug 2017) UL Standard for Safety Electric Plumbing Accessories

UNIFIED FACILITIES CRITERIA (UFC)

UFC 3-310-04	Seismic Design of Buildings
UFC 4-510-01	Design: Military Medical Facilities

1.2 SYSTEM DESCRIPTION

Provide complete and operable plumbing systems including sanitary and storm drainage, domestic water, plumbing fixtures, valves, pumps, water heaters, supports, and all associated appurtenances.

1.2.1 Performance Requirements

1.2.1.1 Cathodic Protection and Pipe Joint Bonding

Provide cathodic protection and pipe joint bonding systems in accordance with Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE) and Section 26 42 19.00 20 CATHODIC PROTECTION BY IMPRESSED CURRENT).

1.2.2 Accessibility of Equipment

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, and equipment requiring access, in locations freely accessible through access doors.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System; G

SD-03 Product Data

Pipe and Fittings; G

Pipe Hangers, Inserts, and Supports; G

Valves; G

Plumbing Fixtures; G

Backflow Preventers; G

Drains and Backwater Valves; G

Cleanouts; G

Water Heaters; G

Storage Tanks; G

Pumps; G

Vibration-Absorbing Features; G

Plumbing System

SD-06 Test Reports

Tests, Flushing and Disinfection

Test of Backflow Prevention Assemblies

SD-07 Certificates

Materials and Equipment

Welding

Bolts

SD-10 Operation and Maintenance Data

Plumbing System; G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Manufacturer Qualifications

Engage manufacturers regularly manufacturing, supplying, and servicing of specified products and equipment, as well as, providing engineering and/or start-up services as specified. Provide evidence demonstrating compliance for a minimum of 5 years, and on 5 projects of similar complexity.

1.4.1.2 Installer Qualifications

Installer must be licensed, and must provide evidence of the successful completion of at least five projects of equal or greater size and complexity. Provide tradespeople skilled in the appropriate trade.

1.4.2 Welding

Weld piping in accordance with qualified procedures using performance-qualified welders and welding operators. Submit a list of names and identification symbols of qualified welders and welding operators. Provide documentation that welders, and welding operators are certified in accordance with American Welding Society Standard AWS B2.1/B2.1M. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests, and perform the tests at the work site if practicable. Welders or welding operators must apply their assigned symbols near each weld they make as a permanent record.

1.4.3 Regulatory Requirements

1.4.3.1 International Code Council (ICC) Codes

Unless otherwise required herein, perform plumbing work in accordance with the ICC IPC.

a. For ICC Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

b. For ICC Codes referenced in the Contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this Contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by their administrative cognizance and the FAR.

1.4.3.2 Referenced Publications

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.4 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.5 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 MAINTENANCE

Provide extra materials as follows:

a. Four additional cartridges for each waterless urinal installed along with any tools needed to remove/install the cartridge. Provide an additional quart of biodegradable liquid for each urinal installed.

b. One spare electrode cell for the copper-silver ionization system.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment must essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Provide standard products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

2.2 MANUFACTURER'S NAMEPLATE

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. See also paragraph "Nameplates" in PART 3.

2.3 MATERIALS AND EQUIPMENT

Submit manufacturer's catalog data with highlighting to show model, size, options, and other features, that are intended for consideration. Provide adequate data to demonstrate compliance with Contract requirements. Submit certificate stating that the design, fabrication, and installation conform to the code, where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code.

a. Provide cast-iron pipe containing a minimum of 100 percent recycled content. Provide data identifying percentage of recycled content for cast iron pipe. Hubless cast-iron soil pipe installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors is not acceptable.

b. The use of lead containing materials or equipment in any potable water system is not acceptable. Comply with PL 93-523, NSF/ANSI 61, Section 8, and NSF/ANSI 372 for inline devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers. Comply with NSF/ANSI 61, Section 9, and NSF/ANSI 372 for endpoint devices such as water coolers, lavatory faucets, kitchen and bar faucets, ice makers, supply stops and endpoint control valves used to dispense water for drinking.

2.4 PIPE AND FITTINGS

2.4.1 Domestic Water Piping

Domestic water piping at service entrance (from 1 foot inside building to 5 feet outside): Provide same as indicated for outside utilities.

a. 2 inches and smaller after service entrance above grade:

(1) Provide copper tube conforming to ASTM B88, type L, with soldered joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

b. 2 1/2-inch and larger after service entrance above grade:

(1) Provide copper tube conforming to ASTM B88, type L, with brazed joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

c. Below grade:

(1) Provide copper tube conforming to ASTM B88, type K soft, with brazed joints and wrought copper ASME B16.22 fittings.

(2) Where below-grade run of piping is shorter than 50 feet, below-grade joints are not acceptable.

2.4.2 Deionized and Reverse Osmosis Water Piping

CPVC Plastic Pipe, Fittings, and Solvent Cement: Provide ASTM D2846/D2846M, Schedule 80 CPVC. Provide transition union connections or threaded gate valve between copper tubing and chlorinated polyvinyl chloride (CPVC) piping. Provide male threaded adapters with PTFE (polytetrafluoroethylene) pipe thread paste for threaded connections to valves, strainers, and equipment.

2.4.3 Drainage Piping (Soil, Waste, Vent, Indirect, and Storm)

a. Above grade:

(1) Provide cast-iron conforming to ASTM A74, hubbed pipe and fittings with ASTM C564 elastomeric push joints.

(2) Provide cast-iron conforming to CISPI 301 or ASTM A888, hubless pipe, fittings, and CISPI 310 elastomeric sealing sleeves with stainless-steel or cast iron clamps.

b. Below grade:

(1) Provide cast-iron conforming to ASTM A 74, hubbed pipe and fittings with ASTM C564 elastomeric push joints.

c. Foundation Drain:

(1) Provide PVC solid-wall pipe, iron pipe size (IPS), 4 inches in diameter, perforated, conforming to ASTM D2729. PVC socket fittings conforming to ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide PVC pipe and fittings manufactured from ASTM D1784 PVC compound cell class of 12454 and conforming to NSF/ANSI 14.

2.4.4 Drainage Piping (Corrosive Waste)

a. Above grade:

(1) Provide corrosive waste borosilicate glass conforming to ASTM C1053, with mechanical joints and borosilicate glass fittings.

(2) Provide corrosive waste Schedule 40 fire retardant polypropylene DWV pipe and fittings conforming to ASTM D4101, ASTM F1412, ASTM D635, and ASTM D3311. Mechanical joints, and fused joints are acceptable in exposed (accessible) locations. Fused joints only are acceptable in concealed (non-accessible) locations.

(3) Provide CPVC drainage pipe and drainage pattern fittings conforming to ASTM F2618. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide CPVC pipe and fittings manufactured from ASTM D1784 CPVC Type IV compound cell class of 23447 and conforming to NSF/ANSI 14.

b. Below grade:

(1) Corrosive waste Schedule 80 polypropylene DWV pipe and fittings conforming with ASTM D4101 and ASTM D3311 with fused joints.

(2) Provide CPVC drainage pipe and drainage pattern fittings conforming to ASTM F2618. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide CPVC pipe and fittings manufactured from ASTM D1784 CPVC Type IV compound cell class of 23447 and conforming to with National Sanitation Foundation (NSF) Standard 14.

2.4.5 Exposed Piping in Finished Areas

a. Chrome or nickel plated brass to wall or floor.

b. Piping 2 inches and larger may be provided with chrome or nickel plated brass sleeves to cover pipe and fittings in lieu of plating.

2.4.6 Trap Primer Pipe Between Primer Device and Drain

a. Above grade: Copper tube conforming to ASTM B88, type K or L, with soldered joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

b. Below grade: Copper tube conforming to ASTM B88, type K soft, with soldered joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

2.5 PIPE JOINT MATERIALS

The use of grooved pipe and hubless cast-iron soil pipe underground is not acceptable. Mark cast iron soil pipe and fittings with the collective trademark of the Cast Iron Soil Pipe Institute. Provide joints and gasket materials conforming to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310

b. Flange Gaskets: Provide gaskets of non-asbestos material in accordance with ASME B16.21. Provide flat gaskets, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Provide full face or self centering

flat ring type gaskets. Provide gaskets bonded with NBR for hydrocarbon service.

c. Brazing Material: Conform to AWS A5.8/A5.8M, BCuP-5.

d. Brazing Flux: Provide flux in paste or liquid form appropriate for use with brazing material. Provide flux as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

e. Solder Material: Solder metal conforming to ASTM B32 and Code approved "Lead Free" having a chemical composition equal to or less than 0.2 percent lead.

f. Solder Flux: Liquid form, non-corrosive, Code approved "Lead Free" and conforming to ASTM B813, Standard Test 1.

g. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

h. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

i. Rubber Gaskets for Grooved Pipe: ASTM D2000, rated for a maximum temperature of not less than 230 degrees F.

j. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

k. Flanged fittings including flanges, bolts, nuts, bolt patterns, and related features, in accordance with ASME B16.5 class 150 and having the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material conforming to ASTM A105/A105M. Blind flange material conforming to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Provide high strength or intermediate strength bolts with material conforming to ASTM A193/A193M. Submit written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

2.6 MISCELLANEOUS MATERIALS

Miscellaneous materials conforming to the following:

a. Water Hammer Arrester: PDI WH 201. Provide diaphragm or piston type water hammer arrester.

b. Copper, Sheet, and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D4586/D4586M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material must be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof, and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Gauges - Pressure Indicating Dial Type - Elastic Element: ASME B40.100.

l. Thermometers: ASTM E1. Mercury in thermometers is not acceptable.

2.7 PIPE INSULATION MATERIAL

Provide insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 PIPE HANGERS, INSERTS, AND SUPPORTS

Provide pipe hangers, inserts, and supports conforming to MSS SP-58. Provide non-ferrous (copper, aluminum, stainless steel hangers in MRI Suites.

2.9 VALVES

Provide valves on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller must be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger must have flanged iron bodies and bronze trim. Base valve pressure ratings on the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Provide valves conforming to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810

Description	Standard
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code, Part CW, Article 5

2.9.1 Thermostatic Mixing Valves

2.9.1.1 Master Mixing Valve Assemblies

ASSE 1017. Provide lead-free high/low type mixing valve assembly with large type thermostatic water mixing valve and intermediate type thermostatic water mixing valve. Provide union angle strainers, checkstops on inlets outlets, and ball valves on outlets of mixing valves. Provide pilot actuated regulating valve with pressure gage, thermostat, adjustable limit stop, and dial thermometer (range) (range 0 to 200 degrees F). Provide mixing valve components with rough bronze finish and mount on welded strut with corrosion resistant wall support and inlet piping manifold. Provide entire assembly factory assembled and tested. Pipe mixing valve assembly and domestic hot water return according to manufacturer's recommended piping method. Set mixing valve outlet temperature as indicated on Contract Drawings. Provide mixing valves which maintain water temperature within 4 degrees F of setpoint.

ASSE 1017. Provide lead-free digital water temperature control and monitoring system with full-color touchscreen interface configurable on site without dedicated software, computer interface and no required factory pre-programming and control of water temperature setpoint within 2 degrees F through full flow range of mixing valve. Provide password protected controller with user-adjustable outlet temperature range of 80 to 180 degrees F, digital monitoring of inlet water pressures and temperatures, mixed outlet temperature, mixed outlet setpoint, pressure, flow and return water temperature, user-set high-temperature sanitization mode. Provide controller with Bacnet and Modbus protocols for interface with building automation systems. Shutdown mixing valve assembly hot water supply upon the loss of cold water or power. Set mixing valve outlet temperature as indicated on Contract Drawings.

2.9.1.2 Lavatory and Sink Mixing Valves

ASSE 1070. Provide line size mixing valves for each lavatory and/or sink faucet in restrooms. Provide mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced constructed with rough or finish bodies either with or without plating. Each valve must be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. Provide heavy cast bronze body, and interior parts of brass, bronze, corrosion-resisting steel or copper materials. Equip the valve with stop valves, check valves, unions, and sediment strainers on the inlets. Set mixing valves at 105 degrees F. Mixing valves must maintain water temperature within 4 degrees F of setpoint.

2.10 PLUMBING FIXTURES

2.10.1 General

Provide water conservation type fixtures. Provide fixtures for use by the physically handicapped in accordance with ICC A117.1 COMM. Provide vitreous china fixtures that are nonabsorbent, hard-burned, and vitrified throughout the body. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Equip fixtures with appurtenances such as traps, faucets, stop valves, and drain fittings. Equip each fixture and piece of equipment requiring connections to the drainage system with a trap. Provide brass expansion or toggle bolts capped with acorn nuts for supports, and provide polished chromium-plated pipe, valves, and fittings where exposed to view. Equip fixtures with the supply discharge below the rim with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years or must be copper alloy with all visible surfaces chrome plated. Plastic in contact with hot water must be suitable for 180 degrees F water temperature. Maximum allowable lead content in wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures, as determined by a weighted average must not exceed 0.25 percent. Provide water closets, urinals, flush valves, lavatory faucets, bathroom sink faucets, and shower heads with WaterSense label.

2.10.2 Flushometer Valves

Provide flushometer valves with an ADA compliant, metal oscillating, non-hold-open handle, backcheck angle control stop, and vacuum breaker. Flushometer valves must be either a large diaphragm, or fixed volume piston type with filtered metering bypass. Valve must not be able to be converted externally or internally to exceed a low consumption flush. Provide handle packing, main seat, stop seat and vacuum breaker molded from a chloramine resistant rubber compound. Provide valve body, cover, tailpiece and control stop in conformance with ASTM Alloy Classification for semi-red brass. Provide all exposed surfaces chrome plated. Provide handle with factory applied antimicrobial coating. Provide flushometer valves conforming to ASSE 1037.

2.10.3 Automatic Controls

Where specified with a fixture, provide automatic, sensor operated faucets complying with ASSE 1037 and UL 1951. Provide faucet systems consisting of solenoid-activated valves with light beam sensors.

2.10.4 Fixture Descriptions

2.10.4.1 Electric Water Coolers

Provide self-contained, mechanically refrigerated electric water coolers with more than a single thickness of metal between the potable water and the refrigerant in the heat exchanger, wall-hung, bubbler style, air-cooled condensing unit, stainless steel splash receptor and basin, and stainless steel cabinet. Provide 8 gph minimum capacity of 50 degrees F water when supplied with 80 degrees F inlet water and a 90 degrees F room

temperature. Control bubblers by push levers or push bars, front mounted or side mounted near the front edge of the cabinet. Mount bubbler spouts at a maximum of 36 inches above floor and at front of unit basin with 27 inch minimum knee clearance from bottom of unit to finished floor. Spouts must direct water flow at least 4 inches above unit basin and trajectory parallel or nearly parallel to the front of unit. Provide chrome plated 3/8 inch OD soft-copper tube supplies with set-screw escutcheons, and loose key stops. Provide chrome plated 1-1/4 by 1-1/2 inch semi-cast P-trap with cleanout with 17 gage by 1-1/2 inch chrome plated copper tube trap arm with set-screw escutcheon. Provide ASME A112.6.1M concealed steel pipe chair carriers. Provide electric water cooler that is Energy Star labeled. Provide data identifying Energy Star label for electric water cooler. Mount electric water coolers for use by the physically handicapped at heights in accordance with ICC A117.1 COMM.

2.10.4.1.1 EWC-1 (JSN R2201)

Self-contained, wall hung, mechanically refrigerated, dual-level, brushed stainless steel finish, top mounted bottle filler on non-accessible water cooler, receptors designed to eliminate splashing and standing waste water. Control bubblers by push levers or push bars, front mounted and side mounted near the front edge of the cabinet.

2.10.4.2 Emergency Fixtures

Provide copper alloy control valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum. Provide a pressure-compensated tempering valve, with leaving water temperature setpoint adjustable throughout the range 60 to 95 degrees F.

2.10.4.2.1 EW-1 (Similar to JSN P1965)

Provide eye/face wash, ANSI/ISEA Z358.1, deck-mounted (sink ledge), swing down, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valve. Spray heads swing down from storage to operational position activating water flow. Spray heads shall be provided with flip-top dust covers. Coordinate configuration with sink faucet location. If required due to sink size, faucet shall be offset to allow for proper clearance at the faucet controls. Coordinate exact sink punching requirements prior to purchase. Improperly punched sinks will be replaced at no additional cost to the Government. Unit shall deliver minimum 3 gpm of aerated water at 30 psi flow pressure. Provide with ASSE 1071 thermostatic mixing valve (Joint Schedule Number: P2450). Thermostatic mixing valve shall be a solid bimetal thermostat directly linked to valve porting and capable of compensating for supply temperature and pressure fluctuations. The valve shall be provided with a locking temperature regulator, cold water bypass capable of minimum 4 gpm, 0-140 F dial thermometer, angle check stops and stainless steel cabinet with hinged door with cylinder lock (wall mounted below counter), ANSI/ISEA Z358.1 and ASSE 1071 compliant.

2.10.4.3 Lavatories

a. Provide ASME A112.19.2/CSA B45.1, white vitreous china, integral back type wall hung lavatories with supply openings for use with top mounted faucet, and openings for concealed arm carrier installation. Provide chrome plated 3/8 inch OD soft-copper tube supplies with set-screw escutcheons, and loose key stops. Provide chrome plated

1-1/4 by 1-1/2 inch semi-cast P-trap with cleanout with 17 gage by 1-1/2 inch chrome plated copper tube trap arm with set-screw escutcheon. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 31 inches above the floor, except 34 inches maximum above floor and with 29 inches minimum clearance from bottom of the front rim to floor for accessible lavatories.

b. Wall-Mounted Lavatories (Joint Schedule Number: P3000): White vitreous china with ASME A112.6.1M concealed arm carrier support, with minimum dimensions of 20 inches wide by 18 inches front to rear. Provide ASME 112.18.1 copper alloy centerset faucets with wrist-blade handles unless battery-powered electronic infra-red control is specified in ESR section D20. Faucets shall be EPA "WaterSense" labeled. Provide with laminar flow fitting, adjustable P-traps, and perforated grid strainers. Faucets with wrist-blade handles shall fully open in a quarter-turn. In public restrooms, flow rate shall be limited to 0.5 gpm at a flowing water pressure of 80 psig for manual faucets; electronic faucet cycle time shall be a maximum of 10 seconds. Provide accessible protection on exposed water supplies and P-traps and drain piping.

c. Wall mounted Lavatories (JSN P3100): 20 x 18 inches. Fixture shall be equipped with combination faucet, elevated gooseneck spout with laminar flow outlet, 4 inch wrist action handles, drain fitting with grid strainer, "P" trap, and angle or straight stop valves. Faucet body shall not have a pop-up drain rod hole. Plugged holes are not acceptable. The flow shall be limited to 1.5 gpm at a flowing water pressure of 80 psi.

2.10.4.4 Mop Service Basin

a. MS-1 (JSN P4700): 36 by 24 by 12 inches, precast terrazzo with integral stainless steel caps with tiling flange, 3-inch cast brass drain with stainless strainer, lead caulk drain connection and 20 gage, type 304 stainless steel 12-inch high splash/wall guards. Provide chrome plated, 8-inch centers, wall mounted cast brass service sink faucet with rigid spout with integral vacuum breaker, 3/4-inch hose threads, pale hook, wall brace, indexed lever handles, hose, hose bracket, and mop hanger. Provide ball type shutoff valves and check valves above ceiling in supply piping to mop sink faucet.

2.10.4.5 Showers

Provide single control pressure equalizing shower valves with body mounted from behind the wall with threaded connections. Provide tubing mounted from behind the wall between faucets and shower assembly. Provide separate globe valves or angle valves with union connections in each supply to faucet. Provide top of drain outlets of chromium-plated or polished stainless steel finish. Provide shower valve with ball type control handle.

2.10.4.5.1 SH-1 (JSN P5040)

Wall mounted detachable spray assembly, 24 inch wall bar, elevated vacuum breaker, supply elbow and flange and valve. All external trim, chrome plated metal. Plastic shower head 5 foot length of rubber lined corrosion resistant steel, chrome plated metal flexible, or white vinyl reinforced hose and supply wall elbow. Provide WaterSense labeled shower head with a

maximum flow rate of 1.5 gpm. Provide data identifying WaterSense label for shower head. Design showerhead to fit in palm of hand. Provide corrosion resistant steel or chrome plated metal wall bar with an adjustable swivel hanger for showerhead. Fasten wall bar securely to wall for hand support. Combination thermostatic and pressure anti-scald balancing valve, with chrome plated metal lever type operating handle adjustable for rough-in variations and chrome plated metal or corrosion resistant steel face plate. Provide copper alloy valve body. Internal parts must be copper, nickel alloy, corrosion resistant steel or thermoplastic material. Provide 1/2 inch IPS valve inlets and outlet. Provide external screwdriver check stops, vacuum breaker and temperature limit stops. Set stops for a maximum temperature of 105 degrees F. Provide vandal resistant exposed fasteners. Provide valve with a maximum flow rate of 1.5 gpm at a flowing pressure of 80 psig.

2.10.4.6 Sinks

Provide ASME A112.19.3/CSA B45.4, Type 302(18-8) or 304(18-8) stainless steel sinks with integral mounting rim for flush installation, with undersides fully sound deadened, with supply openings for use with top mounted faucet, and with 3.5 inch drain outlet. Provide 18 gage sinks for basin depths less than or equal to 10 inch. Provide 16 gage sinks for basin depths greater than 10 inch. Aerators are not acceptable. Provide faucets with a maximum flow rate of 1.5 gpm when measured at a flowing water pressure of 60 psig. Provide chrome plated 3/8 inch OD soft-copper tube supplied with escutcheons, and loose key stops. Provide chrome plated 1-1/2 inch semi-cast P-trap with cleanout with 17 gage by 1-1/2 inch chrome plated copper tube trap arm with escutcheon. Provide separate 1.5 inch P-trap and drain piping to vertical vent piping from each compartment. Coordinate hole quantities, locations, and centerings with faucet types indicated in fixture descriptions. Provide exact numbers of holes necessary. Use of faucet hole covers is not acceptable. Dimensions given are overall, and bowl in the following order: front to back, left to right, depth. Provide sinks located in casework designated as handicap accessible same as specified except basin depths not greater than 6 inches and drain outlets located to the rear of basins.

2.10.4.6.1 S-1 (JSN CS010)

Single bowl, counter-mounted, 18 by 15 by 6-1/2 inches, bowl 12 by 12 by 6 inches. Locate drain outlet to the rear of the basin. Provide 4 inch centerset faucet with two 4 inch wristblades and 5 inch diameter fixed gooseneck spout.

2.10.4.6.2 S-4 (JSN CS140)

Single bowl, counter-mounted, 22 by 17 by 10 inches, bowl 16 by 14 by 10 inches. Provide 4 inch centerset faucet with two 4 inch wristblades and 5 inch diameter fixed gooseneck spout.

2.10.4.6.3 S-5 (JSN CS150)

Single bowl, counter-mounted, 22 by 22 by 10 inches, bowl 16 by 19 by 10 inches. Provide 4 inch centerset faucet with two 4 inch wristblades and 5 inch diameter fixed gooseneck spout.

2.10.4.6.4 S-7 (JSN CS200)

Single bowl, counter-mounted, 22 by 31 by 12 inches, bowl 16 by 28 by 12

inches. Provide 4 inch centerset faucet with two 4 inch wristblades and 5 inch diameter fixed gooseneck spout.

2.10.4.7 Service Sinks

ASME A112.19.2/CSA B45.1, white enameled cast iron with integral back and wall hanger supports, minimum dimensions of 22 inches wide by 18 inches front to rear, with two supply openings in 10 inch high back. Provide floor supported wall outlet cast iron P-trap and stainless steel rim guards. Provide back mounted washerless service sink faucets with vacuum breaker and 3/4 inch external hose threads.

2.10.4.8 Urinals

Provide ASME A112.19.2/CSA B45.1, white vitreous china, wall-mounted, wall outlet, urinals with integral trap, drain line connection, and extended side shields. Provide urinals with trap design complying with the IPC. Install urinal rim 24 inches above the floor at non-accessible locations. Mount urinals installed in compliance with ADA requirements with the rim 17 inches above the floor. Provide ASME A112.6.1M concealed chair carriers. Provide urinals equipped with flush valves with a flushing volume of the urinal and flush valve combination not exceeding the fixture design rating. Mount flush valves not less than 11 inches above the fixture.

2.10.4.9 Water Closets

Provide ASME A112.19.2/CSA B45.1, white vitreous china, elongated bowl, wall-hung water closets. Provide water closets with trap design complying with the IPC. Install top of toilet seat 14 to 15 inches, above the floor at non-accessible locations. Mount water closets installed in compliance with ADA requirements with the rim 17 to 19 inches above the floor. Provide water closets equipped with flush valves with a flushing volume of the water closet and flush valve combination not exceeding the fixture design rating. Provide water flushing volume of the water closet and flush valve combination not exceeding 1.28 gallons per flush unless indicated otherwise. Provide white solid plastic elongated open-front seat without cover, with check hinge. Provide seats conforming to IAPMO Z124.5. Mount flush valves not less than 11 inches above the fixture. Mounted height of flush valve must not interfere with the hand rail in ADA stalls. Provide ASME A112.6.1M heavy duty 500 pound capacity chair carriers.

2.10.4.10 Hose Bibbs and Hydrants

2.10.4.10.1 HB-1

Hose bibb with vacuum-breaker backflow preventer, brass construction with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Provide handle securely attached to stem.

2.10.4.10.2 HB-2

Wall hydrant (freezeproof) ASSE 1019 with vacuum-breaker backflow preventer and must have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. Provide brass or bronze operating rod within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining.

Provide brass or bronze valve with coupling and union elbow having metal-to-metal seat. Valve rod and seat washer must be removable through the face of the hydrant. Provide hydrant with 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.11 BACKFLOW PREVENTERS

Provide backflow preventers approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Provide reduced-pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers tested, approved, and listed in accordance with FCCCHR Manual. Provide backflow preventers with intermediate atmospheric vent conforming to ASSE 1012. Provide reduced pressure principle backflow preventers conforming to ASSE 1013. Provide hose connection vacuum breakers conforming to ASSE 1011. Provide pipe applied atmospheric type vacuum breakers conforming to ASSE 1001. Provide pressure vacuum breaker assembly conforming to ASSE 1020. Provide air gaps in plumbing systems conforming to ASME A112.1.2.

2.12 DRAINS AND BACKWATER VALVES

Provide drains and backwater valves installed in connection with waterproofed floors or shower pans equipped with bolted-type device to securely clamp flashing.

2.12.1 Floor and Shower Drains

Provide floor and shower drains with coated cast iron bodies, double drainage pattern for embedding in the floor construction, and seepage pan having weep holes or channels for drainage to the drainpipe. Provide adjustable grate/strainers to compensate for floor thickness. Provide an integral clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane when required. Provide with threaded outlet connection. Between the outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Provide floor and shower drains conforming to ASME A112.6.3. Grate/strainer weight loading classification is based on ASME A112.6.3. Dimensions are nominal. Provide drain with trap primer connection, trap primer, and connection piping.

2.12.1.1 FD-1

12 inch diameter flashing collar, 4 inch deep body and 8 inch diameter removable, non-tilt heavy-duty cast iron grate with minimal free area of 1.5 times free area of outlet pipe size.

2.12.1.2 FD-2

10 inch diameter invertible flashing collar, 2 inch deep body, and minimum 6 inch diameter removable, secured, light-duty nickel bronze strainer with minimum free area of 1.5 times free area of outlet pipe size.

2.12.2 Floor Sinks

Provide floor sinks with coated cast iron bodies, with acid-resisting interior, and double drainage pattern for embedding in the floor construction, and seepage pan having weep holes or channels for drainage

to the drainpipe. Provide an integral clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane when required. Provide with threaded outlet connection. Between the outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Provide floor sinks conforming to ASME A112.6.3. Provide aluminum sediment bucket. Grate/strainer weight loading classification is based on ASME A112.6.3. Dimensions are nominal. Provide full grate free area a minimum of 1.5 times the free area of the outlet pipe size. Provide drain with trap primer connection, trap primer, and connection piping.

2.12.3 Backwater Valves

Provide backwater valves either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Provide backwater valves with cast-iron bodies and cleanouts large enough to permit removal of interior parts. Provide valves of the flap type, hinged or pivoted, with revolving disks. Provide hinge pivots, disks, and seats of nonferrous metal. Provide backwater valves with disks slightly open in a no-flow, no-backwater condition. Extend cleanouts to finished floor fit with threaded countersunk plugs.

2.13 CLEANOUTS

a. Provide cleanouts with coated cast-iron bodies (unless otherwise noted) with extra-heavy, threaded, tapered, brass plug with solid square nut and American Standard pipe threads. Provide flashing collars and clamps for cleanout bodies being installed in floors with finishes installed over waterproofing. Cleanouts on piping completely accessible from within pipe chases do not require covers. Cleanouts in exposed piping in equipment rooms do not require covers.

b. Provide interior floor-mounted cleanouts with a two-piece, threaded, adjustable housing. Provide top and cover based on floor finish:

(1) Resilient tile and sheet finish: Round flange top with scoriated cover.

(2) Ceramic tile finish: Square flange top with scoriated cover.

(3) Poured finish: Round, wide-flange top with scoriated cover.

(4) Carpet finish: Round top with standard top tapped for carpet-marker bolt.

(5) Terrazzo finish: Round top with recessed-for-terrazzo cover.

(6) Quarry tile finish: Square, heavy-duty top with heavy-duty scoriated cover.

(7) Concrete finish (unfinished areas): Heavy, round frame; satin-bronze, scoriated tractor top, ANSI heavy duty load class.

2.14 TRAPS

2.14.1 Fixture Traps

Unless otherwise specified, provide copper-alloy adjustable tube type

traps with slip joint inlet and swivel. Provide traps without a cleanout. Provide tubes of copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Provide inlets with rubber washer and copper alloy nuts for slip joints above the discharge level. Provide swivel joints below the discharge level and must be of metal-to-metal type as required for the application. Provide nuts nuts flats for wrench grip. Provide outlets with internal pipe thread, except that when required for the application, the provide outlets with sockets for solder-joint connections. The depth of the water seal must be not less than 2 inches and not more than 4 inches. The interior diameter must be not more than 1/8 inch over or under the nominal size, and interior surfaces must be reasonably smooth throughout. Provide a copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange for lavatories. The assembly must be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.14.2 Drain Traps

Unless otherwise specified, provide cast iron traps, one piece pattern, deep seal with depth of water seal of 4 inches. The interior diameter must be not more than 1/8 inch over or under the nominal size, and interior surfaces must be reasonably smooth throughout. Provide standard manufactured trap assemblies. Traps for drains located in fan and plenum housings must maintain seal against the static pressure.

2.15 TRAP PRIMER ASSEMBLIES

Provide fully automatic trap primer assemblies, factory assembled and prepiped and including 3/4 inch NPT female inlet, bronze body 3/4 inch female NPT ball valve, 3/4 inch water hammer arrester, ASSE 1001 atmospheric vacuum breaker, and ASTM B88 3/4 inch Type L copper tubing distribution manifold. Provide calibrated distribution manifold to provide equal water distribution to each trap. Provide minimum supply of 2 ounces of water to each trap. Provide manifold with 5/8 inch by 1/2 inch compression fitting outlets. Provide solder joints made of lead free solder. Provide electronic assembly tested and certified per UL 73 and including circuit breaker, 5 second dwell function, manual override, 24 hour geared timer, and solenoid valve. Provide single point water supply and power supply connections. Provide components in a NEMA 250 Type 1 surface mounted cabinet.

2.16 WATER SOFTNERS

The water softener assembly shall consist of a progressive flow, duplex softener unit, designed for the full-flow capacity, and a brine-solution tank for regeneration of the softener exchanger material. Unit shall be a fully automatic, downflow pressure type water softener. The assembly shall be provided with the alarm and controls necessary to provide a complete operable system. The softener tank shell shall be of fiberglass reinforced polyester. The exterior side shall be reinforced by a continuous roving glass filament overwrap of the same color as the vessel shell. The vessel shall be supported by a molded polypropylene structural base. The brine-solutiontank shall be of polyethylene construction. The exchange material shall not require dosing or the adding of any chemical mixture or solution, either to the water to be treated or the water used for backwashing or regeneration, other than common salt (NaCl). The brine-solution tank shall be provided with indicators for measuring the

correct volume of brine for regeneration and shall be of adequate size to provide for necessary salt storage. A hydraulic ejector or motor-driven all-bronze pump with valves, piping, and connections shall be provided for delivering brine to the softeners. The softeners shall be designed for 150 psi working pressure and a temperature of 120 degrees F.

2.16.1 Automatic Operation and Controls

Operation shall be initiated automatically and regeneration of the unit shall continue automatically. Operational power shall be from a 120 volt, 60 Hz, single-phase ac motor or self-contained hydraulic system. Electrically operated units shall be provided with a 15 foot electrical cord and plug cap matching the electrical receptacle provided for service. Electrical control shall be designed to be operated manually in the event of failure of the electrical equipment. The necessary washing, brining, and rinsing operations shall be timed by suitable timing device and carried out without manual attention or supervision other than to keep the salt-storage tank filled. Following complete regeneration, the softening run shall start automatically. Each function of softener operation shall be controlled mechanically or electrically, or by both methods in combination to assure the highest degree of efficiency; and the controls shall be capable of convenient and accurate manual adjustment. The transfer of water and brine solution to and from the water softener shall be accomplished by a single-unit multiple-port valve or by a package-type valve nest for automatic operation.

2.16.2 Multiple-Port Valve

The multiple-port valve shall consist of an assembly of non-sticking, non-leaking, water-lubricated valve ports that connect to the hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet, all enclosed in a single casing. The design shall permit the various steps of operation service, backwash, brine flow, and rinse to be accomplished by the rotation of a shaft that drives the mechanism causing the opening and closing of ports in correct sequence. The design of the valve mechanism shall be such that gradually increasing flows will be attained as ports are opened and initial surges and sudden inrushes of water or brine solutions are avoided. A dial pointer shall indicate each step of the operation.

2.16.3 Package-Type Valve Nest

The package-type valve nest shall consist of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or electrically operated. The nest of valves shall have connections to hard-waterinlet, soft-water outlet, backwash inlet and outlet, and brine inlet. A dial pointer shall indicate each step of the operation.

2.16.4 Backwash and Brine-Rinse Control

Adequate means shall be provided for automatically controlling the rate of backwashing and brine rinsing. Wash and rinse water shall discharge into an open sump or other suitable drain. The controls shall be entirely automatic in operation and shall accurately regulate the rate of backwash and brine rinse as recommended by the softener manufacturer.

2.17 ICEMAKER CONNECTOR BOX

Provide recessed, white powder coated, 20 gage cold rolled steel icemaker

outlet box with ASME A112.18.1 quarter turn valve and rupture protection device.

2.18 WATER HEATERS

Provide water heaters with replaceable anodes. Provide each primary water heater with controls having an adjustable range that includes 90 to 160 degrees F. Provide each gas-fired water heater and booster water heater with controls having an adjustable range that includes 120 to 180 degrees F. Connect hot water systems utilizing recirculation systems into building off-hour controls. The thermal efficiencies and standby heat losses must conform to or exceed the requirements of ASHRAE 90.1 - IP, or 10 CFR 430 whichever is the most stringent for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing pilot-light is not used. Plastic materials, polyetherimide (PEI) and polyethersulfone (PES), are forbidden to be used for vent piping of combustion gases. Provide a factory pre-charged expansion tank on the cold water supply to each water heater. Provide expansion tanks specifically designed for use on potable water systems and rated for 200 degrees F water temperature and 150 psig working pressure.

2.18.1 Performance of Water Heating Equipment

Standard rating condition terms are as follows:

ET	Thermal efficiency with 70 degrees F delta T.
EC	Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).
SL	Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.
HL	Heat loss of tank surface area.
V	Storage volume in liters

2.18.1.1 Storage Water Heaters

2.18.1.1.1 Gas

Storage Capacity or Input Rating of		Rating Condition
100 gallons or less	75,000 Btu/h or less	minimum EF 0.67-0.0019V per 10 CFR 430

more than 100 gallons	more than 75,000 Btu/h	ET 80 percent; maximum SL Q/800+110 square root of V, Btu/h per ANSI Z21.10.3/CSA 4.3.

2.18.1.2 Instantaneous Water Heater

2.18.1.2.1 Gas

Input Rating	Rating Condition	In accordance with
50,000 to 200,000 Btu/h	EF 0.62-0.0019V	10 CFR 430
more than 200,000 Btu/h	ET 80 percent	ANSI Z21.10.3/CSA 4.3

2.18.2 Automatic Storage Type

Provide heaters complete with control system, temperature gauge, and pressure gauge, and ASME rated combination pressure and temperature relief valve.

2.18.2.1 Gas-Fired Type

Provide natural gas fired heaters that are ultra-high efficiency condensing type with minimum 4:1 modulation, facility Direct Digital Control (DDC) system interface module (coordinate DDC communication protocol with system selected), linked operating control system for multiple units with lead/lag capabilities, stainless steel heat exchanger, factory mounted all bronze system circulating pumps, flame sensor and spark ignition, onboard operating and diagnostic controls with LCD display, low NOx operation, sealed combustion, flow switch, ASME T & P relief valves, temperature and pressure gauges, tank sensor, adjustable high limit with manual reset and condensate neutralization kit (1 per heater). Heaters shall be connected to a separate storage tank as shown and in accordance with the Manufacturer's installation requirements. Coordinate flues and hard piped combustion air intakes with Division 23. Coordinate Manufacturer venting requirements for the heater selected with Division 23. Venting requirements may vary from Manufacturer to Manufacturer. Pipe condensate neutralization kit drains to nearest floor drain.

2.18.3 Relief Valves

Provide water heaters and hot water storage tanks with a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve must have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve must have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Provide relief valves rated according to ANSI Z21.22/CSA 4.4. Provide relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh with 3/4 inch minimum inlets, and 3/4 inch outlets. Provide relief valves for

systems where the maximum rate of heat input is greater than 200,000 Btuh with 1 inch minimum inlets, and 1 inch outlets. Provide discharge pipe from the relief valve full size of the valve outlet to the termination point.

2.19 HOT-WATER STORAGE TANKS

Provide hot-water storage tanks constructed by one manufacturer, ASME stamped for the working pressure, and having the National Board (ASME) registration. Provide cement-lined or glass-lined steel type tanks in accordance with AWWA D100. Provide tanks with heat losses conforming to TABLE III as determined by the requirements of ASHRAE 90.1 - IP. Equip each tank with a thermometer, conforming to ASTM E1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Provide thermometers having a separable socket suitable for a 3/4 inch tapped opening. Equip tanks with a pressure gauge 6 inch minimum diameter face. Provide insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide storage tanks capacities as shown.

2.20 PUMPS

2.20.1 Hydraulic Elevator Sump Pumps

Provide sump pump and control system capable of pumping water while containing oil. The system must function automatically and provide an alarm in the event of the presence of oil in the sump, high liquid in the sump, or high amps or a locked rotor condition. An alarm that sounds only in the event of a high liquid condition is not acceptable. Provide submersible type pump. Provide pumps conforming to UL 778 standards and include thermal and overload protection. Provide motor capable of operating continuously or intermittently. Provide motor housing constructed of 304 stainless steel, and mechanical seals housed in a separate oil-filled compartment. Provide controls approved to UL 508 standards and housed in a NEMA 4X enclosure with stainless steel hinged hardware. Provide controls with dual relays with variable sensitivity settings, magnetic contactor with separate over-current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with illuminated red light and alarm silencing switch, dual floats, clearly marked terminal board and remote monitoring contact. Provide all cables between the pump and control unit a minimum of 16 feet long and the cable and plug from the control unit a minimum of 8 feet long. Provide control unit, pump, floats, and sensor probe factory assembled as a complete, ready to use system and tested and approved by a nationally recognized testing laboratory such as ENTELA.

2.20.2 Circulating Pumps

Provide electrically driven, single-stage, centrifugal domestic hot water circulating pumps with mechanical seals, suitable for the intended service and capacities not less than indicated. Provide pumps with revolutions per minute not exceeding 3600. Provide pump and motor supported by the piping on which it is installed. Provide one-piece, heat-treated, corrosion-resisting steel shaft with bronze impeller, sleeve bearings and glands of bronze to accommodate mechanical seals and the housing of close-grained cast iron. Provide pump seals capable of withstanding 240 degrees F temperature without external cooling. Provide motors with sufficient horsepower for the service required, of a type approved by the manufacturer of the pump, and suitable for the available electric service.

Provide pump motors smaller than 1 horsepower with integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide guards to shield exposed moving parts.

2.20.3 Flexible Connectors

Provide flexible connectors at the suction and discharge of each pump that is 1 horsepower or larger. Provide connectors constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Provide line size flexible connectors and suitable for the pressure and temperature of the intended service.

2.21 ELECTRICAL WORK

a. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

b. Provide motors rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor bearings fitted with grease supply fittings and grease relief to outside of the enclosure.

c. Provide controllers and contactors with auxiliary contacts for use with the controls provided. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown. For packaged equipment, the manufacturer must provide controllers, including the required monitors and timed restart.

d. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.22 FACTORY PAINTING

a. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 1/8 inch on either side of the scratch mark.

b. The film thickness of the factory painting system applied on the

equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

2.23 IDENTIFICATION MATERIALS

General: Provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.23.1 Plastic Pipe Markers

Provide snap-on or adhesive type pipe markers with nomenclature that closely matches Contract Drawings. Comply with designations indicated on Contract Drawings for piping system nomenclature and abbreviate only as necessary for each application length. Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

a. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ASME A13.1.

b. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ASME A13.1.

c. Application: For exterior diameters greater than 2-inch (including insulation if any), provide continuous directional flow arrow tape around pipe circumference; two places, before and after pipe marker. Provide adhesive plastic pipe markers. For external diameters less than 2-inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

(1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

(2) Adhesive lap joint in pipe marker overlap.

(3) Laminated or bonded application of pipe marker to pipe (or insulation).

2.23.2 Valve Tags

Provide 19 gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with hole for fastener, or engraved plastic laminate valve tags, with piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with hole for fastener. Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose. Compile valve schedule for each service. For each page of valve schedule, provide laminated plastic coated cardboard stock sheets.

a. Provide 1 1/2-inch diameter tags, except as otherwise indicated.

b. Provide size and shape as specified or scheduled for each piping system.

c. Fill tag engraving with black enamel.

2.23.3 Engraved Plastic Laminate Signs

Provide engraving stock melamine plastic laminate, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.23.4 Plasticized Tags

Provide pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately, 2-inch by 6-inch with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.23.5 Lettering and Graphics

Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Mixing Valve No. 2, Pump No. 1).

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 GENERAL INSTALLATION REQUIREMENTS

a. Provide piping located in air plenums conforming to NFPA 90A requirements. Installation of plastic pipe in air plenums is prohibited. Piping located in shafts that constitute air ducts or that enclose air ducts must be noncombustible in accordance with NFPA 90A. Install the plumbing system complete with necessary fixtures, fittings, traps, valves, and accessories. Piping must be concealed wherever possible. Under no circumstances reduce pipe size on Contract Documents without written consent of Contracting Officer. Extend water and drainage piping 5 feet outside the building, unless otherwise indicated. Provide a full port ball valve and drain on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping must be connected to the exterior service lines or capped or plugged if the exterior service is

not in place. Lay sewer and water pipes in separate trenches, except when otherwise shown. Exterior underground utilities must be at least 12 inches below the average local frost depth or 18 inches below finish grade whichever is greater. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, mark the location of the end of each plumbing utility with a stake or other acceptable means. Install valves with control no lower than the valve body.

b. Provide piping to fixtures, outlets, and equipment requiring drainage, vent, and water utilities. Arrange and install hot-water and cold-water piping systems to permit draining. Equip the supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Anchor supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices to prevent movement.

c. The work must be carefully laid out in advance, and unnecessary cutting of construction must be avoided. Repair damage to building, piping, wiring, or equipment as a result of cutting by mechanics skilled in the trade involved.

d. Close pipe openings with caps or plugs during installation. Fixtures and equipment must be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, thoroughly clean, adjust and operate the fixtures, materials, and equipment. Provide safety guards for exposed rotating equipment.

e. Branch sizes to individual fixtures must be as scheduled. Consult manufacturer's data, Architectural drawings, and/or Plumbing drawings of rooms containing equipment and plumbing fixtures prior to roughing in piping. Stub piping through wall directly behind equipment item, or fixture being served. Connect equipment furnished by Owner or other divisions of the specification in accordance with this section.

f. Piping must not be routed over communications, electrical and server rooms unless dedicated to serving the room.

3.3 DOMESTIC WATER PIPING SYSTEMS

3.3.1 General

Accurately cut and work piping into place without springing or forcing. Weakening of structural portions of the building is not acceptable. Run aboveground piping parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings must be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines must not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Do not bury water pipe in or under floors unless specifically indicated or approved. Make changes in pipe sizes with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation

practice. Make changes in direction with fittings.

3.3.2 Service Entrance

Provide service entrance installation through below grade exterior wall with water-stop pipe sleeves.

3.3.3 Pipe Drains

Provide pipe drains consisting of 3/4 inch hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, provide 3/4 inch brass plugs or caps. Disconnection of the supply piping at the fixture is an acceptable drain.

3.3.4 Valves

Provide manual isolation valves at base of risers, on branch runouts from piping mains, on each branch serving a rest room, on each branch serving an equipment item, and on each branch to hose bibb or wall hydrant. Wire isolation valves on emergency fixture supply open and tag "Do Not Close". Balance hot water circulation system.

3.3.5 Expansion and Contraction of Piping

Allowance must be made throughout for expansion and contraction of water pipe. Provide each hot-water and hot-water circulation riser with expansion loops or other provisions such as offsets, changes in direction, or manufactured expansion fittings. Securely anchor risers to force expansion to loops. Make branch connections from risers with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Anchor horizontal runs of pipe over 50 feet in length to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility must be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility must be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.3.6 Thrust Restraint

Provide thrust blocks at plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger to prevent movement. Provide thrust blocking concrete of a mix not leaner than: 1 cement, 2.5 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, pour the base and thrust bearing sides of the thrust block against undisturbed earth. Pour t side of the thrust block not subject to thrust against forms. The area of bearing will be as shown. Place blocking so that the joints of the fitting are accessible for repair. Provide steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.

3.3.7 Commercial-Type Water Hammer Arresters

Provide commercial-type water hammer arresters on hot- and cold-water

supplies. Locate arresters as generally indicated, with precise location and sizing to be in accordance with PDI WH 201 Sizing and Placement Data. Water hammer arresters, where concealed, must be accessible by means of access doors or removable panels. Provide commercial-type water hammer arresters conforming to ASSE 1010. Vertical capped pipe columns (air chambers) are not be permitted.

3.3.8 Water Meter Remote Readout Register

a. Provide true absolute remote readout encoder register providing direct electronic transfer of meter reading information from water meter to automatic meter reading device. Mount the remote register at the location indicated, or as directed by the Contracting Officer.

b. Provide permanently sealed register to exclude dirt and/or moisture infiltration. Provide with a straight reading odometer-type display, and 360 degree test circle with center sweep hand and low flow (leak) detector. Provide tamperproof locking feature to resist tampering with the register. Provide factory potted moisture resistant wire assembly for pit applications.

c. Provide registers with full 6-wheel encoding, and a 6-wheel odometer assembly for direct manual reading. The register must transmit data using open architecture variable length protocol in ASCII format (American Standard Code for Information Interchange). Provide with capacity of remote installation up to 300 feet to an outside wall mounted touch pad.

d. The register must use an absolute encoder to directly read the actual position of the index odometer wheels, when interrogated by a reading device. The reading device must provide all necessary power. Pulse outputs and/or memory must not require programming. Battery powered registers are not acceptable. When a reading device interrogates the register, the translator encoder must communicate to the device in ASCII computer language the absolute meter reading, and an eight-digit identification number. Any error or nonread must be immediately indicated by the meter reading equipment.

3.3.9 Backflow Prevention Devices

Do not cross connect or interconnect plumbing fixtures, equipment, and pipe connections between a potable water supply and any source of nonpotable water. Install backflow preventers where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition, install backflow preventers at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Locate backflow preventers so that no part of the device will be submerged. Provide backflow preventers of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Do not provide bypass piping around backflow preventers. Maintain backflow preventers manufacturers access clearances for maintenance and testing. Each device must be a standard commercial unit. Install reduced pressure principle backflow prevention devices horizontally and located in an accessible location not more than 4 feet above finished floor. Pipe drain from reduced pressure principle backflow prevention devices to the exterior, or a floor drain of adequate capacity,

or a mop sink.

3.4 DRAINAGE AND VENT PIPING SYSTEMS

3.4.1 General

a. Provide wye fittings and eighth bends, or combination wye and eighth fittings at changes of direction and junctions. Provide sanitary tee fittings only in vertical pipe. Sanitary crosses are not permitted. Provide P-trap for each direct waste-pipe connection to equipment. Provide ice makers with an indirect drain consisting of either a floor sink or a dedicated, under-counter P-trap. Provide air gaps at indirect drains.

b. Install horizontal soil, waste, and storm piping with the following minimum slopes; 3 inch and smaller pipes must be 1/4 inch per foot; 4 inch to 6 inch must be 1/8 inch per foot; 8 inch and larger pipes: 1/16 inch per foot. Slopes indicated on plans override those indicated here.

c. Provide vent stacks parallel to soil and waste stacks to receive branch vents from fixtures. Each vent stack must originate from a soil or waste stack at its base. To permit proper flashing, offset through-the-roof piping away from walls on roof before passing through roof. Carry vent stacks 4 inch and larger full size through roof. Install vent lines so they will drain and not trap water. Where possible, combine soil, waste or vent stacks before passing through roof to minimize roof openings. Where minimum vent-through-roof size is larger than vent size, provide an increaser a minimum of 12 inch below roof line.

d. Provide drip pans under drainage piping installed over critical areas to include but not limited to: operating rooms, recovery rooms, delivery rooms, nurseries, food preparation areas, food serving areas, food storage areas, central service areas, and electronic data processing areas. Provide drain piping from drip pans. Discharge drain piping to drain in exposed area.

e. Do not insulate, conceal, or fur around installed piping until it has been tested to satisfaction of the Contracting Officer. If inspection or test indicates defects, replace such defective work or material and repeat inspection and tests. Make repairs with new materials. Peening and chiseling of holes or screwed joints is not allowed.

f. Install underground PVC piping according to ASTM D2321. Clean and dry joining surfaces of PVC piping. Join PVC piping according to ASTM D2855 and ASTM D2665 appendixes. Comply with ASTM D2564 for solvent cements. Comply with ASTM F656 for PVC primers. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Provide all pipe and fittings produced by a single manufacturer and install in accordance with manufacturer's recommendations. Do not test with or transport/store compressed air or gas in PVC pipe or fittings.

g. Install PVC waste piping underground or below slab. PVC piping installed aboveground or slab is not acceptable.

h. Install foundation drainage piping as indicated. Lay perforated drain pipe with perforations facing down.

3.4.2 Pipe Cleanouts

Provide pipe cleanouts of the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. Provide cleanouts installed in connection with cast-iron soil pipe consisting of a long-sweep 1/4 bend or one or two 1/8 bends extended to the location shown. Caulk an extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug into the hub of the fitting and flush with the floor. Cleanouts in connection with other pipe must be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs. Provide plugs of the same size as the pipe up to and including 4 inches. Provide cleanout tee branches with screw plug at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drains where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Provide cleanouts on pipe concealed in partitions with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Provide round access covers secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls must have access covers and frames installed flush with the finished wall. Provide cleanouts installed in finished floors subject to foot traffic with a chrome-plated cast brass,nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws must not project above the cover surface. Where cleanouts are provided with adjustable heads, provide cast iron heads. Provide cleanout extensions through floor above where cleanouts are required in piping above critical areas, or to an accessible location outside of critical area.

3.4.3 Sight Drains

Install sight drains so that the indirect waste will terminate a minimum of 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.4.4 Traps

Place traps as near the fixture as possible, and no fixture must be double-trapped. Provide cast-iron traps on cast-iron soil pipe. Traps installed on steel pipe or copper tubing must be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste must be of the same material as the pipe.

3.5 JOINTS

Install pipe and fittings in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees is not be permitted. Make joints with fittings of compatible material and made for the specific purpose intended.

3.5.1 Threaded

Provide threaded joints with American Standard taper pipe threads conforming to ASME B1.20.1. Coat only male pipe threads with graphite or with an approved graphite compound, or with an inert filler and oil, or

have polytetrafluoroethylene tape applied.

3.5.2 Unions and Flanges

Do not conceal unions, flanges and mechanical couplings in walls, ceilings, or partitions. Provide unions on pipe sizes 2-1/2 inches and smaller; provide flanges on pipe sizes 3 inches and larger.

3.5.3 Cast Iron Soil Pipe

Install bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping per the manufacturer's recommendations.

3.5.4 Copper Tube and Pipe

3.5.4.1 Brazed Joint

In conformance with AWS B2.2/B2.2M and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints must include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

3.5.4.2 Soldered Joint

Make with flux. Provide soldered joints conforming to ASME B31.5 and CDA A4015.

3.5.5 Corrosive Waste Plastic Pipe

Make joints for polypropylene pipe and fittings by mechanical joint or electrical fusion coil method in accordance with ASTM D2657 and ASTM F1290.

3.5.6 Other Joint Methods

Make connections between ferrous and non-ferrous copper water pipe with dielectric unions or flange waterways. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Provide dielectric waterways internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways. Make connecting joints between plastic and metallic pipe with transition fitting for the specific purpose.

3.6 CORROSION PROTECTION FOR BURIED PIPE AND FITTINGS

Ductile iron, cast iron, and steel pipe, fittings, and joints must have a protective coating. Additionally, provide ductile iron, cast iron, and steel pressure pipe with a cathodic protection system and joint bonding. Provide the cathodic protection system, protective coating system, and joint bonding. Select, apply, and inspect coatings in accordance with NACE SP0169 and as otherwise specified. Clean piping and apply the coating system prior to pipe tightness testing. Clean joints and fittings and apply the coating system after pipe tightness testing. For tape coating systems, provide tape conforming to AWWA C203 and apply with a minimum 50 percent overlap. Provide primer utilized with tape type

coating systems as recommended by the tape manufacturer.

3.7 PIPE SLEEVES AND FLASHING

Provide pipe sleeves set in their proper and permanent location.

3.7.1 Sleeve Requirements

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Sleeves are not required for supply, drainage, waste and vent pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links must be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt must cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe and sleeve involved. Do not install sleeves in structural members, except where indicated or approved. Rectangular and square openings must be as detailed. Extend each sleeve through its respective floor, or roof, and cut flush with each surface, except for special circumstances. Extend pipe sleeves passing through floors, exposed or within partitions, in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas a minimum of 4 inches above the finished floor. Unless otherwise indicated, provide sleeves of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Provide steel pipe or cast-iron pipe sleeves in bearing walls and concrete slab on grade floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, seal the annular space between pipe and sleeve, or between jacket over insulation and sleeve, with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. Do not seal the annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve for interior walls which are not designated as fire rated. Recess sleeves through below-grade walls in contact with earth 1/2 inch from wall surfaces on both sides. Fill annular space between pipe and sleeve with backing material and sealants in the joint between the pipe and concrete or masonry wall as specified above. Sealant selected for the earth side of the wall must be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls must conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.7.2 Flashing Requirements

Install pipes passing through roof through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing must be suitably formed, and extend the skirt or flange not less than 8 inches from the pipe and set over the roof or floor membrane in a solid coating of bituminous cement. Extend the flashing up the pipe a minimum of 10 inches.

For cleanouts, the turn down the flashing into the hub and caulked after placing the ferrule. Flash pipes passing through pitched roofs, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. Seal the annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as indicated. Turn down flashing for dry vents into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Fit flashing shield into the sleeve clamping device. Sleeve pipes passing through wall waterproofing membranes as described above. Install a waterproofing clamping flange.

3.7.3 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.7.4 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, form a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep around the pipe, fitting or drain. Fill the groove with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.7.5 Pipe Penetrations

Provide sealants for all pipe penetrations. Seal all pipe penetrations to prevent infiltration of air, insects, and vermin.

3.7.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.8 PIPE HANGERS, INSERTS, AND SUPPORTS

Install pipe hangers, inserts and supports conforming to MSS SP-58, except as modified herein.

a. Type 1, provide with adjustable type steel support rods.

b. Types 5, 12, and 26 are not be permitted.

c. Type 3 is not permitted on insulated pipe.

d. Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they

otherwise meet the requirements for Type 18 inserts.

e. Provide Type 19 and 23 C-clamps for attachment to steel joists and torque per MSS SP-58. Provide both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

f. Provide Type 20 attachments on steel angles and vertical web steel channels and furnish with an added malleable-iron heel plate or adapter. Attach to horizontal web steel channel with drilled hole on centerline and double nut and washer.

g. Provide Type 21, 28, 29, and 30 clamps for attachment to steel W or S beams.

h. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

i. Provide Type 39 saddles on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Provide Type 39 saddles welded to the pipe.

j. Provide Type 40 shields:

(1) On insulated pipe less than 4 inches.

(2) On insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for all pipe sizes. High density inserts must have a density of 8 pcf or greater.

k. Space horizontal pipe supports as specified in MSS SP-58 and install a support not over 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe supports not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe must be 120 degrees F for PVC and 180 degrees F for CPVC. Include allowances for expansion and contraction in horizontal pipe runs.

l. Support vertical pipe at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Include allowances for expansion and contraction in vertical pipe risers.

m. Provide Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides to allow longitudinal pipe movement. Slide materials must be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints must be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

n. Pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation. The insulation must be continuous through the hanger on all pipe sizes and applications.

o. Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

p. Hangers and supports for plastic pipe must not compress, distort, cut or abrade the piping, and must allow free movement of pipe except where otherwise required in the control of expansion/contraction.

q. Hangers used to support piping 2 inches and larger must be fabricated to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, provide a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Formed or bent threaded sections of rods are not permitted.

3.8.1 Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as required by UFC 3-310-04 and UFC 4-510-01.

3.8.2 Structural Attachments

Provide attachment to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Provide inserts and anchors with a safety factor not less than 5. Supports attached to metal decking is not permitted. Supports to the underside of concrete filled floor or concrete roof decks is not permitted, unless approved by the Contracting Officer. Construct masonry anchors for overhead applications of ferrous materials only.

3.9 FIXTURES AND FIXTURE TRIMMINGS

Provide polished chromium-plated pipe, valves, and fittings where exposed to view. Provide angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, use a beading tool to mechanically deform the tubing above the compression fitting. Connect exposed traps and supply pipes for fixtures and equipment to the rough piping systems at the wall, unless otherwise specified under the item. Insulate drain lines and hot water lines of fixtures for handicapped/accessible fixtures and do not require polished chrome finish. Install plumbing fixtures and accessories within

the space shown.

3.9.1 Fixture Connections

Make connections between earthenware fixtures and flanges on soil pipe gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty is not be permitted. Set fixtures with outlet flanges the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.9.2 Flushometer Valves

Secure flushometer valves to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Arrange flushometer valves for water closets to avoid interference with grab bars. In addition, for water closets intended for handicap use, install the flush valve handle on the wide side of the enclosure. Install bumpers for water closet seats on the wall.

3.9.3 Height of Fixture Rims Above Floor

Unless otherwise noted, mounting heights must be as indicated. Comply with ICC A117.1 COMM for the installation of fixtures for use by the physically handicapped.

3.9.4 Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate must be made watertight by caulking or gasketing.

3.9.5 Fixture Supports

Provide fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, of the chair-carrier type. The carrier must provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability must be provided to locate the fixture at the desired height and in proper relation to the wall. The use of support plates, in lieu of chair carrier, fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.9.5.1 Support for Solid Masonry Construction

Anchor chair carrier to the floor slab. Where a floor-anchored chair carrier cannot be used, imbed a suitable wall plate in the masonry wall.

3.9.5.2 Support for Concrete-Masonry Wall Construction

Anchor chair carrier to floor slab. Where a floor-anchored chair carrier cannot be used, fasten a suitable wall plate to the concrete wall using through-bolts and a back-up plate.

3.9.5.3 Support for Steel Stud Frame Partitions

Provide chair carriers. The anchor feet and tubular uprights must be of the heavy duty design; and feet (bases) must be steel and welded to a square or rectangular steel tube upright. The use of wall plates, in lieu

of floor-anchored chair carriers, are permitted only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.9.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, provide a floor-anchored chair carrier. Where entire construction is wood, install wood crosspieces. Fasten fixture hanger plates, supports, brackets, or mounting lugs with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. Extend wood crosspieces the full width of the fixture and securely support.

3.9.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, provide reinforced wax, treated felt, or neoprene gaskets. Provide gasket type as recommended by the chair-carrier manufacturer.

3.9.6 Access Panels

Provide access panels for concealed valves and controls, or any item requiring inspection or maintenance. Provide access panels of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.9.7 Escutcheons

Provide escutcheons at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Fasten escutcheons securely to pipe or pipe covering and must be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Provide one-piece escutcheons held in place by silicon caulk.

3.10 WATER HEATERS AND HOT WATER STORAGE TANKS

3.10.1 Relief Valves

Valves installed between a relief valve and its water heater or storage tank are not permitted. Install pressure and temperature relief valves where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, install the relief valve directly in a tapping in the tank or heater; otherwise, install the pressure and temperature valve in the hot-water outlet piping. Provide a vacuum relief valve on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.10.2 Connections to Water Heaters

Make connections of metallic pipe to water heaters with dielectric unions or flanges.

3.10.3 Expansion Tank

Install a pre-charged expansion tank on the cold water supply between the water heater inlet and the cold water supply shut-off valve. Adjust the

expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.10.4 Gas- and Oil-Fired Water Heaters

Install in accordance with NFPA 54 for gas fired.

3.10.5 Direct Fired Domestic Water Heaters

Notify the Contracting Officer when any direct fired domestic water heater over 117,124.2 Watts (400,000 BTU/hour) is operational and ready to be inspected and certified.

3.11 IDENTIFICATION SYSTEMS

Identify piping and physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, NEMA Z535.1. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Identify each piping system and item of equipment indicated on contract drawings.

3.11.1 Piping System Identification

Install plastic pipe markers on each system, and include arrows to show normal direction of flow. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, crawl spaces) and exterior non-concealed locations.

a. Near each valve and control device.

b. Near each branch; mark each pipe at branch, where there could be question of flow pattern.

c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points which permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

f. Spaced intermediately at maximum spacing of 20 feet along each piping run, except reduce spacing to 10 feet in congested areas of piping and equipment. Provide a minimum of one pipe label in each space where partitions extend to structure.

3.11.2 Valves

Provide valve tag on every valve, cock and control device in each piping system. List each tagged valve in valve schedule for each piping system. Mount laminated valve schedules under glass in mechanical equipment rooms. Coordinate location with Contracting Officer. Provide 1/2-inch red adhesive identification dots on ceiling tiles located immediately below balancing valves and shutoff valves.

3.11.3 Plumbing Equipment

Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device. Provide minimum 1/4-inch high lettering for name of unit where viewing distance is less than 3 feet 1/2-inch high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.11.4 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number must be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags must be 1-3/8 inch minimum diameter, with stamped or engraved marking. Provide black indentations, for reading clarity. Attach tags to valves with No. 12 AW, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.11.5 Nameplates

Provide 1/8 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 1/4 inch high normal block lettering into the white core. Minimum size of nameplates must be 1 by 2-1/2 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

3.11.6 Labels

Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:

a. Identification of the sensor and its operation with graphic description.

b. Range of the sensor.

c. Battery replacement schedule.

3.11.7 Pipe Color Code Marking

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.11.8 Color Coding Scheme for Locating Hidden Utility Components

Provide scheme in buildings having suspended grid ceilings. The color coding scheme must identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. Operable components include valves. The color coding scheme must consist

of a color code board and colored metal disks. Each colored metal disk must be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. Insert fasteners into the ceiling panels so that the fasteners will be concealed from view. The fasteners must be manually removable without tools and must not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks must follow completion of the finished surface on which the disks are to be fastened. Provide the color code board with approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. Provide board made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols must be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount and locate the color code board in the mechanical or equipment room. Provide color code system as indicated below:

Color	System	Item	Location
_____	_____	_____	_____

3.12 PAINTING

3.12.1 General

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS. Provide new equipment with factory applied or shop applied paint, and as specified herein or in PART 2 paragraph FACTORY PAINTING, and provided under each individual section.

3.12.2 Shop Painting Systems for Metal Surfaces

a. Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

b. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

(1) 120 Degrees F: Immediately after cleaning, the metal surfaces must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

(2) Temperatures Between 120 and 400 Degrees F: Metal surfaces must receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

(3) Temperatures Greater Than 400 Degrees F: Metal surfaces must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

3.13 VIBRATION-ABSORBING FEATURES

Isolate mechanical equipment, including pumps, from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation must include an adequate number of standard isolation units. Each unit must consist of machine and floor or foundation fastening, together with intermediate isolation material, and must be a standard product with printed load rating. Provide piping connected to mechanical equipment with flexible connectors. Isolation unit installation must limit vibration to 10 percent of the lowest equipment rpm. Submit details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

3.14 TRAINING

a. Provide the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

b. Provide instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

c. When significant changes or modifications in the equipment or system are made under the terms of the Contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

3.15 POSTED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

3.16 TESTS, FLUSHING AND DISINFECTION

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Indicate the final position of controls in each test report.

3.16.1 Plumbing System

Perform the following tests on the plumbing system in accordance with the ICC IPC , except that the drainage and vent system final test must include the smoke test. The Contractor has the option to perform a peppermint

test in lieu of the smoke test. If a peppermint test is chosen, submit a testing procedure to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. Include a smoke test in the final test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.16.1.1 Test of Backflow Prevention Assemblies

Test backflow prevention assemblies using gauges specifically designed for the testing of backflow prevention assemblies. Certification of proper operation must be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. Submit written documentation of the tests performed and signed by the individual performing the tests. Gauges must be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly must include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit must be repaired and retested.

3.16.1.2 Submittal Requirements

Submit the following:

a. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Indicate clearances required for maintenance and operation on the detail drawings. Where piping and equipment are to be supported other than as indicated, include loadings and proposed support methods details. Draw plan,

elevation, view, and detail drawings to scale.

b. Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

c. Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.16.2 Defective Work

If inspections or test shows defects, replace or repair such defective work or material as necessary and repeat inspections and tests. Make repairs to piping with new materials. Caulking of screwed joints or holes is not acceptable.

3.16.3 Pressure-Seal (Press-Fit) Fittings Connection Tests

Perform a step-test on all piping systems containing pressure-seal (press-fit) connections. Test may utilize air, water, or dry nitrogen, to pressurize the system at a pressure not to exceed 85 psig. Examine and check each joint in the pressurized piping system for leaks. If a leaking joint is identified, relieve the pressure from the system, ensure the tube is full inserted into the fitting and proceed to press the fitting. Remove and replace any fitting that has already been pressed but is identified as leaking. Repeat the step-test until the system is determined to be leak-free.

3.16.4 System Flushing

3.16.4.1 During Flushing

Before operational tests or disinfection, flush potable water piping system with hot potable water. Sufficient water must be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) must specify the number of fixtures to be operated during flushing. Provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor is responsible for any flood damage resulting from flushing of the system. Continue flushing until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. Flush all faucets and drinking water fountains, including any device considered as an end point device by NSF/ANSI 372, a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

3.16.4.2 After Flushing

Drain system at low points. Remove, clean, and replace strainer screens. After flushing and cleaning, prepare systems for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system must be repaired. When the system flushing is complete, adjust the hot-water system for uniform circulation. Adjust flushing devices and

automatic control systems for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in Part 2 of this Section. Unless more stringent local requirements exist, lead levels must not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). Test the water supply to the building separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.16.5 Operational Test

Upon completion of flushing and prior to disinfection procedures, subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests must cover a period of not less than 8 hours for each system and include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

3.16.6 Disinfection

After operational tests are complete, disinfect the entire domestic hot- and cold-water distribution system. Flush the system as specified, before introducing chlorinating material. Provide hypochlorites or liquid chlorine chlorinating materials. Except as herein specified, water chlorination procedure must be in accordance with AWWA C651 and AWWA C652. Feed the chlorinating material into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Use a properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. Flush the system, including the tanks, with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period, open and close each valve and faucet several times. Obtain samples of water in disinfected containers from several locations selected by the Contracting Officer. The samples of water must be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used must be either the multiple-tube

fermentation technique or the membrane-filter technique. Repeat disinfection procedure until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

-- End of Section --

SECTION 22 60 70

GAS AND VACUUM SYSTEMS FOR HEALTHCARE FACILITIES
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2015) Scheme for the Identification of Piping Systems
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.50	(2013) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 6000 SERIES	(2012) Professional Qualification Standard for Medical Gas Systems Installers, Inspectors and Verifiers

AMERICAN WELDING SOCIETY (AWS)

AWS C3.8M/C3.8	(2011) Specification for the Ultrasonic Pulse-Echo Examination of Brazed Joints

ASTM INTERNATIONAL (ASTM)

ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B819	(2000; R 2011) Standard Specification for Seamless Copper Tube for Medical Gas Systems
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM F437	(2015) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F439	(2019) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441/F441M	(2015) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F493	(2014) Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-4.1	(2009) Cleaning Equipment for Oxygen Service; 6th Edition
CGA M-1	(2018) Standard for Medical Gas Supply Systems at Health Care Facilities; 4th Edition
CGA V-5	(2019) Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications); 6th Edition

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2018) International Plumbing Code

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

ISO 11143	(2008) Dentistry - Amalgam Separators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2018) Motors and Generators
NEMA Z535.1	(2017) Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 55	(2016; TIA 16-1; TIA 16-2) Compressed Gases and Cryogenic Fluids Codes
NFPA 99	(2018; TIA 18-1; ERTA 2 2018; ERTA 3 2020) Health Care Facilities Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards

UNDERWRITERS LABORATORIES (UL)

UL 508A	(2018; Reprint Apr 2020) UL Standard for Safety Industrial Control Panels

1.2 SYSTEM DESCRIPTION

a. Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 3 criteria: dental compressed air (DA), oral evacuation (OE).

1.2.1 Design Requirements

1.2.1.1 Oral Evacuation (OE)

System is a wet vacuum system and must not be supplied to or used for any purpose other than patient care applications.

1.2.1.2 Support Utilities

Dental Compressed Air (DA) systems are support utilities and must not be supplied to or used for patient respiration applications.

1.2.2 Performance Requirements

a. Provide all labor, equipment and services necessary for and incidental to the installation of piped dental gas, support, and vacuum systems. Provide all systems complete, started, tested and ready for use.

b. Government Furnished Materials provided to the Contractor for installation under this section include initial supply of gases in cylinders or containers as appropriate for cylinder source.

c. Provide system delivery pressure as follows:

Dental compressed air	90 psi

d. Provide system vacuum as follows:

Dental oral evacuation	8 inches Hg vacuum
inches Hg vacuum is gauge	

1.2.3 Accessibility of Equipment

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, and equipment requiring access, in locations freely accessible through access doors.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer Qualifications

Installer Qualifications

Inspector Qualifications

Verifier Qualifications

Inspection, Testing, and Verification Agency

SD-02 Shop Drawings

Dental Gas, Support and Vacuum Systems; G

SD-03 Product Data

Dental Compressed Air (DA) Source; G

Dental Oral Evacuation (OE) Source; G

Pipe and Fittings; G

Valves and Assemblies; G

Nitrogen and Instrument Compressed Air Control Panels; G

Hangers and Supports; G

Dental Gas and Support Systems Outlets and Vacuum Systems Inlets; G

Warning Systems; G

Vibration-Absorbing Features; G

SD-06 Test Reports

Test Reports

SD-07 Certificates

Station Outlets/Inlets

SD-10 Operation and Maintenance Data

Dental Gas, Support, and Vacuum Systems; G

Maintenance Data Package; 1

Submit in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA; G.

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer Qualifications

Manufacturers must be regularly engaging in the manufacturing, supplying, and servicing of specified products and equipment, as well as, providing engineering services, for gas and vacuum systems for healthcare facilities. Provide evidence demonstrating compliance for a minimum of 5 years, and on 5 projects of similar complexity.

1.4.2 Installer Qualifications

a. Dental gas, support, and vacuum systems. Installer ASSE 6000 SERIES (Standard #6010 Medical Gas System Installer) certification card must be issued within the previous 36 months and Installers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all

facets of ASSE 6000 SERIES Standard #6010, NFPA 99, and NFPA 55. Course instruction must have been conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Instructors). The installer must have a minimum of four (4) years of documented practical experience in the installation of medical gas and vacuum piping systems.

b. Dental oral evacuation systems must be installed only by contractors/tradespersons who have at least 5 years experience installing central oral evacuation systems for dental operatories.

1.4.3 Agency Qualifications

Retained by the general contractor, but independent of the facility, installing contractor, and product manufacturer(s).

1.4.3.1 Inspector qualifications

Systems must be inspected only by Certified Medical Gas System Inspectors. Inspector ASSE 6000 SERIES (Standard #6020 Medical Gas Systems Inspectors) certification card must be issued within the previous 36 months and Inspectors certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 24-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES (Standard #6020), NFPA 99, NFPA 55. Course instruction must be conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). Certification to ASSE 6000 SERIES (Standard # 6030 Medical Gas Systems Verifier) meets the requirements of this section. The inspector must have a minimum of four (4) years of documented practical experience in the inspection of medical gas and vacuum systems. Certified Medical Gas System Inspectors will be retained by the general contractor, independent of Certified Medical Gas System Verifiers.

1.4.3.2 Verifier qualifications

Systems must be verified only by Certified Medical Gas System Verifiers. Verifier ASSE 6000 SERIES (Standard #6030 Medical Gas System Verifiers) certification card must be issued within the previous 36 months and verifiers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES Standard #6030, NFPA 99, NFPA 55 and CGA M-1. Course instruction must be conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). The verifier must have a minimum of four (4) years of documented practical experience in the verification of medical gas and vacuum systems. The verifier must have a current certificate of insurance, in the individual's name or employing verification company for general liability, and professional liability insurance. Certified Medical Gas System Verifiers will be retained by the general contractor, independent of Certified Medical Gas System Inspectors.

1.4.4 Certifying Agency Qualifications

Agency must be an American National Standards Institute accredited certifier. Agency is responsible for testing and certifying individuals in compliance with ASSE 6000 SERIES Standards. Provide installer,

inspector, and verifier certifications by one of the following agencies or by an agency with comparable qualifications:

a. Medical Gas Professional Healthcare Organization (MGPHO).

b. National Inspection, Testing and Certification Corporation (NITC), Los Angeles, California.

1.4.5 Regulatory Requirements

1.4.5.1 Standards

The Standards for design, materials, installation, and testing of gas and vacuum systems for healthcare facilities:

a. National Fire Protection Association Standard for Health Care Facilities: NFPA 99.

b. Interpret reference to the "Authority Having Jurisdiction" to mean the "Contracting Officer." For Government owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, interpret references to the "owner" to mean the "lessor." Interpret references to the "permit holder" to mean the "Contractor."

c. The provisions of Chapter 1, "Administration" in NFPA 99 do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project.

1.4.5.2 Referenced Publications

In each of the publications referred to herein, interpret references to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.5.3 Alternative Qualifications

Products having less than a three-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.5.4 Service Support

Provide equipment items supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract. Provide Maintenance Data Package 1 .Submit manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4.6 Shop Drawings

Submit detailed Shop Drawings for the complete systems including piping layouts and location of connections; dimensions for roughing-in,

foundation, and support points; schematic diagrams; and wiring diagrams or connection and interconnection diagrams. Indicate clearances required for maintenance and operation on detail drawings. Where piping and equipment are to be supported other than as indicated, include loadings and proposed support method. Draw all plans, elevations, views, and details to scale.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver equipment and parts to site factory cleaned and processed in their original factory sealed package ready for installation. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 COMMISSIONING

Refer to Section 01 91 00.15 TOTAL BUILDING COMMISSIONING for requirements

1.6.1 Inspection, Testing, and Verification Agency

Commissioning must include retaining the Inspection, Testing, and Verification Agency prior to commencement of the installation of these systems. The Inspection, Testing, and Verification Agency shall coordinate their scope of work with that of the Project CxC, Commissioning Specialist and Project CxG, Government Commissioning Specialist and shall function in coordination with, not in lieu of, the Project CxC, Commissioning Specialist and Project CxG, Government Commissioning Specialist.

1.6.2 Responsibilities

The Inspection, Testing, and Verification Agencies responsibilities include:

a. Review of the project drawings and specifications and providing comments and additional clarification(s), as needed, to the Contracting Officer and the Designer of Record.

b. Witnessing by the Contracting Officer and a certified inspector or certified verifier of the brazing of a minimum of two joints (one vertical and one horizontal) by each brazer assigned to the project. Evaluation of adequacy of the brazed joints must be in accordance with NFPA 99 through observation of the brazing techniques, and by destructive methods (sectioning of the joint). This is required of all brazers utilized throughout the duration of the project. Brazing of project materials is not permitted until the brazer qualifications, and the adequacy of their joints have been determined to be acceptable.

c. Review and comment on the compliance of the project submittals required under "SUBMITTALS" and the specified items. Review must be concurrent with the review being performed by the designated representative of the Government.

d. Performing site observation visits prior to 1) backfilling exterior or interior below grade piping, 2) concealing above ceiling piping, and 3) concealing in wall piping. Conduct site observation visits by a certified inspector or certified verifier. Provide for each visit a written report stating progress of installation and any deficiencies needing corrective action.

e. Review of revisions/substitutions relating to the Contract Documents and/or the Project Commissioning Plan.

f. Coordination with the Project CxC, Commissioning Specialist and Project CxG, Government Commissioning Specialist in establishing a commissioning plan for components specific to the systems specified herein.

g. Coordination with the Project CxC, Commissioning Specialist and Project CxG, Government Commissioning Specialist of the equipment start-up, and the system testing and verification procedures required by this specification.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products, essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening, and have been in satisfactory commercial or industrial use for 3 years prior to bid opening. The 3-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period. Submit manufacturer's catalog data with highlighting to show features such as model, size, and options that are intended for consideration. Provide adequate data to demonstrate compliance with contract requirements.

2.2 MANUFACTURER'S NAMEPLATE

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

2.3 DENTAL COMPRESSED AIR (DA) SOURCE

a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Provide air compressors manufactured to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Size cooling capacity of the aftercooler for the total capacity of the compressors.

2.3.1 Air Compressors

Provide scroll type compressors or reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section. Provide a pressure gauge calibrated to 300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Provide compressors sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.3.2 Air Receiver

Provide air receiver delivering air to dental operatories designed for 150 psi working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or supplied with factory applied commercial enamel finish exterior. Provide the interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.3.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

2.3.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers to achieve a pressure dewpoint minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.3.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency of 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron final filters with an efficiency 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.3.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the dental compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 2 degrees F. Provide dew point alarm factory set at 36 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 39 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor in conformance with NFPA 99.

2.3.7 Carbon Monoxide Monitor

Provide carbon monoxide monitor to continuously monitor the dental compressed air for carbon monoxide and to actuate a local alarm if the carbon monoxide level is 10 ppm or higher. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor in conformance with NFPA 99.

2.4 DENTAL ORAL EVACUATION (OE) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, separator(s), control panel, source shutoff, pump isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.4.1 Vacuum Pumps

Provide turbine, oil-lubricated rotary-vane, or regenerative blower vacuum pumps. Connect pumps in parallel to the central wet separator tanks.

2.4.1.1 Turbines

Provide self-governing, multistage, centrifugal type turbines of overhung or outboard design. The vacuum pumps must operate at a speed not to exceed 3,600 rpm and connected to its driving motor by a flexible coupling. Provide sealed or lubricatable type bearings. Provide a fan connected directly to the vacuum pump shaft adjacent to vacuum pump shaft bearings to create a flow of ambient air over the bearing carrier while the unit is operating. Provide a steel coupling guard encompassing the flexible coupling between the motor and vacuum pump. Cases must be cylindrical in design. Provide cases and end plates (inlet and exhaust heads included) constructed of either heavy-gauge sheet steel rigidly welded at seams and sections, or of cast grey iron. Provide either concave or convex sheet steel end plates. Inlet and exhaust connections must be tangential to the vacuum pump except the inlet connection can be axial to vacuum pump and sized to allow free air movement through the vacuum pump, without flow restriction and have class 150 flanges. Provide vacuum pump input with an adjustable volume control valve, a directional flow valve and antisurge valve. Provide vacuum pump output with an exhaust silencer. Connect plumbing to the vacuum pump through flexible sleeve connectors. Construct internal moving parts with not less than 0.125 inch clearance throughout to prevent damage by transient particulates. Construct impellers of fabricated sheet metal or high-tensile aluminum alloy, smooth on all surfaces to prevent imbalance by uneven dust deposits. Provide impellers of the backward curved or radial design to provide optimal performance over a wide range of volume requirements. Securely attach impellers to the vacuum pump shaft by set screws or clamps of high-tensile material. Provide individually balanced impellers. The complete assembly, with motor, must not exceed 1.5 mils of vibration when given a running test. Power to operate the vacuum pump must be in direct proportion to the volume of air exhausted and must not exceed the normal motor rating. The vacuum produced must be substantially constant throughout the operating range of the vacuum pump. Provide continuous duty NEMA MG 1, 3500 RPM maximum, T-frame, dripproof design motor with either sealed or lubricatable bearings. Operating temperature rise of the motor must not exceed 72 degrees F. Mount each vacuum pump assembly on resilient isolator pads as recommended by the manufacturer. Do not fasten pads to the facility floor.

2.4.1.2 Rotary-Vane Vacuum Pump

Provide low speed, positive displacement, oil lubricated rotary-vane vacuum pumps with separate, standard NEMA frame size, high efficiency motors. Provide automatic lubrication of moving pump parts by an oiling system not dependent on moving parts and operated only by gravity and vacuum. Provide vacuum pump constructed to provide protection against ingesting particulates larger than 15 µ into pump, operating with insufficient lubrication, and water contamination of oil. Provide electrical overload by thermal sensors built into single phase motors or thermal sensors built into three phase motor starters; three phase motor starters additionally protected against single phasing. Provide continuous duty, NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 1800 RPM.

2.4.1.3 Regenerative Blower

Provide regenerative blower consisting of one impeller, mounted directly on the motor shaft. Provide precision cast aluminum impeller with multiple radial blades at its periphery. The impeller must be the only moving part, and must not require any lubrication. Dynamically balance the impeller to provide vibration-free operation without the need for vibration isolators. Install the impeller between the blower housing and cover. Provide housing and cover of cast aluminum and provided with multiple heat-dissipating fins. There must be no metal-to-metal contact within the blower housing. Oil lubrication must not be required, providing oil free discharge gas. The heat-dissipating fins must efficiently minimize heating of the compressed gas. Provide blower with a guaranteed ultimate vacuum of 12 inches Hg vacuum. Provide motor supported by outboard mounted, grease lubricated, anti-friction bearings. The bearings must be located outside of the compression chamber to maximize operating efficiency and bearing life. Provide bearing housing conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Provide shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Provide a lip seal to minimize leakage where the motor shaft passes through the blower housing. Blower producing noise levels must not exceed 75 dBA. Additional silencers may be installed to further reduce the noise level. Provide continuous duty NEMA rated, TEFC motor with 1.15 service factor, and maximum of 3600 RPM. Provide direct driven blowers. Provide blower manufactured in accordance with ISO 9001 and UL listed. Provide each blower module with a separator with check valve, flex connector, isolation valve, and a relief valve. Provide control panel mounted vacuum pump control switches and set as follows:

a. Lead Pump: Continuous Operation

b. Lag Pump Start: 5 inches Hg vacuum

c. Lag Pump Stop: 8 inches Hg vacuum

2.4.2 Pipe Isolators

Provide flexible, resilient band-sealed (clamped) sleeves furnished to isolate the vacuum pump from associated piping. Size sleeve couplings in accordance with the exhauster intake and output connections. Provide pipe isolators with steel coupling guards.

2.4.3 Valves

2.4.3.1 Volume Control Valve

Provide the input of each vacuum pump with an adjustable air volume control valve to prevent accidental vacuum pump overload and to provide a means of adjusting the upper design capacity limit. Provide volume control valve built in or immediately adjacent to the first or input stage of the vacuum pump and preset by the manufacturer during certification procedure. Provide butterfly type valve with cast iron body with corrosive resistant internals.

2.4.3.2 Antisurge Valve

Provide the input of each vacuum pump with an antisurge valve that will operate proportionally and automatically throughout the vacuum pump's

designed range. This valve must continually sense the motor current and maintain a predetermined operational level of volume by proportionally bleeding air into the system. Equip valve with a silencer to attenuate air noise to 85 dBA or below. Install the valve in, on, or near the first stage of the vacuum pump mounted in conjunction with the directional flow valve.

2.4.3.3 Directional Flow Valve

Provide the input of each vacuum pump with a directional flow valve to prevent back flow of air through the shutdown. Provide cast iron directional flow valve with corrosive resistant internals.

2.4.4 Exhaust Silencer

Provide each vacuum pump exhaust with a separate air discharge silencer of the open-bore expansion type. No interior baffling or shrouding is permitted. Provide silencer to attenuate air noise to 85 dBA or less.

2.4.5 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use

b. System Malfunction

Provide vacuum pump systems with microprocessor master control panel in a NEMA 250 Type 12 enclosure. Provide controls connections for vacuum pressure switch, oral evacuation remote control panel, and each individual vacuum pump controller to microprocessor. Microprocessor must provide for selection of normal operation (automatic alternation) or manual selection of lead, lag, and follow vacuum pumps. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start

automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide a magnetic motor starter with integral overload and short circuit protection, with lockable disconnecting means at each vacuum pump. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with a single point power feed connection to each vacuum pump. Provide control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide contacts to transmit system on/off status to the facility building management system to enable the separator tank liquid level control sequence. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel and the facility building management system if one or more local alarms are activated. Provide the master control panel with a remote control panel with visual indication of start/stop status located in the reception area adjacent to the master alarm and area alarm panels. Provide the master control panel with integrated controls for automatic actuation of the accumulator tank auto-wash system during off hours. For each vacuum pump system, provide the following alarms at the master alarm panel:

a. Lag vacuum pump In Use

b. System Malfunction

2.4.6 Central Wet Separators

Provide the oral evacuation system with central wet separators. Provide separator tanks constructed of a nonmetallic, noncorrosive, inert material or composite such as glass-reinforced plastic (GRP). Provide freestanding tanks of one-piece construction, with smooth, interior walls. Tanks must be high-pressure vessels able to withstand a constant negative pressure of 15 inches Hg vacuum. Provide convex tank bottoms with drain at the apex of convexity. Provide separator tanks equipped with mechanical overflow protection. Provide preplumbed with a 360 degree nozzle internal washdown system with timer. Provide washdown system with a 120 VAC automatic-flush, clock-controlled mechanism to provide a complete washdown of the interior of the separator at any predetermined time of day or night. Provide washdown time adjustable for up to at least 3 minutes. Locate timers in the main electric control panel. Equip the cold water supply to the automatic tank flush unit with an in-line filter with 40-mesh stainless steel screens. Filter must be supplied as part of the oral evacuation system. Equip each separator tank with an electronic high-low liquid level sensor which must perform as the primary overfill protector. In multiple-tank installations, one tank must be adjusted to sense 90 percent of its capacity and the other tank 100 percent of its capacity via the liquid-level sensing devices. Each sensor must control a 120 volt ac electrically operated output air solenoid valve located to control the outgoing air from the tank to the vacuum pump. Equip each tank with a gate and swing type check valves at the bottom drain. With negative pressure in the tank, the check valve must remain closed to

maintain vacuum. When negative pressure ceases, either by vacuum pump shutdown or by closure of the outgoing air solenoid control by the liquid level sensor, the check valve must open and the tank will undergo gravity drain.

2.4.7 Vacuum Relief Valve

Provide vacuum relief valve. The valve must operate automatically. Equip the valve with a silencer to attenuate air noise to 85 dBA or below.

2.4.8 Amalgam Separator

Provide amalgam separator consisting of a sedimentation collection chamber that is removable. Separation process must be sedimentation which may be supplemented with filtration, and/or ion exchange. Provide unit compatible for use on wet and dry vacuum systems. Provide wall or floor mounted assembly. Provide minimum 1-1/2 inch inlet and outlet connection. Unit must be ISO 11143 Certified and have a minimum of 99 percent removal efficiency.

2.5 PIPE AND FITTINGS

2.5.1 Service Entrance

Piping at service entrance (from 12 inches inside building to 5 feet outside): Same as Indicated for outside utilities.

2.5.2 Positive pressure piping systems up to 200 psi

Hard-drawn seamless copper tubing (ASTM B819), Type K or L, bearing one of the following markings, OXY, MED, OXY/MED, and brazed solder-type wrought copper fittings (ASME B16.22), or brazed fittings (ASME B16.50) cleaned for oxygen service by the manufacturer in accordance with Pamphlet CGA G-4.1. Cast fittings must not be used. Minimum size must be 1/2 inch. Install branch piping full size to each terminal device, including vertical drops, and provide reducer fitting at the device pigtail. Type L tubing is not acceptable for installation below grade. Provide with NF nitrogen purge and capped/plugged ends until prepared for installation. Tubing joining material must be ANSI/AWS-BCuP series filler material.

2.5.3 Dental Oral Evacuation System

Provide polyvinyl chloride (PVC) solid-wall drainage, waste and vent (DWV) pipe and fittings conforming to ASTM D1785 and ASTM D2466 in accordance with NFPA 99. Provide solvent cement for PVC pipe fittings conforming to ASTM D2564ASTM D2672 in aacordance with NFPA 99. Provide fittings, supports, and joint assembly complying with ICC IPC. Provide long-radius type fittings for turns and the wye type for branches. The most distant end of each trunk line from the separators may terminate with a vacuum relief valve.

2.5.4 Compressed Air Intake and Vacuum Pump Exhaust Line(s)

Hard-drawn seamless copper tubing (ASTM B88 or ASTM B819), Type K or L, and solder-type wrought copper fittings (ASME B16.22). Cast fittings must not be used. Tubing joining material must be ANSI/AWS-BCuP series filler material. For Dental Oral Evacuation systems only, provide ASTM F441/F441M Schedule 80 chlorinated polyvinyl chloride (CPVC) pipe, ASTM F439 Schedule 80 CPVC socket fittings and ASTM F437 Schedule 80 CPVC threaded

fittings. Provide solvent cements for joining CPVC pipe conforming to ASTM F493.

2.6 VALVES AND ASSEMBLIES

2.6.1 Valves

a. Positive pressure piping systems up to 200 psi: Bronze, full port, quarter-turn ball type, three piece construction, 600 psi WOG, blow-out proof stem, in-line repairable. Cleaned for oxygen service by manufacturer in accordance with Pamphlet CGA G-4.1. All sizes: 316 stainless steel ball and stem, glass reinforced polytetrafluoroethylene (RPTFE) seat seals and packings. Clean, cap and deliver to site in sealed package bearing manufacturer's identifying tag or stamp. Keep sealed until prepared for installation. Provide with valve manufacturer installed brazed Type K copper tube extensions a minimum of 6 inch long on the inlet and outlet side of the valve for making connection to the pipeline(s). Provide a purge port on both the inlet and outlet tube extensions. Valves in locations other than zone valve boxes must be lockable.

b. Vacuum piping systems up to 20 inches Hg vacuum: Bronze full port, quarter-turn ball type, three piece construction, 29 inches Hg vacuum, blow out proof stem, in-line repairable. All sizes: 316 stainless steel ball and stem, glass reinforced polytetrafluoroethylene (RPTFE) seat seals and packings. Provide with valve manufacturer installed brazed Type K copper tube extensions a minimum of 6 inch long on the inlet and outlet side of the valve for making connection to the pipeline(s). Provide a purge port on both the inlet and outlet tube extensions. Valves in locations other than zone valve boxes must be lockable.

2.6.2 Zone Valve Assemblies

a. Recessed wall box, minimum 18 GA sheet steel, baked enamel finish. Stainless steel or chrome front trim. Transparent plastic door with pull handle or ring for emergency access to valves. Service access to valves must be by removal and replacement of door, which must neither cause damage nor require special tools. Opaque plastic is not acceptable. Openings to box interior must be dust-tight. Provide each shutoff valve with pressure gauge and integral extension tubes for joining to piping system outside of box. Provide gauge port on each tubing extension. Lockable valves are not required..

b. Up to 5 shutoff valves of 1 inch size or smaller may be installed in one box. Use single-valve boxes for 1-1/4 inch valves and larger. Front trim with interlocking edges where single-valve boxes are jointed together for multiple valve installations. Provide custom-made boxes as specified above for those valves that are too large for pre-manufactured boxes.

c. Surface mounted wall box, same as recess mounted except provide with exposed surface finish primed for field painting and provide only where surface mounting is specifically indicated on drawings.

d. Arrange shutoff valves in following order from top to bottom: Oxygen, nitrous oxide, carbon dioxide, dental compressed air, medical compressed air, nitrogen, Waste Anesthesia Gas Disposal, dental surgical vacuum, and medical-surgical vacuum. If 2 or more valves for

same service are located in common box, larger of valves must be lower.

2.7 NITROGEN AND INSTRUMENT COMPRESSED AIR CONTROL PANELS

Nitrogen and instrument compressed air control panels must be designed to deliver variable pressures to power pneumatic surgical tools. Provide the control panel with a 0-300 psi pressure gauge, shutoff valve, pressure regulator, delivery pressure gauge and Diameter-Index Safety System (DISS) outlet. Provide quarter turn valves to obtain a fully "open" or "closed" position. Provide an adjustable self relieving type pressure regulator, with a operating range of 10 to 250 psi. Control panels must be pre-piped internally requiring only external supply line connections. Additional outlets in the same room may be connected to the remote outlet pigtail furnished in the control panel. Remote outlets must be regulated by the adjustable pressure regulator within the panel and shall match the nitrogen control panel outlet type. Provide control panels in horizontal or vertical orientation.

2.8 HANGERS AND SUPPORTS

Provide copper plated pipe hangers and supports when in direct contact with copper tubing. Tubing installed on trapeze hanger must be secured in place with appropriately sized clamp and be fully isolated from dissimilar metals.

2.9 GAUGES

a. Provide for line pressure use adjacent to source equipment, ASME B40.100 pressure gauges, 4 1/2 inches in diameter with metal case for oxygen, nitrous oxide, carbon dioxide, dental compressed air, medical compressed air, laboratory compressed air, process compressed air, and nitrogen, accurate to within two percent. Range must be two times operating pressure. Dial graduations and figures must be black on a white background, or white on a black background. Provide gauges expressly made for and cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Provide bourdon tube and brass movement. Install with gauge cock. Gauges for all services downstream of main shutoff valve must be same as those adjacent to source equipment except diameter may be reduced to 1-1/2 inches. Dial ranges must be 0 to 100 psi for pressurized gases and compressed air services except nitrogen and instrument compressed air; 0 to 300 psi for nitrogen and instrument compressed air.

b. Provide for vacuum line use adjacent to source equipment, ASME B40.100 vacuum compound gauges, 4 1/2 inches in diameter with metal case for dental surgical vacuum, medical-surgical vacuum, dental oral evacuation, Waste Anesthesia Gas Disposal, and laboratory dust evacuation, accurate to within two percent. Dial graduations and figures must be black on a white background, or white on a black background. Label for vacuum service. Provide with bourdon tube and brass movement. Install with gauge cock. Gauges for all services upstream of main shutoff valve must be same as those adjacent to source except diameter may be reduced to 1 1/2 inches. Dial range must be 0 to 30 inches Hg vacuum.

2.10 DENTAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS

2.10.1 Station Outlets/Inlets

Submit proof that outlets/inlets, as an assembly, are listed by Underwriters Laboratories, Inc., and are manufactured in accordance with applicable NFPA 99 and CGA standards. Provide station outlets/inlets (Oxygen, Nitrogen, Nitrous Oxide, Dental Surgical Vacuum, Waste Anesthesia Gas Disposal, Instrument Compressed Air) conforming to NFPA 99. Provide station outlets/inlets for concealed piping made of brass and having an adjustable valve mechanism to compensate for variation in wall thickness. Each unit must be securely mounted and self-sealing. Each unit as an assembly must conform to the requirements of the Underwriters Laboratories Inc.; submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the Contractor may submit a written certificate from any approved nationally recognized testing organization adequately equipped and competent to perform such services, including the follow-up service, stating that the item has been tested and conforms to the requirements, including method of testing, of the specified agency. Provide station outlets/inlets equipped with threaded DISS connector per CGA standards noninterchangeable quick disconnect coupler, except for nitrogen which shall be equipped with DISS connections as assigned for gas and vacuum systems in CGA V-5, except that inlets for the Waste Anesthesia Gas Disposal system must be 7/8 inch nonthreaded connections. Provide DISS outlets for all dental vacuum and ceiling mount applications. Provide recessed wall type outlets/inlets unless specified otherwise. Provide station outlets cleaned for oxygen service in accordance with Pamphlet CGA G-4.1 and the assembly capped and the finished assembly poly bagged for shipment.

2.10.1.1 Couplers

Where quick-disconnect couplers are furnished they must be of the noninterchangeable type. Connector must lock firmly into position and have a finger-type quick release. Coordinate quick-disconnect coupler type with the Contracting Officer.

2.10.1.2 Faceplates

Provide polished chromium-plated metal or satin-finish stainless steel faceplates secured with chromium-plated countersunk screws. Provide service identification either cast into, or permanently etched by the manufacturer into each faceplate.

2.10.1.3 Rough-In Assembly

Provide rough in assembly of modular design and include a gas specific 16 gauge steel mounting plate designed to permit on-site ganging of multiple outlets, on 5 inch center line spacing. Provide a machined brass outlet block permanently attached to the mounting bracket to permit the 1/2 inch OD, type-K copper inlet to swivel 360 degrees for attachment to the piping system. The rough in assembly must contain a double seal to prevent gas leakage between the rough in and latch-valve assemblies after the wall is finished. A single o-ring seal is not acceptable. The latch-valve assembly shall telescope up to 3/4 inches to allow for variation in finished wall thickness from 1/2 to 1-1/4 inches.

2.10.1.4 Ceiling Applications/Hose Assemblies

Provide hose assemblies for all ceiling outlets for the finished ceiling height as indicated on drawings. Provide each hose with a heavy-duty chain type dual retractor for pressure gases and for vacuum. Retractions made of stainless cable are not acceptable. Allow an extra 18 inches of hose length for retractors.

2.10.1.5 Vacuum Slides

Provide one vacuum slide of the same manufacturer of the vacuum inlet for each vacuum inlet. Coordinate location with room elevations.

2.10.2 Dental Compressed Air Outlets

Provide dental compressed air outlets as follows:

a. Provide dental treatment rooms (DTR) with a 1/2 inch service pipe terminated with a 1/2 by 3/8 inch compression angle stop valve.

b. Dental laboratory. Provide each of the following, and coordinate locations with the laboratory casework supplier.

(1) 1/2 inch service pipe terminated with a ball valve. 1/2 inch service pipe terminated with a needle valve.

(2) 1/2 inch service pipe terminated with a quick disconnect brass body coupler and sleeve, 3/8 inch NPT, 300 psimaximum pressure rating, Buna-N seals, and complying with the dimensional requirements of military specification MIL-C-4109.

c. Provide dental instrument processing center with a 5/8 inch OD service pipe terminated with a quick disconnect brass body coupler and sleeve, 3/8 inch NPT, 300 psi maximum pressure rating, Buna-N seals, and complying with the dimensional requirements of military specification MIL-C-4109.

2.10.3 Dental Oral Evacuation Inlets (Dental Treatment Room)

Provide dental 2 inches above bottom of floor box or above finished floor. Cover pipe end to prevent entrance of debris. Prepare end for continuation of service by another Division.

2.11 WARNING SYSTEMS

Locate alarm panels for gas and vacuum systems as specified and indicated. Each signal and gauge must be appropriately labeled "OPERATING" and "EMERGENCY." Clearly identify each gauge and device by means of engraved plastic nameplates. Provide alarms and pressure gauges for each pressurized system. Provide alarms and vacuum gauges for each vacuum, Waste Anesthesia Gas Disposal, and oral evacuation system. Energize signal systems by the normal and emergency power systems.

2.11.1 Master Alarm Panels

a. Master alarm panel features:

(1) Provide recessed panel, complete with all necessary displays, factory wiring, transformers, and circuitry requiring only 115 VAC

60 Hz primary power connected to the Life Safety branch. Provide with metallic back (rough-in) box. Provide panel that is compliant with NFPA 99 and UL Listed as an assembly.

(2) Provide one green Light Emitting Diode (LED) indicating that the panel is powered and operating normally, and one red LED indicating a fault in the panel power and/or microprocessor has been detected. The red LED must not be able to be reset until the fault has been repaired, and then the red LED must automatically reset to green. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(3) Provide each individual signal with one green and one red LED. Provide illuminated green LED for "Normal" status. Provide illuminated red LED for "Abnormal" status. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(4) Provide audible alarm upon actuation of any abnormal condition. Provide audible signal producing a minimum sound pressure level of 80 dBA measured at a distance of 3 feet. Provide the audible alarm with a reset relay to shut off only the audible alarm and not affect the illuminated "Abnormal" LED, until the condition is corrected. The audible alarm must sound again upon actuation of any additional abnormal condition.

(5) Provide back (rough-in) box factory configured for internal sensor mounting. Provide gas specific sensors for periodic testing without interrupting pipeline pressures or vacuum. External sensors, when applicable, must be designed to function up to 5,000 feet from the alarm panel.

(6) Provide front panel TEST button to initiate a self-test function to test the LED indicators, visual displays, audible alarm, and to view alarm set points.

(7) Provide contacts for connecting to UMCS (UFGS 23 09 00). Alarms requiring installation of additional circuit boards for PC-based monitoring are not acceptable.

b. Provide alarm points based on installed systems:

(1) Dental Compressed Air Main Line Pressure High/Low

(2) Dental Surgical Vacuum Main Line Vacuum Low

2.11.2 Area Alarm Panels

a. Area alarm panel features:

(1) Provide recessed panel, complete with all necessary displays, factory wiring, transformers, and circuitry requiring only 120 VAC 60 Hz primary power connected to the Life Safety branch. Provide with metallic back (rough-in) box. Provide panel that is compliant with NFPA 99 and UL Listed as an assembly.

(2) Provide one green Light Emitting Diode (LED) indicating that the

panel is powered and operating normally.

(3) Provide each individual signal with one green and one red LED. Provide illuminated green LED for "Normal" status. Provide illuminated red LED for "Abnormal" status. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(4) Provide audible alarm upon actuation of any abnormal condition. Provide audible signal producing a minimum sound pressure level of 80 dBA measured at a distance of 3 feet. Provide the audible alarm with a reset relay to shut off only the audible alarm and not affect the illuminated "Abnormal" LED, until the condition is corrected. The audible alarm must sound again upon actuation of any additional abnormal condition.

(5) Provide back (rough-in) box factory configured for internal sensor mounting. Provide gas specific sensors for periodic testing without interrupting pipeline pressures or vacuum. External sensors are not permitted.

(6) Provide front panel TEST button to initiate a self-test function to test the LED indicators, visual displays, audible alarm, and to view alarm set points.

b. Provide alarm points based on installed systems:

(1) High/Low Line Pressure (for each positive pressure system piped to the area). Actuation when the pressure in the line being monitored reaches approximately 20 percent above or below normal operating pressure.

(2) Low Line Vacuum (for each vacuum system piped to the area). Medical-surgical alarm must be actuated when the vacuum in the line being monitored reaches 12 inches Hg vacuum. .

2.11.3 Local Alarm Panels

a. Provide alarm points based on installed systems:

2.12 IDENTIFICATION MATERIALS

General: Provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.12.1 Plastic Pipe Markers

Provide snap-on or adhesive type pipe markers with nomenclature that closely matches Contract Drawings. Comply with designations indicated on Contract Drawings for piping system nomenclature and abbreviate only as necessary for each application length. Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

a. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid

snap-on, color-coded pipe markers, complying with ANSI A108.11 ASME A13.1.

b. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ASME A13.1.

c. Application: For exterior diameters greater than 2-inch (including insulation if any), provide continuous directional flow arrow tape around pipe circumference; two places, before and after pipe marker. Provide adhesive plastic pipe markers. For external diameters less than 2 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

(1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

(2) Adhesive lap joint in pipe marker overlap.

(3) Laminated or bonded application of pipe marker to pipe (or insulation).

2.12.2 Valve Tags

Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with hole for fastener, or engraved plastic laminate valve tags, with piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with hole for fastener. Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose. Compile valve schedule for each service. For each page of valve schedule, provide laminated plastic coated cardboard stock sheets.

a. Provide 1 1/2-inch diameter tags, except as otherwise indicated.

b. Provide size and shape as specified or scheduled for each piping system.

c. Fill tag engraving with black enamel.

2.12.3 Engraved Plastic Laminate Signs

Provide manufacturer's standard laminated plastic, color coded equipment markers. Include terminology matching equipment schedules as closely as possible. Provide approximate 2-inch by 4-inch markers for control devices, and 4-inch by 6-inch for equipment. Identify equipment and electrical devices furnished under this section.

2.12.4 Plastic Equipment Markers

Provide manufacturer's standard laminated plastic, color coded equipment markers. Include terminology matching equipment schedules as closely as possible. Provide approximate 2-inch by 4-inch markers for control devices, and 4-inch by 6-inch for equipment. Identify equipment and electrical devices furnished under this section.

2.12.5 Plasticized Tags

Provide pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately, 2-inch by 6-inch with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.12.6 Lettering and Graphics

Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Oral Evacuation Pump No. 2, Dental Air Compressor No. 1).

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 COMPRESSED AIR AND VACUUM SOURCES

Installation must be in accordance with manufacturer's instructions and recommendations and NFPA 99. Align compressor and vacuum pump couplings in accordance with manufacturers' specifications. Provide factory service representative to supervise installation and to set pressure and vacuum switches. Perform system start-up by factory trained personnel and documented.

3.2.1 Central Dry Separator for High-Volume Laboratory Dust Evacuation

Locate the separator so that the lower canister can be removed easily and cleaned. Equip the separator with a cut-off valve to permit shutdown when the system is not in use.

3.2.2 Amalgam Separator for Dental Oral Evacuation

Install amalgam separator between the treatment rooms and the central wet separator in a location that is accessible from a standing position adjacent to the separator.

3.3 PIPING SYSTEMS

a. Piping must be cleaned, tested, and installed as specified in NFPA 99.

b. Provide Nitrogen NF gas purge to prevent oxide formation inside the copper tubing when brazing joints. Make joints with BCuP series brazing alloy, except as permitted otherwise by NFPA 99. Brazing alloy must fully penetrate joints to the depth of an ASME B16.50 fitting.

c. Make up threaded joints, as permitted by NFPA 99, with polytetrafluoroethylene tape, or other thread sealant approved for oxygen service. Apply thread sealant to male threads only.

d. Install pipe lines where they will not be subject to physical damage.

e. Install branch piping full size to each outlet/inlet, including vertical drops. Provide reducer at the outlet/inlet pigtail connection.

f. Provide protection of underground piping against frost, corrosion, and physical damage by installing piping in nonmetallic ducts or casings. Encase underground piping passing beneath load bearing surfaces and traffic areas in split PVC pipe sized to accommodate piping. Secure split PVC piping with galvanized steel draw bands. Support at regular intervals by insulating spacers providing complete circumferential clearance.

g. Install piping intended to contain cryogenic liquids such that the liquid does not come in contact with concrete in the event of a leak.

h. Connect piping near the top of receivers.

i. Extend compressed air intake pipe, and vacuum pump exhaust pipe to the outside of the building and turn their end down and screen against insects. Terminate compressed air intake piping a minimum of 36 inches above the roofing surface.

j. Provide vibration-absorbing couplings between the compressed air and vacuum source(s) and the system pipeline, and the compressed air and vacuum sources and the intake air/vacuum pump exhaust piping.

k. Provide laboratory and process air piping system(s) separate from the dental and medical compressed air system(s).

l. Install dental oral evacuation system piping with a minimum slope of 1/4 inch per 10 feet from the DTR utility box to the separator tanks.

m. Provide pipelines with appropriate system labeling conforming to NFPA 99.

n. Provide protective bushings on medical gas and vacuum piping passing through metal stud partitions.

o. Install vacuum exhaust piping with a minimum slope of 1/4-inch per 10 feet towards vacuum source equipment.

3.4 STATION OUTLETS/INLETS

3.4.1 Wall Outlets/Inlets

Locate wall outlets/inlets 60 inches from finished floor or as indicated. Permanently stamp back boxes with the gas or vacuum service identification and must be safety-keyed to accept only the appropriate gas or vacuum faceplate.

3.4.2 DISS Connections

Where threaded connections are furnished, DISS connections as described in

CGA V-5 must be used to provide noninterchangeable connections. In order to facilitate connection making, the threads of the connection must engage before the check valve is depressed and pressure is allowed to enter the attached fitting. No leakage must occur when threads are fingertight.

3.4.3 Height of Hose-reel Type Outlets/Inlets

Termination must be a minimum of 80 inches above the finished floor.

3.5 VALVES AND ASSEMBLIES

Valve cabinets must be recess mounted on the corridor side of the partition. Cabinets must house alarm system sensors and zone control valves. The valves must be installed in the cabinet 5 feet above the floor at the center line of the box and provide complete shutoff of each of the piped services. Provide valves and exposed piping connecting the valves with appropriate system labeling conforming to NFPA 99. Valves and exposed piping connecting the valves must be labeled or identified in an approved manner with colors as follows:

System	Colors (Background/Text)
Dental Compressed Air	Yellow and White Diagonal Stripe/Black
Dental Surgical Vacuum	White and Black Diagonal Stripe/Black Boxed
Medical Compressed Air	Yellow/Black
Carbon Dioxide	Gray/Black or Gray/White
Instrument Air	Red/White
Laboratory Air	Yellow and White Checkerboard/Black
Laboratory Vacuum	Yellow and White Checkerboard/Black Boxed
Nitrogen	Black/White
Nitrous Oxide	Blue/White
Oral Evacuation	White and Black Checkerboard/Black Boxed
Oxygen	Green/White or White/Green
Medical Surgical Vacuum	White/Black
Waste Anesthetic Gas Disposal	Violet/White

Securely mount each valve in a fixed position by means of brackets. Position of each valve must allow for a firm grip to facilitate easy closing and opening. Each valve or valve box must be labeled in substance as follows:

"Caution - (Name of applicable system) Valves. Do not close except in

emergency. This valve controls (Name of applicable system) to insert room name/number."

3.6 GAUGES

a. Calibrate and zero gauges at job site.

b. Permanently label gauges with system name.

3.7 VIBRATION-ABSORBING FEATURES

Isolate mechanical equipment, including compressors and pumps, from the building structure by approved vibration-absorbing features unless otherwise shown. Each foundation must include standard isolation units as indicated. Each unit must consist of machine and floor or foundation fastening, together with intermediate isolation material, and be a standard product with printed loading rating. Provide piping connected to mechanical equipment with flexible connectors. Isolation unit installation must limit vibration to 30 percent of the lowest equipment rpm. Submit details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

3.7.1 Tank or Skid Mounted Compressors

Provide floor attachments as recommended by compressor manufacturer.

3.7.2 Foundation Mounted Compressors

Provide foundation attachment as recommended by the compressor manufacturer.

3.8 TRAINING

a. Provide the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and be trained in operating theory as well as practical operation and maintenance work.

b. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

c. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

3.9 IDENTIFICATION SYSTEMS

Identify piping and physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, and NEMA Z535.1. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification

after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Identify each piping system and item of equipment indicated on Contract Drawings.

3.9.1 Piping System Identification

Install plastic pipe markers on each system, and include arrows to show normal direction of flow. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, crawl spaces) and exterior non-concealed locations as follows.

a. Near each valve and control device.

b. Near each branch; mark each pipe at branch, where there could be question of flow pattern.

c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points which permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

f. Spaced intermediately at maximum spacing of 20 feet along each piping run, except reduce spacing to 10 feet in congested areas of piping and equipment. Provide a minimum of one pipe label in each space where partitions extend to structure.

g. Align pipe labels and flow arrows on systems where parallel piping is installed.

3.9.2 Valves

Provide valve tag on every valve, cock and control device in each piping system. List each tagged valve in valve schedule for each piping system. .Mount laminated valve schedules under glass in mechanical equipment rooms. Coordinate location with the Contracting Officer. Provide 1/2-inch red adhesive identification dots on ceiling tiles located immediately below balancing valves and shutoff valves.

3.9.3 Medical/Dental Source Equipment

Provide minimum 1/4-inch high lettering for name of unit where viewing distance is less than 1/2-inch high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.9.4 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.9.5 Color Coding Scheme for Locating Hidden Utility Components

Scheme must be provided in buildings having suspended grid ceilings. The color coding scheme must identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components must include valves. The color coding scheme must consist of a color code board and colored metal disks. Each colored metal disk must be approximately 3/8-inch in diameter and secured to removable ceiling panels with fasteners. Insert fasteners into the ceiling panels so that the fasteners will be concealed from view. The fasteners must be manually removable without tools and must not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks must follow completion of the finished surface on which the disks are to be fastened. Provide the color code board with approximate dimensions of 3-foot width, 30-inch height, and 1/2-inch thickness. Provide board made of wood fiberboard and framed under glass or 1/16-inch transparent plastic cover. Unless otherwise directed, the color code symbols must be approximately 3/4-inch in diameter and the related lettering in 1/2-inch high capital letters. Mount and locate the color code board in the mechanical or equipment room.

3.10 GAS, SUPPORT, AND VACUUM SYSTEMS TESTING

3.10.1 Joint Validation

At its discretion, the Government reserves the right to validate joint fill through destructive and non-destructive methods. Non-destructive methods include, but are not limited to, Visual Examination and Ultrasonic Examination, in accordance with AWS C3.8M/C3.8. Validation of joint fill through destructive or non-destructive methods and extents of examinations will be as determined by the Contracting Officer.

3.10.2 Test Reports

a. Certified installers, inspectors, and verifiers must conduct, document tests in accordance with NFPA 99, furnish their own test equipment and supplies (including gases) for their respective tests. Reports must be certified with the signature of an officer of the company responsible for conducting the test.

b. Submit reports in booklet form, within two weeks of test date with separate copies of each report for Contractor Quality Control, and Contracting Officer. Submit reports of both failed and passed tests. Except as indicated under specific test description, reports may be subdivided by tested area to allow timely submission. Submit test reports showing all field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed systems. Each test report must indicate the final position of controls.

c. Document each report separately in an easy-to-follow manner, organized by areas and systems tested. (An area is typically a group of outlets downstream of a zone valve assembly.)

d. At the beginning of each report, document the following information:

(1) Name of project.

(2) Date of report.

(3) Name of company responsible for performing test.

(4) Name of person conducting test.

(5) Date of test.

(6) Area(s) tested.

(7) Name and address of facility.

e. Make pressure readings with calibrated gauges that have accuracies of plus or minus 1 psi.

f. Make temperature readings with calibrated thermometers that have accuracies of plus or minus 1 degrees F.

3.10.3 Report Status

Project is acceptable only after systems have passed tests performed by the Inspection, Testing, and Verification Agency. Failure of test requires corrective action and retesting. Corrective actions taken to pass test and subsequent retesting must be provided at no extra cost.

3.10.4 Tests and Reports Prior to Start of Installation

Conduct test of existing medical gas/vacuum warning system to verify existing conditions and document.

3.10.5 Category 3 Systems Testing

3.10.5.1 General

a. Perform inspection and testing on all new piped systems, additions, renovations, temporary installations, or repaired systems, to ensure by a documented procedure, that all applicable provisions of NFPA 99 and the Contract Documents have been adhered to and system integrity has been achieved or maintained.

b. Inspection and testing to include all components of the system or portions thereof, including, but not limited to, medical gas source(s), compressed air sources (e.g., compressors, dryers, filters, regulators), alarms and monitoring safeguards, pipelines, isolation valves, and station inlets (vacuum) and outlets (positive pressure gases).

c. Inspect and test all systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new medical gas sources, compressors, dryers, alarms). Systems are deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition. Breached portions of the systems subject to inspection and testing must be confined to only the specific altered zone and components in the immediate zone or area that is located upstream (inlet side) for vacuum systems and downstream (outlet side) for positive pressure gases at the point or area of intrusion.

d. Provide inspection, testing and verifier reports containing detailed findings and results directly to the Contracting Officer. Maintain all inspection, testing, and verification records on-site within the facility. The Contracting Officer must review the records prior to the use of all systems.

e. The Contracting Officer will accept the Verifier's Report as determining that the gas/vacuum delivered to the outlet/inlet is that shown on the outlet/inlet label and the proper connecting fittings are installed for the specific gas/vacuum service.

3.10.5.2 Initial Tests and Reports - All Category 3 Systems

The installing Contractor, a representative of the system supplier, or a representative of the system manufacturer is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

a. Initial Blow Down Test.

b. Initial Pressure Test for Positive Pressure Gas Systems and Copper Vacuum Piping.

c. Initial Leak Test for PVC Vacuum Piping. Subject piping to a vacuum of not less than 12 inches Hg vacuum.

d. Initial Cross-Connection Test. Conduct this test only after completion of every system within test area.

e. Initial Piping Purge Test.

f. Initial Standing Pressure Test for Positive-Pressure Gas Piping.

g. Initial Standing Vacuum Test for Copper and PVC Vacuum Systems. Subject PVC piping to a vacuum of not less than 12 inches Hg which must not reduce to less than 8 inches Hg vacuum at the end of the 24 hour test period.

3.10.5.3 I,T&V Agency Tests and Reports

The Inspection, Testing and Verification Agency is responsible for conducting and documenting gas and Nitrogen tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

a. Verifier Standing Pressure Test.

b. Verifier Cross-Connection Test.

c. Verifier Warning System Test.

d. Verifier Piping Purge Test.

e. Verifier Piping Particulate Test.

f. Verifier Piping Purity Test.

g. Verifier Operational Pressure Test.

h. Verifier Gas Concentration Test.

i. Labeling.

j. Oxygen and Nitrous Oxide Source Equipment Operational Test.

3.10.5.4 Final Tests and Reports - All Category 3

The installing Contractor, a representative of the system supplier, a representative of the system manufacturer, or a certified system verifier is responsible for conducting and documenting Gas, Support, and Vacuum Systems (except Oxygen and Nitrous Oxide) tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

a. Final Standing Pressure Test.

b. Final Standing Vacuum Test.

c. Final Cross-Connection Test.

d. Final Piping Purge Test.

e. Labeling.

f. Gas, Support Systems Source Equipment Operational Test.

g. Vacuum Systems Source Equipment Operational Test.

h. Dental Oral Evacuation (OE) System Test

Materials needed: Two vacuum gauges, accuracy of at least ±0.5" Hg at 6-8" Hg. Flow restrictors (quantity = 70 percent by number of dental treatment rooms). Flow restrictor components:

(1)

Part A	Hose, smooth bore OE tubing, 5/8 inch ID by 4 inch long.
Part B	Hose adaptor, brass, 1/2 inch male pipe thread by 3/8 inch hose barb.
Part C	Tubing, vinyl, 1/2 inch ID by 1-3/8 inch long.
Part D	Tubing, vinyl, 1/2 inch OD, 3/16 inch ID by 1 inch long.
Part E	Tubing, soft copper, 5/16 inch by 2 inch long.

(2) Clear burrs on cut ends with 15/16 inch drill bit.

Flow restrictor assembly:

a. Insert threaded end of the hose barb (Part B) completely into the 5/8 inch OE hose (Part A).

b. Slip the 1/2 inch ID tubing (Part C) completely over the hose barb (Part B).

c. Slip 1/2 inch OD tubing (Part D) into the 1/2 inch ID tubing (Part C)

to butt against the hose barb (Part B).

d. Slip the copper tubing (Part E) into the 1/2 inch OD tubing (Part D) approximately 3/4 inch.

e. Flow restrictors as designed allow a flow of 7.4 SCFM when attached to plumbing under 6 inches Hg vacuum pressure.

(1) Install vacuum gauge No. 1 on a pipe common to the power units close to the separating tanks. Install this gauge in a manner that will have minimal effect on airflow through the pipe.

(2) Install vacuum gauge No. 2 on the dental oral evacuation inlet in the floor box of the dental treatment room (DTR) farthest from the vacuum power units. Note that this inlet will be closed, with no flow passing through it.

(3) Place a flow restrictor over one dental oral evacuation inlet in 70 percent of the facility DTRs. DTRs fitted with flow restrictors should include a mix of DTRs most distant and DTRs nearest the vacuum source.

(4) Block off all other dental oral evacuation inlets and any other openings in the fixed pipe system.

(5) Operate the vacuum system with one pump inoperable and note the readings on the two vacuum pressure gauges. Next, operate the vacuum system with a different pump inoperable and note the reading on both vacuum pressure gauges. Continue this process until a vacuum reading has been obtained with each of the system pumps taking a turn as the inoperable pump.

(6) An acceptable dental oral evacuation system must be able to maintain a minimum of 6 inches Hg vacuum as measured on the vacuum gauge on the furthest DTR inlet (gauge No. 2) under the conditions outlined above. The system piping pressure drop between the vacuum gauge near the power units (gauge No. 1) and the vacuum gauge at the farthest DTR (gauge No. 2) must be no more than 1 inch Hg vacuum.

3.10.6 Category 1 Systems Testing

3.10.6.1 General

a. Perform inspection and testing on all new piped systems, additions, renovations, temporary installations, or repaired systems, to assure by a documented procedure, that all applicable provisions of NFPA 99 and the Contract Documents have been adhered to and system integrity has been achieved or maintained.

b. Inspection and testing must include all components of the system or portions thereof, including, but not limited to, bulk source(s), cylinder manifolds, compressed air sources (e.g., compressors, dryers, filters, regulators), source alarms and monitoring safeguards, master alarms, pipelines, isolation valves, area alarms, zone valves, and station inlets (vacuum) and outlets (pressure gases).

c. All systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new gas sources: bulk,

manifolds, compressors, dryers, alarms) must be inspected and tested. Systems are deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition. Breached portions of the systems subject to inspection and testing must be confined to only the specific altered zone and components in the immediate zone or area that is located upstream for vacuum systems and downstream for pressure gases at the point or area of intrusion.

d. Provide inspection, testing, and verifier reports containing detailed findings and results directly to the Contracting Officer. Maintain all inspection, testing, and verification records on-site within the facility. The Contracting Officer or their appointed representative must review the records prior to the use of all systems.

e. Before piping systems are initially put into use the Contracting Officer must accept the Verifier's Report as determining that the gas/vacuum delivered to the outlet/inlet is that shown on the outlet/inlet label and the proper connecting fittings are installed for the specific gas/vacuum service.

3.10.6.2 Installer Performed Tests and Reports

The installing Contractor is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests. Tests apply to all Gas, Support, and Vacuum Systems.

a. Initial Blow Down Test.

b. Initial Pressure Test.

c. Cross Connection Test.

d. Piping Purge Test.

e. Standing Pressure Test for Positive Pressure Piping.

f. Standing Vacuum Test for Vacuum Piping.

3.10.6.3 I,T&V Agency Tests and Reports

The Inspection, Testing, and Verification Agency is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests. Tests apply to all Gas, Support, and Vacuum Systems.

a. Standing Pressure Test.

b. Cross Connection Test.

c. Individual Pressurization Test.

d. Pressure Differential Test.

e. Valve Test.

f. Alarm Test. Master Alarms. Area Alarms.

g. Piping Purge Test.

h. Piping Particulate Test.

i. Piping Purity Test.

j. Operational Pressure Test.

k. Medical Gas Concentration Test.

l. Medical Compressed Air Purity Test.

m. Labeling.

n. Source Equipment Verification:

(1) Gas Cylinder Supply Sources.

(2) Medical Compressed Air Compressor Sources.

(3) Medical-Surgical Vacuum Sources.

3.11 WARNING SYSTEM

Provide wiring required for warning system except for power source at each alarm panel, which is provided by Electrical Specification Division contractor. Install wiring in conduit.

a. Label each alarm position on each alarm panel. Coordinate designations with using facility. Coordinate area designations with associated zone valve assembly designations.

b. Do not daisy-chain master alarm panels. Provide panel dedicated sensors and wiring from the alarm points to each installed master alarm panel.

c. Provide master alarm panels at the following locations:

Emergency Receiving Desk	Room _____
Central Information Desk	Room _____
Building Engineers Office	Room _____
Building Security Office	Room _____

d. Provide master alarm connection to UMCS (UFGS 23 09 00).

e. Do not daisy-chain area alarm panels.

-- End of Section --

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SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS
08/10, CHG 3: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a

conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

[1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.
]
[~~1.6 ELECTRICAL INSTALLATION REQUIREMENTS~~

~~Electrical installations must conform to IEEE C2, NFPA 70, and~~

requirements specified herein.

1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters [(except starters/controllers which are indicated as part of a motor control center)], control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, [the motor control equipment forming a part of motor control centers,] and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.6.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.6.3 High Efficiency Motors

1.6.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.6.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.6.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

]1.6 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.7 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat

after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F must receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
11/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)
ASA S1.11 PART 1	(2014) American National Standard Electroacoustics – Octave-Band and Fractional-Octave-Band Filters – Part 1: Specifications

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 203	(1990; R 2011) Field Performance Measurements of Fan Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2010) Ventilation for Acceptable Indoor Air Quality
ASHRAE HVAC APP IP HDBK	(2016) HVAC Applications Handbook, I-P Edition

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002; 6th ed) National Standards for Total System Balance
AABC MN-4	(1996) Test and Balance Procedures

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV	(2006) Procedural Standards for Measurements and Assessment of Sound and Vibration
NEBB PROCEDURAL STANDARDS	(2015) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1858	(2004) HVAC Sound And Vibration Manual - First Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council

b. COTR: Contracting Officer's Technical Representative

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means ~~"a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class."~~"a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems)

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

n. TAB Agency: TAB Firm

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

~~o. TAB team field leader: TAB team field leader~~

~~p. TAB team supervisor: TAB team engineer~~

~~q. TAB team technicians: TAB team assistants~~

r. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of ~~[~~new~~][and existing]~~ heating, ventilating, and cooling (HVAC) air~~[~~ and water~~]~~ distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings~~, including records of existing conditions~~.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

1.3.1 Air Distribution Systems

Test, adjust, and balance system~~[~~s~~]~~ (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.2 Water Distribution Systems

TAB system~~[~~s~~]~~ in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Water quantities and temperatures in thermal energy transfer equipment schedules.

5. Water quantities and heads in pump schedules.

6. Water flow measurement fittings and balancing fittings.

7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or

mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-gra

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation. ~~The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.~~

Submit ~~[~~three~~]~~~~[_____]~~ copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than ~~[~~21~~]~~~~[_____]~~ days prior to the start of TAB field measurements.

1.3.4 Related Requirements

~~Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.~~

~~Specific requirements relating to Reliability Centered Maintenance (RCM) principals and Predictive Testing and Inspection (PTI), by the construction contractor to detect latent manufacturing and installation defects must be followed as part of the Contractor's Quality Control program. Refer to the paragraph SUSTAINABILITY for detailed requirements.~~ Requirements for price breakdown of HVAC TAB work are specified in Section 01 20 00.05 20 PRICE AND PAYMENT PROCEDURES FOR DESIGN BUILD.

Requirements for construction scheduling related to HVAC TAB work are specified in Section 01 32 17.00 20 COST LOADED NETWORK ANALYSIS SCHEDULES (NAS).

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions; G~~[, [_____]]~~

Independent TAB Agency and Personnel Qualifications; G~~[, [_____]]~~

TAB Design Review Report; G~~[, [_____]]~~

~~TAB Firm; G[, [_____]]~~

~~Designation of TAB Team Assistants; G[, [_____]]~~

~~Designation of TAB Team Engineer; G[, [_____]] or TAB Specialist; G [, [_____]]~~

~~Designation of TAB Team Field Leader; G[, [_____]]~~

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G~~[, [_____]]~~

SD-03 Product Data

Equipment and Performance Data; G~~[, [_____]]~~

TAB Related HVAC Submittals; G~~[, [_____]]~~

A list of the TAB Related HVAC Submittals, no later than ~~[~~7~~]~~ ~~[_____]~~ days after the approval of the TAB team engineer ~~[and assistant]~~.

~~TAB Procedures; G[, [_____]]~~

~~Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.~~

~~Calibration; G[, [_____]]~~

~~Systems Readiness Check; G[, [_____]]~~

~~TAB Execution; G[, [_____]]~~

~~TAB Verification; G[, [_____]]~~

SD-06 Test Reports

Completed Pre-Final DALT Report; G~~[, [_____]]~~

Certified Final DALT Report; G~~[, [_____]]~~

Prerequisite HVAC Work Checkout List For Proportional Balancing; G ~~[, [_____]]~~

Certified Final TAB Report for Proportional Balancing; G~~[, [_____]]~~

Prerequisite HVAC Work Checkout List For Season 1; G~~[, [_____]]~~

Certified Final TAB Report for Season 1; G~~[, [_____]]~~

Prerequisite HVAC Work Checkout List For Season 2; G~~[, [_____]]~~

Certified Final TAB Report for Season 2; G~~[, [_____]]~~
~~TAB Design Review Report; G[, [_____]]~~

~~TAB Report for Season 1; G[, [_____]]~~

~~TAB Report for Season 2; G[, [_____]]~~

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications; G~~[, [_____]]~~

DALT and TAB Submittal and Work Schedule; G~~[, [_____]]~~

TAB Pre-Field Engineering Report; G~~[, [_____]]~~

Instrument Calibration Certificates; G~~[, [_____]]~~

DALT and TAB Procedures Summary; G~~[, [_____]]~~

Completed Pre-Final DALT Work Checklist; G~~[, [_____]]~~

Advance Notice of Pre-Final DALT Field Work; G~~[, [_____]]~~

Advance Notice of TAB Field Work for Proportional Balancing; G~~[, [_____]]~~

Advance Notice of TAB Field Work for Season 1; G~~[, [_____]]~~

Advance Notice of TAB Field Work for Season 2 G~~[, [_____]]~~

~~TAB Firm; G[, [_____]]~~

~~Design Review Report; G[, [_____]]~~

~~[~~ ~~Pre-field DALT Preliminary Notification; G[, [_____]]~~

~~]~~ ~~Advanced Notice for [Season 1] TAB Field Work; G[, [_____]]~~

~~Prerequisite HVAC Work Check Out List [For Season 1]; G[, [_____]]~~

~~[~~ ~~Advanced Notice for Season 2 TAB Field Work; G[, [_____]]~~

~~]~~[~~Prerequisite HVAC Work Check Out List For Season 2; G[, [_____]]~~

~~]~~

1.5 QUALITY ASSURANCE

1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team

field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.5.1.1 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.1.2 Qualifications

a. TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including ~~[~~TAB of environmental systems~~]~~ ~~[the performance of clean rooms and clean air devices] [building systems commissioning] [~~and~~]~~ ~~[~~the measuring of sound and vibration in

environmental systems].

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

b. TAB Specialist

The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

c. TAB Specialist Responsiblities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.

1.5.1.3 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.2 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work

responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.2.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system

installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.2.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.2.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is

anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of ~~[~~one~~]~~ ~~[two] [_____]~~ 8 hour workday~~[s]~~ duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

~~[~~ (1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of ~~[~~one~~]~~ ~~[two] [_____]~~ 8 hour workday ~~[s]~~ duration.

~~]~~~~[~~ (2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of ~~[~~one~~]~~ ~~[two] [_____]~~ 8 hour workday~~[s]~~ duration. Review the TAB final report data and certify the TAB final report.

~~]~~

~~[(1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.~~

~~Review the TAB final report data and certify the TAB final report.~~

~~]~~ k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise ~~[~~ Season 1 ~~]~~ ~~[~~and Season 2 ~~]~~ TAB field check.

1.5.2.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

~~[1.5.3 Project/Site Conditions~~

~~1.5.3.1 DALT and TAB Services to Obtain Existing Conditions~~

~~Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct this DALT and TAB work in accordance with the requirements of this section.~~

~~]~~1.5.3 Sequencing and Scheduling

~~[1.5.3.1 Projects with Phased Construction~~

~~This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase. When the construction is completed in phases, the DALT work and TAB work must be planned, completed, and accepted for each construction phase.~~

~~a. Phasing of Work~~

~~This specification section is structured as though the HVAC~~

~~construction, and thereby the TAB work, is going to be completed in a single phase[in spite of the fact that there will be two seasons]. All elements of the TAB work are addressed on this premise. When a contract is to be completed in construction phases, including the TAB work, and the DALT work, the TAB work and DALT work must be planned for, completed and approved by the Contracting Officer with each phase. An example of this case would be one contract that requires the rehabilitation of the HVAC in each of several separated buildings. At the completion of the final phase, compile all approved reports and submit as one document.~~

~~]~~1.5.3.1 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within ~~[~~45~~]~~ ~~[_____]~~ calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within ~~[~~30~~]~~ ~~[_____]~~ calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within ~~[~~60~~]~~ ~~[_____]~~ calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within ~~[~~15~~]~~ ~~[_____]~~ calendar days after completion of successful DALT Work Field Check, submit ~~[~~Season 1 ~~]~~ TAB report.

Pre-Field TAB Engineering Report: Within 30~~[_____]~~ calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List [For Season 1] and Advanced Notice For [Season 1] TAB Field Work: At a minimum of [115] [_____] calendar days prior to CCD, submit [Season 1] prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of [Season 1] TAB field work.

[[Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work.

Submit [Season 1] TAB Report: Within [15] [_____] calendar days after completion of [Season 1] TAB field work, submit [Season 1] TAB report.

[Season 1] TAB Field Check: [30] [_____] calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct [Season 1] field check.

Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]

[[Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work; submit [Season 1] TAB report; and conduct [Season 1] field check.

Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]

[Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within [150] [_____] calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

]

[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within [15] [_____] calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 TAB Field Check: [30] [_____] calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

]

[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish [Season 2] TAB field work; submit [Season 2] TAB report; and conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 field data check, complete TAB work.

] a. TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

b. Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.5.3.2 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.5.4 Subcontractor Special Requirements

Perform all work in this section in accordance with the paragraph SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00.05 20 ADMINISTRATIVE REQUIREMENTS FOR DESIGN BUILD, stating that all contract requirements of this section must be accomplished directly by a first tier subcontractor. No work may be performed by a second tier subcontractor.

1.5.5 Instrument Calibration Certificates

It is the responsibility of the TAB firm to provide instrumentation that meets the minimum requirements of the standard under which the TAB Firm's qualifications are approved for use on a project. Instrumentation must be in proper operating condition and must be applied in accordance with the instrumentation's manufacturer recommendations.

All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing. All instrumentation must be calibrated within no later than one year of the date of TAB work or government acceptance testing field work.

~~1.5.6 TAB Standard~~

~~Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.~~

~~All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.~~

1.5.7 Sustainability

Contractor must submit the following as part of the Quality Control Plan for acceptance testing:

a. List all test equipment to be used, including its manufacturer,model number, calibration date, and serial number.

b. Certificates of test personnel qualifications and certifications. Provide certification of compliance with 40 CFR 82.

c. Proof of equivalency if the contractor desires to substitute a test requirement.

Perform the following PTI as an integral part of the TAB process per the most recent edition of the NASA RCBEA GUIDE:

[Compressors:
a. Vibration Analysis
b. Balance Test and Measurement
c. Alignment (laser preferred)
d. Lubricating Oil Test
e. Thermodynamic Performance Test
][f. Hydraulic Oil Test (optional)
]

[Fans:
a. Vibration Analysis
b. Balance Test and Measurement
c. Alignment (laser preferred)
d. Lubricating Oil Test
e. Thermodynamic Performance Test
]

[Heat Exchangers (General):
a. Hydrostatic Test
b. Airborne Ultrasonic Test
c. Thermodynamic Performance Test
][d. Infrared Thermography (optional)
]

[Heat Exchangers (Condenser Air Cooled):
a. Hydrostatic Test
b. Thermodynamic Performance Test
][c. Airborne Ultrasonic Test (optional)
][d. Pulse Ultrasonic Test (optional)
][e. Infrared Thermography (optional)
]

[Heat Exchangers (Condenser Water Cooled):
a. Hydrostatic Test
b. Thermodynamic Performance Test
][c. Airborne Ultrasonic Test (optional)
][d. Pulse Ultrasonic Test (optional)
][e. Infrared Thermography (optional)
]

[Heat Exchange Cooling Tower:
a. Vibration Analysis
b. Balance Test and Measurement
c. Alignment (laser preferred)
d. Lubricating Oil Test
e. Performance Test
]

[HVAC Ducts:
a. Operational Test
b. Ductwork Leak Testing (DALT); Pre-Final DALT report, Final DALT report
]
[Piping Systems:
a. Vibration Analysis
b. Infrared Thermography
]
[Steam Coils:
a. Warranty Test
b. Vibration Analysis
c. Performance Test
d. Infrared Thermography
]
[Valves:
a. Hydrostatic Test
b. Airborne Ultrasonic Test (optional)
c. Thermodynamic Performance Test (optional)
][d. Infrared Thermography (optional)
]

1.5.8 Qualifications

1.5.8.1 TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including [TAB of environmental systems] [the performance of clean rooms and clean air devices] [building systems commissioning] [and] [the measuring of sound and vibration in environmental systems].

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.8.2 TAB Specialist

The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the

NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.8.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process[specified in Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING].

1.5.8.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.9 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.9.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB

SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

~~1.5.9.2 TAB Agency~~

~~Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.~~

~~1.5.9.3 TAB Team Supervisor~~

~~a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.~~

~~b. Pre-DALT/TAB meeting: Attend meeting with Contractor.~~

~~c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.~~

~~d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.~~

~~e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.~~

~~f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.~~

~~g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.~~

~~h. Technical assistance for DALT work.~~

~~(1) Technical assistance: Provide immediate technical assistance to TAB field team.~~

~~(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.~~

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

[(1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.

][(2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration. Review the TAB final report data and certify the TAB final report.
]
[(1) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration. Review the TAB final report data and certify the TAB final report.

] k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise [Season 1] [and Season 2] TAB field check.

1.5.9.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.10 Test Reports

1.5.10.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition,provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.10.2 Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated

in the following list:

(1) [Specifier: List desired rooms and/or zones here]. Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the [Season I TAB Report] [Season I and Season 2 TAB Report].

[c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.

][d. Static Pressure Profiles: Report static pressure profiles for air duct systems including: [_____]. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

]

[(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.[and also at the following locations:

Main Duct: Take readings at four locations along the full length of the main duct, 25 percent, 50 percent, 75 percent, and 100 percent of the total duct length.

Floor Branch Mains: Take readings at floor branch mains served by a main duct vertical riser.

Branch Main Ducts: Take readings at branch main ducts.

VAV Terminals: Take readings at inlet static pressure at VAV terminal box primary air branch ducts.

VAV Terminals, Fan Powered: Take readings at fan discharge and inlet static pressures for series and parallel fan powered VAV terminal boxes.]

]

e. Duct Traverses: Report duct traverses for main [and branch main] supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

[1.6 PROJECT/SITE CONDITIONS

1.6.1 DALT and TAB Services to Obtain Existing Conditions

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct this DALT and TAB work in accordance with the requirements of this section.

~~]1.7 SEQUENCING AND SCHEDULING~~

~~[1.7.1 Projects with Phased Construction~~

~~This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase. When the construction is completed in phases, the DALT work and TAB work must be planned, completed, and accepted for each construction phase.~~

~~1.7.1.1 Phasing of Work~~

~~This specification section is structured as though the HVAC construction, and thereby the TAB work, is going to be completed in a single phase[in spite of the fact that there will be two seasons]. All elements of the TAB work are addressed on this premise. When a contract is to be completed in construction phases, including the TAB work, and the DALT work, the TAB work and DALT work must be planned for, completed and approved by the Contracting Officer with each phase. An example of this case would be one contract that requires the rehabilitation of the HVAC in each of several separated buildings. At the completion of the final phase, compile all approved reports and submit as one document.~~

~~]1.7.2 DALT and TAB Submittal and Work Schedule~~

~~Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.~~

~~Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.~~

- ~~Qualify TAB Personnel: Within [45] [_____] calendar days after date of contract award, submit TAB agency and personnel qualifications.~~

- ~~Pre-DALT/TAB Meeting: Within [30] [_____] calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.~~

- ~~Design Review Report: Within [60] [_____] calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.~~

- ~~Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.~~

- ~~Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.~~

- ~~DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.~~

- ~~Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to~~

system.

- DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

- Submit Final DALT Report: Within [15] [_____] calendar days after completion of successful DALT Work Field Check, submit [Season 1] TAB report.

- Pre-Field TAB Engineering Report: Within [_____] calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

- Prerequisite HVAC Work Check Out List [For Season 1] and Advanced Notice For [Season 1] TAB Field Work: At a minimum of [115] [_____] calendar days prior to CCD, submit [Season 1] prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of [Season 1] TAB field work.

[- [Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work.

- Submit [Season 1] TAB Report: Within [15] [_____] calendar days after completion of [Season 1] TAB field work, submit [Season 1] TAB report.

- [Season 1] TAB Field Check: [30] [_____] calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct [Season 1] field check.

- Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]
[- [Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work; submit [Season 1] TAB report; and conduct [Season 1] field check.

- Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]
[- Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within [150] [_____] calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

]
[- Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

- Submit Season 2 TAB Report: Within [15] [_____] calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

- Season 2 TAB Field Check: [30] [_____] calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

]

[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish [Season 2] TAB field work; submit [Season 2] TAB report; and conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 field data check, complete TAB work.

]1.7.2.1 TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

1.7.2.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.7.2.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the

~~contract site by the TAB field team.~~

~~(3) Designate the actual data to be measured in the TAB field work.~~

~~(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.~~

~~c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.~~

~~At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.~~

~~1.8 WARRANTY~~

~~Furnish workmanship and performance warranty for the [DALT and] TAB system work performed for a period not less than [1] [2] [3] [5] [_____] years from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a [1] [2] [3] [5] [_____] year contractor installation warranty.~~

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

3.2 PRE-DALT/TAB MEETING

Meet with the Contracting Officer's technical representative (COTR)~~[and the designing engineer of the HVAC systems]~~ to develop a mutual

understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.3 DALT PROCEDURES

3.3.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

3.3.2 ~~Advance Notice of Pre-Final DALT Field Work~~Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.

3.3.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

~~[~~ It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

~~]~~3.3.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

3.3.5 Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.

TAB supervisor shall review, approve and sign the Pre-Final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-Final DALT Report data can commence. ~~After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.~~

3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

3.3.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

3.3.8 Certified Final DALT Report

~~On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval.~~ On successful completion of all field checks of the Pre-Final DALT Report data for all systems, the TAB Supervisor shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB to the Contracting Officer for approval.

3.3.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

3.4.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1 ~~[and AABC MN-4,][NEBB PROCEDURAL STANDARDS, NEBB MASV,]~~ or SMACNA 1780 (TABB) and

SMACNA 1858 (TABB),except as supplemented and modified by this section.

~~[Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.~~
~~]~~

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.~~[~~ The only water flow and air flow reporting which can be deferred until the Season 2 is that data which would be affected in terms of accuracy due to outside ambient conditions.~~]~~

3.4.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.4.3 TAB Air Distribution Systems

3.4.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

   Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

   Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

   Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, exhaust fans and winter ventilation fans), coils, ducts, plenums, mixing boxes, terminal units, variable air volume boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

~~[3.4.3.3 Rooftop Air Conditioning~~

~~Rooftop air conditioning systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.~~

~~For refrigeration compressors/condensers/condensing units/evaporators, report data as required by NEBB, AABC, and TABB standard procedures, including refrigeration operational data.~~

~~][3.4.3.4 Heating and Ventilating Units~~

~~Heating and ventilating unit systems including fans, coils, ducts, plenums, roof vents, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.~~

~~][3.4.3.5 Makeup Air Units~~

~~Makeup air unit systems including fans, coils, ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.~~

~~][3.4.3.6 Return Air Fans~~

~~Return air fan system including fan ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.~~

~~][~~3.4.3.3 Fan Coils

Fan coil unit systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.

~~][~~3.4.3.4 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

~~][3.4.3.5 Cabinet Heaters~~

~~][3.4.3.6 Cooling Units~~

~~][3.4.3.7 Door Heaters~~

~~Door heater systems, including fans, coils, and diffusers.~~

~~][3.4.3.8 Unit Heaters~~

~~]~~[3.4.4 TAB Water Distribution Systems

3.4.4.1 Chilled Water

Chilled water systems including chillers, condensers, cooling towers, pumps, coils, system balance valves and flow measuring devices.

For water chillers, report data as required by AABC, NEBB and TABB standard procedures, including refrigeration operational data.

3.4.4.2 Heating Hot Water

Heating hot water systems including boilers, hot water converters (e.g., heat exchangers), pumps, coils, system balancing valves and flow measuring devices.

~~3.4.4.3 Dual Temperature Water~~

~~Dual temperature water systems including boilers, converters, chillers, condensers, cooling towers, pumps, coils, and system balancing valves, and flow measuring devices.~~

~~]~~[3.4.5 Sound Measurement Work

3.4.5.1 Areas To Be Sound Measured

In the following spaces, measure and record the sound power level for each octave band listed in ASHRAE HVAC APP IP HDBK Noise Criteria:

a. All HVAC mechanical rooms, including machinery spaces and other spaces containing HVAC power drivers and power driven equipment.

b. All spaces sharing a common barrier with each mechanical room, including rooms overhead, rooms on the other side of side walls, and rooms beneath the mechanical room floor.

~~[c. AHU No. 1 System: Rooms: [_____]~~

~~][d. [_____] System: Rooms: [_____]~~

~~][e. [_____] System: Rooms: [_____]~~

~~]~~3.4.5.2 Procedure

Measure sound levels in each room, when unoccupied except for the TAB team, with all HVAC systems that would cause sound readings in the room operating in their noisiest mode. Record the sound level in each octave band. Attempt to mitigate the sound level and bring the level to within the specified ASHRAE HVAC APP IP HDBK noise criteria goals, if such mitigation is within the TAB team's control. State in the report the ASHRAE HVAC APP IP HDBK noise criteria goals. If sound level cannot be brought into compliance, provide written notice of the deficiency to the Contractor for resolution or correction.

3.4.5.3 Timing

Measure sound levels at times prescribed by AABC or NEBB or TABB.

3.4.5.4 Meters

Measure sound levels with a sound meter complying with ASA S1.4, Type 1 or 2, and an octave band filter set complying with ASA S1.11 PART 1. Use measurement methods for overall sound levels and for octave band sound levels as prescribed by NEBB.

3.4.5.5 Calibration

Calibrate sound levels as prescribed by AABC or NEBB or TABB, except that calibrators emitting a sound pressure level tone of 94 dB at 1000 hertz (Hz) are also acceptable.

3.4.5.6 Background Noise Correction

Determine background noise component of room sound (noise) levels for each (of eight) octave bands as prescribed by AABC or NEBB or TABB.

~~][~~3.4.6 TAB Work on Performance Tests Without Seasonal Limitations

3.4.6.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the ~~[~~heating systems~~]~~ ~~[~~and~~]~~ ~~[~~cooling systems~~]~~.

3.4.6.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

~~[~~3.4.6.3 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

~~][3.4.6.4 Water Chillers~~

~~For water chillers, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.~~

~~][3.4.6.5 Refrigeration Units~~

~~For refrigeration compressors/condensers/condensing units, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.~~

~~]3.4.6.6 Coils~~

~~Report heating and cooling performance capacity tests for [hot water], [chilled water], [DX] [and steam coils] for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:~~

[a. For Central station air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing".

Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

][b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

]][3.4.7 TAB Work on Performance Tests With Seasonal Limitations

3.4.7.1 Performance Tests

Accomplish proportional balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy. Accomplish proportionate balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy.

3.4.7.2 Season Of Maximum Load

Visit the contract site for at least two TAB work sessions for Season 1 and Season 2 field measures. [Visit the contract site during the season of maximum heating load] [and] [visit the contract site during the season of maximum cooling load], the goal being to TAB the operational performance of the [heating systems] [and] [cooling systems] under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the [heating systems] [and] [cooling systems]. Visit the contract site for at least two TAB work sessions for TAB field measurements. [Visit the contract site during the season of maximum heating load] [and] [visit the contract site during the season of maximum cooling load], the goal being to TAB the operational performance of the [heating systems] [and] [cooling systems] under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the [heating

~~systems] [and] [cooling systems].~~

3.4.7.3 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.7.4 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

~~[3.4.7.5 Water Chillers~~

~~Water chillers: For water chillers,report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.~~

~~][3.4.7.6 Refrigeration Units~~

~~For refrigeration compressors/condensers/condensing units,report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.~~

~~][3.4.7.7 Coils~~

~~Report heating and cooling performance capacity tests for [hot water], [chilled water], [DX] [and steam coils] for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:~~

~~a. For Central station air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."~~

~~Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."~~

~~Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).~~

~~b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:~~

~~Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb~~

temperatures; submit the calculations with the coil reports.

]]3.4.8 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

]3.4.9 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.4.10 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB

[After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and certification, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.
]
[After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

~~]~~

3.4.11 Quality Assurance - COTR TAB Field Acceptance Testing

3.4.11.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion, ~~[~~sound level readings~~]~~) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All chillers, boilers, return fans, computer room units, and air handling units (rooftop and central stations).

Group 2: 25 percent of the VAV terminal boxes and associated diffusers and registers.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

3.4.11.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

~~Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.~~

~~If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.~~

3.4.11.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB

Report submitted.

3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

3.7 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - DALT and TAB
Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE
Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.

b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.

d. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.

e. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph CONSTRUCTION DEFICIENCIES. Correct each deficiency as soon as practical with the Contracting Officer, and submit revised schedules and other required documentation.

f. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

   Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

g. Give Notice of Testing: Submit advance notice of proportional balancing, Season 1, and Season 2 TAB field work accompanied by completed prerequisite HVAC Work List

h. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.

Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.

e. Design Review Report: Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

f. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.

Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

g. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.

h. Technical Assistance: Provide technical assistance to the DALT and TAB field work.

i. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph CONSTRUCTION DEFICIENCIES. Resolve each deficiency as soon as practical and submit revised schedules and other

required documentation.

j. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.

b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.

c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.

d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.

e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.

f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.

g. A thorough checklist of the work items and inspections that need to be accomplished before the ~~[~~Season 1 ~~]~~TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed ~~[~~Season 1 ~~]~~Pre-TAB Work Checklist before the ~~[~~Season 1 ~~]~~TAB field work can be accomplished.

~~[~~ h. A thorough checklist of the work items and inspections that need to be

accomplished before the Season 2 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 2 Pre-TAB Work Checklist before the Season 2 TAB field work can be accomplished.

] i. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Design Review Report

Submit report containing the following information:

a. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

b. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

4. Completed Pre-Final DALT Work Checklist

Report the data for the Pre-Final DALT Report meeting the following requirements:

a. Submit a copy of the approved DALT and TAB Procedures Summary: Provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Node numbers shall be included in the completed report forms to identify each duct section.

c. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.

d. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments are to be calibrated within one year of the date of use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and Technology.

e. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

5. Final DALT Report

On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer for approval.

6. TAB Reports: Submit TAB Report for Proportional Balancing, Season 1, and Season 2 in the following manner:

a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.

c. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

Sterile processing.~~[_____]~~

(1) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the ~~[Season I TAB Report] [~~Season I and Season 2 TAB Report~~]~~.

d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.

e. Air Static Pressure Profiles: Report static pressure profiles for air

duct systems ~~including:~~ as indicated on the drawings ~~[AHU-1][RTAC-1][MUA-1][_____]~~. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

~~[~~ f. Duct Transverses: Report duct traverses for main ~~[and branch main]~~ supply, return~~[~~, exhaust, relief and outside air~~]~~ ducts. ~~[~~This shall include all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows.~~]~~ The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane".

~~]~~ g. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings shall provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

h. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.

j. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below. Include the major items listed in this schedule in the project network analysis schedule required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS).

Submit TAB Agency and TAB Personnel Qualifications: Within ~~[~~42~~]~~ ~~[_____]~~ calendar days after date of contract award.

Submit the DALT and TAB Work Execution Schedule: within ~~[~~14~~]~~ ~~[_____]~~ days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

Submit the DALT and TAB Work Procedures Summary: within ~~[~~14~~]~~ ~~[_____]~~ days after receipt of the initial approved DALT and TAB Work Execution Schedule.

Meet with the COTR at the Pre-DALT/TAB Meeting: Within ~~[~~28~~]~~ ~~[_____]~~ calendar days after receipt of the approved initial DALT/TAB Execution Schedule.

Submit Design Review Report: Within ~~[~~56~~]~~ ~~[_____]~~ calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

~~[~~ ~~Conduct measurements and submit the Record of Existing Facility Conditions: within [28] [_____] days after receipt of approved DALT and TAB Work Procedures Summary.~~

~~]~~ Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Contracting Officer an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist for the subject duct system.

Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's technical representative (COTR) will select the project ductwork sections to be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.

Submit Pre-Final DALT Report: Within two working days after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

Quality Assurance - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Contracting Officer.

Submit Final DALT Report: Within ~~[~~14~~]~~ ~~[_____]~~ calendar days after

completion of successful DALT Work Field Check, submit [Season 1]TAB report.

Advance Notice of [Season 1]TAB Field Work: At a minimum of [14][_____] calendar days prior to [Season 1]TAB Field Work, submit advance notice of TAB field work accompanied by completed [Season 1] Pre-TAB Work Checklist.

[Season 1]TAB Field Work: At a minimum of [84][_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1]TAB field work.

Submit [Season 1]TAB Report: Within [14] [_____] calendar days after completion of [Season 1]TAB field work, submit initial [Season 1]TAB report.

[Season 1]Quality Assurance - COTR TAB Field Check: [30] [_____] calendar days after initial [Season 1]TAB report is approved by the Contracting Officer, conduct [Season 1]field check.

Complete [Season 1]TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work] and submit final.

Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.

Advance Notice of Season 2 TAB Field Work: At a minimum of [126] [_____]calendar days after CCD, submit advance notice of Season 2 TAB field work accompanied by completed Season 2 Pre-TAB Work Checklist.

[Season 2 TAB Field Work: Within [14] [_____] calendar days after date of advance notice of Season 2 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within [14] [_____] calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 Quality Assurance - COTR TAB Field Checks: [28] [_____] calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within [14] [_____] calendar days after the completion of Season 2 TAB field data check, complete all TAB work.]

Receive the approved TAB report: Within calendar 21 days, receive the report from Contracting Officer.

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		[Package Rooftop w/VAV Unit No. [1] [_____]]	[Package Rooftop w/VAV Unit No. [2] [_____]]	[Package Rooftop w/CV Unit No. [1] [_____]]	[Package Rooftop w/CV Unit No. [2] [_____]]
Duct System Static Pressure, in inches W.C.	for Supply	[4] [_____]	[4] [_____]	[2] [_____]	[2] [_____]
	for Return	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A	A	A
	for Return	A	A	A	A
	for Exhaust	A	A	A	A
	for Outside Air	A	A	A	A
System Oval/Round Duct SMACNA Leak Class	for Supply	[3] [_____]	[3] [_____]	[6] [_____]	[6] [_____]
	for Return	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		[Package Rooftop w/VAV Unit No. [1] [_____]]	[Package Rooftop w/VAV Unit No. [2] [_____]]	[Package Rooftop w/CV Unit No. [1] [_____]]	[Package Rooftop w/CV Unit No. [2] [_____]]
System Rectangular Duct SMACNA Leak Class	for Supply	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]
	for Return	[12] [_____]	[12] [_____]	[24][_____]	[24][_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[12] [_____]	[12] [_____]	[24] [_____]	[24] [_____]
	for Supply	[4] [_____]	[2] [_____]	[50] [_____]	[2] [_____]
	for Return	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[2] [_____]	[2] [_____]	[1] [_____]	

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		[AHU w/ Economizer & CV Unit No. [1] [_____]]	[AHU w/ Economizer & CV Unit No. [2] [_____]]	[Series VAV Terminal Boxes Unit No. [1] [_____]]	[Exhaust Systems Unit No. [1] [_____]]
Duct System Static Pressure, in millimeters W.C.	for Supply	[2] [_____]4	[2] [_____]	[0.5] [_____]	n/a
	for Return	[1] [_____]2	[1] [_____]	[0.5] [_____]	n/a
	for Exhaust	[0.5] [_____]	[0.5] [_____]	n/a	[1] [_____]
	for Outside Air	2[1] [_____]	[1] [_____]	n/a	n/a
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A	A	A
	for Return	A	A	A	A
	for Exhaust	A	A	A	A
	for Outside Air	A	A	A	A
System Oval/Round Duct SMACNA Leak Class	for Supply	3[6] [_____]	[6] [_____]	12	n/a
	for Return	[12] [_____]	[12] [_____]	12	n/a
	for Exhaust	[12] [_____]	[12] [_____]	n/a	[12] [_____]
	for Outside Air	6[12] [_____]	[12] [_____]	n/a	n/a

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		~~[~~AHU w/ Economizer & CV Unit ~~No. [1] [_____]]~~	~~[AHU w/ Economizer & CV Unit No. [2] [_____]]~~	~~[~~Series VAV Terminal Boxes ~~Unit No. [1] [_____]]~~	~~[~~Exhaust Systems ~~Unit No. [1] [_____]]~~
System Rectangular Duct SMACNA Leak Class	for Supply	6~~[12] [_____]~~	~~[12] [_____]~~	24	n/a
	for Return	12~~[24] [_____]~~	~~[24] [_____]~~	24	n/a
	for Exhaust	~~[~~24~~]~~ ~~[_____]~~	~~[24] [_____]~~	n/a	~~[~~24~~]~~ ~~[_____]~~
	for Outside Air	12~~[24] [_____]~~	~~[24] [_____]~~	n/a	n/a
Duct Test Pressure, in inches W.C.	for Supply	4~~[2] [_____]~~	~~[2] [_____]~~	~~[~~0.5~~]~~ ~~[_____]~~	n/a
	for Return	2~~[1] [_____]~~	~~[1] [_____]~~	~~[~~0.5~~]~~ ~~[_____]~~	n/a
	for Exhaust	~~[~~0.5~~]~~ ~~[_____]~~	~~[0.5] [_____]~~	n/a	~~[~~1~~]~~ ~~[_____]~~
	for Outside Air	2~~[1] [_____]~~	~~[1] [_____]~~	n/a	n/a

-- End of Section --

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SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
02/13, CHG 7: 05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2020a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	(2017) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534/C534M	(2020a) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2019) Standard Specification for Mineral Fiber Pipe Insulation

ASTM C552	(2021) Standard Specification for Cellular Glass Thermal Insulation
ASTM C591	(2021) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C610	(2015) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C755	(2019b) Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation
ASTM C795	(2008; R 2018) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C1126	(2018) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C1136	(2021) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay

ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials
ASTM E2231	(2019) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(8th Ed) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2021) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T403 OM	(2015) Bursting Strength of Paper

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987; Notice 2 2020) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-PRF-19565	(1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

UNDERWRITERS LABORATORIES (UL)

UL 94	(2013; Reprint May 2021) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 2818	(2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Insulation of heat distribution systems and chilled water systems outside of buildings shall be as specified in Section 33 61 13 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM, Section 33 63 13.19 CONCRETE TRENCH HYDRONIC AND STEAM ENERGY DISTRIBUTION, Section 33 60 02 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, and Section 33 61 13.13 PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

~~SD-02 Shop Drawings~~

~~MICA Plates; G[, [_____]]~~

~~Pipe Insulation Systems and Associated Accessories~~

~~Duct Insulation Systems and Associated Accessories~~

~~Equipment Insulation Systems and Associated Accessories~~

~~Recycled content for insulation materials; S~~

SD-03 Product Data

Pipe Insulation Systems; G~~[, [_____]]~~

Duct Insulation Systems; G~~[, [_____]]~~

Equipment Insulation Systems; G~~[, [_____]]~~

SD-04 Samples

Thermal Insulation; G~~[, [_____]]~~

Display Samples; G~~[, [_____]]~~

SD-07 Certificates

Indoor air quality for adhesives; S

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G~~[, [_____]]~~

Duct Insulation Systems; G~~[, [_____]]~~

Equipment Insulation Systems; G~~[, [_____]]~~

1.4 CERTIFICATIONS

1.4.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet ~~and in conjunction with the MICA plates booklet (SD-02). Annotate the product data to indicate which MICA plate is applicable~~.

2.1.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

2.1.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.

2.2 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.4~~[ ][ASHRAE 90.2]~~. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless

steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

2.2.1 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants must meet limit requirements of "Other" category within SCAQMD Rule 1168 sealants table). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.2.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2.2.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2.2.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. ~~[~~To resist mold/mildew, lagging adhesive shall meet ASTM D5590 with 0 growth rating. ~~]~~Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Adhesive shall be MIL-A-3316, Class 1, pigmented ~~[~~white~~]~~ ~~[red]~~ and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.2.1.4 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Flexible

Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

2.2.2 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.3 Corner Angles

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.

2.2.4 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.2.5 Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

2.2.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

Outward clinching type ~~[monel] [~~ASTM A167, Type 304 or 316 stainless steel~~]~~.

2.2.8 Jackets

2.2.8.1 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory

fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.2.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

~~2.2.8.3 Vapor Barrier/Weatherproofing Jacket~~

~~Vapor barrier/weatherproofing jacket shall be laminated self-adhesive, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.~~

2.2.8.3 Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

a. On ducts, piping and equipment operating below 92~~[_____]~~ degrees F or located outside shall be equipped with a vapor barrier.

b. Ducts, pipes and equipment that are located inside and that always operate above 92~~[_____]~~ degrees F shall be installed with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

2.2.9 Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. The product shall meet all physical property and performance requirements of ASTM C1136, Type I, except the burst strength shall be a minimum of 85 psi. ASTM D2863 Limited Oxygen Index (LOI) shall be a minimum of 31.

In addition, neither the outer exposed surface nor the inner-most surface

contacting the insulation shall be paper or other moisture-sensitive material. The outer exposed surface shall be white and have an emittance of not less than 0.80. The outer exposed surface shall be paintable.

2.2.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.2.9.2.1 Vapor Barrier

The vapor barrier shall be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Permeability shall be less than 0.02 when tested in accordance with ASTM E96/E96M. Products shall meet UL 723 or ASTM E84 flame and smoke requirements and shall be UV resistant.

2.2.9.2.2 Vapor Retarder

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be in accordance with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions. The coating shall be nonflammable, fire resistant type. ~~[To resist mold/mildew, coating shall meet ASTM D5590 with 0 growth rating.]~~Coating shall meet MIL-PRF-19565 Type II (if selected for indoor service) and be Qualified Products Database listed. All other application and service properties shall be determined pursuant to ASTM C647.

2.2.9.3 Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Vapor retarder shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.2.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

The PVDC film vapor retarder shall have a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.2.9.6 Vapor Barrier/Weather Barrier

The vapor barrier shall be greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Vapor barrier shall meet UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV

resistant. Minimum burst strength 185 psi in accordance with [TAPPI T403 OM] [ISO 2758]. Tensile strength 68 lb/inch width (PSTC-1000). Tape shall be as specified for laminated film vapor barrier above.

2.2.10 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Jacket shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.12 Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

2.2.13 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of [ASHRAE 90.1 - SI][ASHRAE 90.2]. Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.3.1 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Rock Wool: 75 percent slag of weight
Fiberglass: 20 percent glass cullet
Rigid Foam: 9 percent recovered material
Phenolic Rigid Foam: 9 percent recovered material

Provide data identifying percentage of recycled content for insulation materials.

2.3.2 Aboveground Cold Pipeline (-30 to 60 deg. F)

Insulation for outdoor, indoor, exposed or concealed applications, shall be as follows:

2.3.2.1 Cellular Glass

ASTM C552, Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ))

ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.3.2.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials. Type I and II shall have vapor retarder/vapor barrier skin on one or both sides of the insulation, and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.

~~2.3.2.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)~~

~~ASTM C547. Install in accordance with manufacturer's instructions. Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.~~

2.3.2.3 Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.3 Aboveground Hot Pipeline (Above 60 deg. F)

Insulation for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.1 Mineral Fiber

ASTM C547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.2 Calcium Silicate

ASTM C533, Type I indoor only, or outdoors above 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.3 Cellular Glass

ASTM C552, Type II and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.4 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II to 220 degrees F service. Type I for tubular materials. Type II for sheet materials.

2.3.3.5 Phenolic Insulation

ASTM C1126 Type III to 250 degrees F service shall comply with ASTM C795. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.6 Perlite Insulation

ASTM C610

2.3.3.7 Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.4 Aboveground Dual Temperature Pipeline

Selection of insulation for use over a dual temperature pipeline system (Outdoor, Indoor - Exposed or Concealed) shall be in accordance with the most limiting/restrictive case. Find an allowable material from paragraph PIPE INSULATION MATERIALS and determine the required thickness from the most restrictive case. Use the thickness listed in paragraphs INSULATION THICKNESS for cold & hot pipe applications.

2.3.5 Below-ground Pipeline Insulation

For below-ground pipeline insulation, use cellular glass, ASTM C552, type II.

2.4 DUCT INSULATION SYSTEMS

2.4.1 Factory Applied Insulation

Provide factory-applied ~~[~~ASTM C552, cellular glass thermal~~]~~ ~~[ASTM C534/C534M Grade 1, Type II, flexible elastomeric closed cell]~~ insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier ~~[, with identification of installed thermal resistance (R) value and out-of-package R value]~~.

2.4.1.1 Rigid Insulation

Calculate the minimum thickness in accordance with ASHRAE 90.1~~[ASHRAE 90.2][]~~.

2.4.1.2 Blanket Insulation

Calculate minimum thickness in accordance with ASHRAE 90.1~~[ASHRAE 90.2][][ASTM C553]~~.

~~2.4.2 Kitchen Exhaust Ductwork Insulation~~

~~Insulation thickness shall be a minimum of 2 inches, blocks or boards, either mineral fiber conforming to ASTM C612, Class 5, 20 pcf average [or calcium silicate conforming to ASTM C533, Type II. Provide vapor barrier for outside air connection to kitchen exhaust hood]. The enclosure~~

~~materials and the grease duct enclosure systems shall meet testing requirements of ASTM E2336 for noncombustibility, fire resistance, durability, internal fire, and fire-engulfment with a through-penetration fire stop.~~

2.4.2 Acoustical Duct Lining

2.4.2.1 General

For ductwork indicated or specified in Section 23 30 00 HVAC AIR DISTRIBUTION to be acoustically lined, provide external insulation in accordance with this specification section and in addition to the acoustical duct lining. Do not use acoustical lining in place of duct wrap or rigid board insulation (insulation on the exterior of the duct).

2.4.2.2 Duct Liner

Flexible Elastomeric Acoustical and Conformable Duct Liner Materials: Flexible Elastomeric Thermal, Acoustical and Conformable Insulation Compliance with ASTM C534/C534M Grade 1, Type II; and NFPA 90A or NFPA 90B as applicable.

2.4.3 Duct Insulation Jackets

2.4.3.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2.4.3.2 Metal Jackets

2.4.3.2.1 Aluminum Jackets

ASTM B209, Temper H14, minimum thickness of 27 gauge (0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 8 inches and larger. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.3.2.2 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.3.3 Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty white or natural).

2.4.4 Weatherproof Duct Insulation

Provide ~~[~~ASTM C552, cellular glass thermal insulation~~]~~ ~~[ASTM C534/C534M Grade 1, Type II, flexible elastomeric cellular insulation]~~, and weatherproofing as specified in manufacturer's instruction. Multi-ply, Polymeric Blend Laminate Jacketing: Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.5 EQUIPMENT INSULATION SYSTEMS

Insulate equipment and accessories as specified in Tables 5 and 6. In outside locations, provide insulation 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems ~~in coordination with the submitted MICA Insulation Stds plates booklet. Annotate their installation instructions to indicate which product data and which MICA plate are applicable~~. The instructions must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. A booklet is also required by paragraphs titled: Pipe Insulation Systems and Duct Insulation Systems.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

3.1.1 Display Samples

Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

3.1.1.1 Pipe Insulation Display Sections

Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of

insulation is used for these services.

3.1.1.2 Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for duct insulation exposed to weather

3.1.2 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until ~~[~~tests~~]~~ ~~[tests and heat tracing]~~ specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.3 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and/or NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

3.1.4 Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.5 Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather and not shown to have vapor barrier weatherproof jacketing with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured.

3.1.5.1 Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to touch but tacky under slight pressure before joining the surfaces.

Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

3.1.5.2 Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

3.1.6 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.7 Pipes/Ducts/Equipment That Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

~~Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.~~

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

e. Adjacent insulation.

f. ASME stamps.

g. Access plates of fan housings.

h. Cleanouts or handholes.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

Pipe insulation shall be continuous through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

The aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

3.2.1.2.2 Penetrating Floors

Extend the aluminum jacket from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

3.2.1.2.3 Penetrating Waterproofed Floors

Extend the aluminum jacket rom below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.1.2.4 Penetrating Exterior Walls

Continue the aluminum jacket required for pipe exposed to weather through the sleeve to a point 2 inches beyond the interior surface of the wall.

3.2.1.2.5 Penetrating Roofs

Insulate pipe as required for interior service to a point flush with the top of the flashing and sealed with flashing sealant. Tightly butt the insulation for exterior application to the top of flashing and interior insulation. Extend the exterior aluminum jacket 2 inches down beyond the end of the insulation to form a counter flashing. Seal the flashing and counter flashing underneath with metal jacketing/flashing sealant.

3.2.1.2.6 Hot Water Pipes Supplying Lavatories or Other Similar Heated Service

Terminate the insulation on the backside of the finished wall. Protect the insulation termination with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). Extend the coating out onto the insulation 2 inches and seal the end of the insulation. Overlap glass tape seams 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inches.

3.2.1.2.7 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service

Terminate the insulation on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). Protect the insulation with two coats of weather barrier mastic (breather emulsion type weatherproof mastic impermeable to water and permeable to air) with a minimum total thickness of 1/16 inch. Extend the mastic out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the outer surface of the pipe insulation and caulk the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-58. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-58, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.3.2 Horizontal Pipes Larger Than 2 Inches and Below 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-58. An insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 80 degrees F shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-58 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be

continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 1-1/2 inches, and seal as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation. Type II requires an additional exterior vapor retarder/barrier covering for high relative humidity and below ambient temperature applications.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, ~~[~~welded PVC~~]~~ ~~[stainless steel]~~, aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) ~~[~~aluminum~~]~~ jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected. ~~[Other areas that specifically require protection to the 6 foot level are [_____].]~~

3.2.1.6 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of ASHRAE 90.1~~[][ASHRAE 90.2]~~.

TABLE 1

Insulation Material for Piping

Service	Material	Specification	Type	Class	VR/VB Req'd
Chilled Water (Supply & Return, Dual Temperature Piping, 40 F nominal)					
	Cellular Glass	ASTM C552	II	2	Yes
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~		~~Yes~~
	~~[Mineral Fiber with Wicking Material][Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.]~~	~~[ASTM C547]~~	~~[I]~~		~~[Yes]~~
Heating Hot Water Supply & Return, Heated Oil (Max 250 F)					
	Mineral Fiber	ASTM C547	I	1	No
	~~Calcium Silicate~~	~~ASTM C533~~	~~I~~		~~No~~
	~~Cellular Glass~~	~~ASTM C552~~	~~II~~	~~2~~	~~No~~
	~~Faced Phenolic Foam~~	~~ASTM C1126~~	~~III~~		~~Yes~~
	~~Perlite~~	~~ASTM C610~~			~~No~~
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~	~~2~~	~~No~~
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping					
	Cellular Glass	ASTM C552	II	2	No
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~		~~No~~
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)					
	Mineral Fiber	ASTM C547	I	1	No
	~~Cellular Glass~~	~~ASTM C552~~	~~II~~	~~2~~	~~No~~
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~		~~No~~
	~~Faced Phenolic Foam~~	~~ASTM C1126~~	~~III~~		~~Yes~~
Refrigerant Suction Piping (35 degrees F nominal)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Cellular Glass	ASTM C552	II	1	Yes
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F					
	Cellular Glass	ASTM C552	II		No

TABLE 1

Insulation Material for Piping

	Material	Specification	Type	Class	VR/VB Req'd
Service					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
~~Horizontal Roof Drain Leaders (Including Underside of Roof Drain Fittings)~~					
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~		~~No~~
	~~Faced Phenolic Foam~~	~~ASTM C1126~~	~~III~~		Yes
	~~Cellular Glass~~	~~ASTM C552~~	~~III~~		~~Yes~~
Condensate Drain Located Inside Building					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Medium Temperature Hot Water, Steam and Condensate (251 to 350 Degrees F)					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552	I or II		No
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
High Temperature Hot Water & Steam (351 to 700 Degrees F)					
	Mineral Fiber	ASTM C547	I	2	No
	Calcium Silicate	ASTM C533	I		No
	Perlite	ASTM C610			No
	Cellular Glass	ASTM C552			No
~~Brine Systems Cryogenics (30 to 0 Degrees F)~~					

TABLE 1

Insulation Material for Piping

Service					
	Material	Specification	Type	Class	VR/VB Req'd
	~~Cellular Glass~~	~~ASTM C552~~	~~II~~	~~2~~	~~No~~
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~		~~No~~
~~Brine Systems Cryogenics (0 to 34 Degrees F)~~					
	~~Cellular Glass~~	~~ASTM C552~~	~~II~~	~~2~~	~~No~~
	~~Flexible Elastomeric Cellular~~	~~ASTM C534/C534M~~	~~I~~		~~No~~
Note: VR/VB = Vapor Retarder/Vapor Barrier					

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
~~[Chilled Water (Supply & Return, Dual Temperature Piping, 40 Degrees F nominal)]~~						
	~~Cellular Glass~~	~~1.5~~	~~2~~	~~2~~	~~2.5~~	~~3~~
	~~Mineral Fiber with Wicking Material~~	~~1~~	~~1.5~~	~~1.5~~	~~2~~	~~2~~
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~
~~[~~Chilled Water (Supply & Return, Dual Temperature Piping, 40 Degrees F nominal)~~]~~						
	Cellular Glass	1.5	1.5	1.5	1.5	2
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~
	~~Mineral Fiber with Wicking Material~~	~~1~~	~~1.5~~	~~1.5~~	~~2~~	~~2~~
Heating Hot Water Supply & Return, Heated Oil (Max 250 F)						

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Mineral Fiber	1.5	1.5	2	2	2
	~~Calcium Silicate~~	~~2.5~~	~~2.5~~	~~3~~	~~3~~	~~3~~
	~~Cellular Glass~~	~~2~~	~~2.5~~	~~3~~	~~3~~	~~3~~
	~~Perlite~~	~~2.5~~	~~2.5~~	~~3~~	~~3~~	~~3~~
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)						
	Mineral Fiber	1	1	1	1.5	1.5
	~~Cellular Glass~~	~~1.5~~	~~1.5~~	~~1.5~~	~~2~~	~~2~~
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~
Refrigerant Suction Piping (35 degrees F nominal)						
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F						
	Mineral Fiber	1.5	1.5	2	2	2
		1.5*	2*	2.5*	3*	3.5*
	Calcium Silicate	2.5	3	4	4	4.5

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Cellular Glass	2	2.5	3	3	3
	Perlite	2.5	3	4	4	4.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel						
	Flexible Elastomeric Cellular	0.5	0.5	0.5	0.5	0.5
~~Horizontal Roof Drain Leaders (Including Underside of Roof Drain Fittings)~~						
	~~Cellular Glass~~	~~1.5~~	~~1.5~~	~~1.5~~	~~1.5~~	~~1.5~~
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~
	~~Faced Phenolic Foam~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~
Condensate Drain Located Inside Building						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Medium Temperature Hot Water, Steam and Condensate (251 to 350 Degrees F)						
	Mineral Fiber	1.5	3	3	4	4
		2.5*	*	3.5*		
	Calcium Silicate	2.5	3.5	4.5	4.5	5
	Perlite	2.5	3.5	4.5	4.5	5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
High Temperature Hot Water & Steam (351 to 700 Degrees F)						

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
	Mineral Fiber	2.5	3	3	4	4
	Calcium Silicate	4	4.5	6	6	6
	Perlite	4	4.5	6	6	6
~~Brine Systems Cryogenics (-30 to 0 Degrees F)~~						
	~~Cellular Glass~~	~~2.5~~	~~2.5~~	~~3~~	~~3~~	~~3.5~~
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~	~~N/A~~
~~Brine Systems Cryogenics (0 to 34 Degrees F)~~						
	~~Cellular Glass~~	~~2~~	~~2~~	~~2~~	~~2.5~~	~~3~~
	~~Flexible Elastomeric Cellular~~	~~1~~	~~1~~	~~1~~	~~N/A~~	~~N/A~~

3.2.2 Aboveground Cold Pipelines

The following cold pipelines for minus 30 to plus 60 degrees F, shall be insulated in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. ~~This includes but is not limited to the following:~~

~~a. Make-up water.~~

~~b. Horizontal and vertical portions of interior roof drains.~~

~~c. Refrigerant suction lines.~~

~~d. Chilled water.~~

~~e. Dual temperature water, i.e. HVAC hot/chilled water.~~

~~f. Air conditioner condensate drains.~~

~~g. Brine system cryogenics~~

~~h. Exposed lavatory drains and domestic water lines serving plumbing~~

~~fixtures for handicap persons.~~

~~[i. Domestic cold and chilled drinking water.]~~

3.2.2.1 Insulation Material and Thickness

Insulation thickness for cold pipelines shall be determined using Table 2.

3.2.2.2 Factory or Field applied Jacket

Insulation shall be covered with a factory applied vapor retarder jacket/vapor barrier or ~~[~~field applied~~]~~ seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe. Insulation inside the building, to be protected with an aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, white & black, shall be provided for pipe insulation to the 6 ft level. ~~Other areas that specifically require protection to the 6 ft level are [_____].~~

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 1-1/2 inches. Provide butt strips 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or

repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation

Install by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. Secure all seams and butt joints and seal with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Push insulation on the pipe, never pulled. Stretching of insulation may result in open seams and joints. Clean cut all edges. Rough or jagged edges of the insulation are not be permitted. Use proper tools such as sharp knives. Do not stretch Grade 1, Type II sheet insulation around the pipe when used on pipe larger than 6 inches. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing

completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.

(1) The MICA plates shall detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. The MICA plates shall present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.

(2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, the detail drawings shall be technically equivalent to the edited MICA Plate submittal.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

3.2.3.1 General Requirements

All hot pipe lines above 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, shall be insulated in accordance with Table 2. This includes but is not limited to the following:

a. Domestic hot water supply & re-circulating system.

b. Steam.

c. Condensate & compressed air discharge.

d. Hot water heating.

e. Heated oil.

f. Water defrost lines in refrigerated rooms.

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

3.2.3.2 Insulation for Fittings and Accessories

Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant. Insulation shall be marked showing the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

3.2.3.2.1 Precut or Preformed

Place precut or preformed insulation around all fittings and accessories. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

3.2.3.2.2 Rigid Preformed

Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, a laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability (greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket, stainless steel or PVC jacket shall be applied.

PVC jacketing requires no factory-applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not

furnished. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION in PART 3.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with metal jacketing/flashing sealant while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant.

3.2.4.3 PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.2.4.4 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

3.2.5 Below Ground Pipe Insulation

Below ground pipes shall be insulated in accordance with Table 2, except as precluded in subparagraph Pipe Insulation in PART 3. ~~This includes, but is not limited to the following:~~

~~a. Heated oil.~~

~~b. Domestic hot water.~~

~~c. Heating hot water.~~

~~d. Dual temperature water.~~

~~e. Steam.~~

~~f. Condensate.~~

3.2.5.1 Type of Insulation

Below ground pipe shall be insulated with Cellular Glass insulation, in accordance with manufacturer's instructions for application with thickness as determined from Table 2 (whichever is the most restrictive).

3.2.5.2 Installation of Below ground Pipe Insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials shall not be used for this coating. Note that unless this is for a cyclic application (i.e., one that fluctuates between high and low temperature on a daily process basis) there is no need to bore coat the material.

b. Stainless steel bands, 3/4 inch wide by 0.020 inch thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 12 inches in diameter. A minimum of two bands per section of insulation shall be applied.

c. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

d. At point of entry to buildings, underground insulation shall be terminated 2 inches inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with high temperature silicone sealant and covered with fibrous glass tape.

e. Provision for expansion and contraction of the insulation system shall be made in accordance with the insulation manufacturer's recommendations.

f. Flanges, couplings, valves, and fittings shall be insulated with factory pre-molded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured as recommended by the manufacturer.

g. Insulation, including fittings, shall be finished with three coats of asphaltic mastic, with 6 by 5.5 mesh synthetic reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 2 inches at joints. Total film thickness shall be a minimum of 3/16 inch. As an alternate, a prefabricated bituminous laminated jacket, reinforced with internal reinforcement mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions. Vapor barrier - less than 0.0000 permeability self adhesive (minimum 2 mils adhesive, 3 mils embossed) jacket greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty, white or natural). Application procedures shall match the

manufacturer's written instructions.

h. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 2 inches along the bare pipe.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

~~Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions. Duct insulation minimum thickness and insulation level must be as listed in Table 3 and must meet or exceed the requirements of[][ASHRAE 90.2].~~

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. ~~[Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces [where the difference between supply air temperature and room air temperature is less than 15 degrees F] unless otherwise shown.]~~ Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Minimum Thickness

Duct insulation minimum thickness in accordance with Table 4.

Table 4 - Minimum Duct Insulation (inches)

Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Insulation and vapor retarder/vapor barrier shall be provided for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible run-outs (field-insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes (field-insulated).

l. Supply fans (field-insulated).

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Combustion air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf, and rigid type where exposed, minimum density 3 pcf. Insulation for both concealed or exposed round/oval ducts shall be flexible type, minimum density 3/4 pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Insulation for all exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified, the total field applied dry film thickness shall be approximately 1/16 inch. Insulation on all concealed duct shall be provided with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder/vapor barrier shall cover the collar, neck, and any un-insulated surfaces of diffusers, registers and grills. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, flexible insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick

pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches. Mechanical fasteners shall be as corrosion resistant as G60 coated galvanized steel, and shall indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.

b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder/barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

c. Impale insulation on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.

d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a flashing sealant.

g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

Insulation and vapor barrier shall be provided for the following warm air ducts and associated equipment:.

a. Supply ducts.

b. Return air ducts.

c. Relief air ducts

d. Flexible run-outs (field insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil-headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes.

l. Supply fans.

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Exhaust ducts passing through concealed spaces exhausting conditioned air.

Insulation for rectangular ducts shall be flexible type where concealed, and rigid type where exposed. Insulation on exposed ducts shall be provided with a white, paint-able, factory-applied Type II jacket, or finished with adhesive finish. Flexible type insulation shall be used for round ducts, with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 16 inches apart and not more than 6 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be

brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin trimmed and bent over.

d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of tape and brushed with vapor retarder coating.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by staples spaced not more than 16 inches and not more than 6 inches from the degrees of joints. Joints shall be sealed in accordance with item "d." above.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

3.3.5 Insulation for Evaporative Cooling Duct

Evaporative cooling supply duct located in spaces not evaporatively cooled, shall be insulated. Material and installation requirements shall be as specified for duct insulation for warm air duct.

3.3.6 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.7 Duct Exposed to Weather

3.3.7.1 Installation

Ducts exposed to weather shall be insulated and finished as specified for the applicable service for exposed duct inside the building. After the above is accomplished, the insulation shall then be further finished as detailed in the following subparagraphs.

3.3.7.2 Round Duct

Laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - Less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply, heavy duty, white and natural) membrane shall be applied

overlapping material by 3 inches no bands or caulking needed - see manufacturer's recommended installation instructions. Aluminum jacket with factory applied moisture retarder shall be applied with the joints lapped not less than 3 inches and secured with bands located at circumferential laps and at not more than 12 inch intervals throughout. Horizontal joints shall lap down to shed water and located at 4 or 8 o'clock position. Joints shall be sealed with metal jacketing sealant to prevent moisture penetration. Where jacketing abuts an un-insulated surface, joints shall be sealed with metal jacketing sealant.

3.3.7.3 Fittings

Fittings and other irregular shapes shall be finished as specified for rectangular ducts.

3.3.7.4 Rectangular Ducts

Two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application shall be applied to the entire surface. Each coat of weatherproof mastic shall be 1/16 inch minimum thickness. The exterior shall be a metal jacketing applied for mechanical abuse and weather protection, and secured with screws or vapor barrier/weatherproofing jacket less than 0.0000 permeability greater than 3 ply, standard grade, silver, white, black, and embossed or greater than 8 ply, heavy duty white and natural. Membrane shall be applied overlapping material by 3 inches. No bands or caulking needed-see manufacturing recommend installation instructions.

~~3.3.8 Kitchen Exhaust Duct Insulation~~

~~NFPA 96 for [ovens,] [griddles,] [deep fat fryers,] [steam kettles,] [vegetable steamers,] [high pressure cookers,] [and] [mobile serving units]. Provide insulation with 3/4 inch wide, minimum 0.15 inch thick galvanized steel bands spaced not over 12 inches o.c.; or 16 gauge galvanized steel wire with corner clips under the wire; or with heavy welded pins spaced not over 12 inches apart each way. Do not use adhesives.~~

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

~~Install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.~~

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Hand-holes.

b. Boiler manholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

f. Duct Test/Balance Test Holes.

3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

d. Cold water storage tanks.

e. Water softeners.

f. Duct mounted coils.

g. Cold and chilled water pumps.

h. Pneumatic water tanks.

i. Roof drain bodies.

j. Air handling equipment parts that are not factory insulated.

k. Expansion and air separation tanks.

3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Material and thicknesses shall be as shown in Table 5:

TABLE 5

Insulation Thickness for Cold Equipment (inches)

Equipment handling media at indicated temperature		
	Material	Thickness (inches)
35 to 60 degrees F		
	Cellular Glass	1.5
	Flexible Elastomeric Cellular	1
1 to 34 degrees F		
	Cellular Glass	3
	Flexible Elastomeric Cellular	1.5

TABLE 5		
Insulation Thickness for Cold Equipment (inches)		
Equipment handling media at indicated temperature		
	Material	Thickness (inches)
Minus 30 to 0 degrees F		
	Cellular Glass	3.5
	Flexible Elastomeric Cellular	1.75

3.4.2.2 Pump Insulation

a. Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Flashing sealant shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered with contact adhesive. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass shall be installed in accordance with manufacturer's instructions. Joints and ends shall be sealed with joint sealant, and sealed with a vapor retarder coating.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished

by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.4 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating or vapor barrier jacket shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Flashing sealant or vapor barrier tape shall be applied to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

a. Converters.

b. Heat exchangers.

c. Hot water generators.

d. Water heaters.

e. Pumps handling media above 130 degrees F.

f. Fuel oil heaters.

g. Hot water storage tanks.

h. Air separation tanks.

i. Surge tanks.

j. Flash tanks.

k. Feed-water heaters.

l. Unjacketed boilers or parts of boilers.

m. Boiler flue gas connection from boiler to stack (if inside).

n. Induced draft fans.

o. Fly ash and soot collectors.

p. Condensate receivers.

3.4.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table 6:

TABLE 6

Insulation Thickness for Hot Equipment (inches)

Equipment handling steam or media at indicated pressure or temperature limit		
	Material	Thickness (inches)
15 psig or 250 degrees F		
	Rigid Mineral Fiber	2
	Flexible Mineral Fiber	2
	Calcium Silicate/Perlite	4
	Cellular Glass	3
	Faced Phenolic Foam	1.5
	Flexible Elastomeric Cellular (<200 F)	1
200psig or 400 degrees F		
	Rigid Mineral Fiber	3
	Flexible Mineral Fiber	3
	Calcium Silicate/Perlite	4
	Cellular Glass	4
600 degrees F		
	Rigid Mineral Fiber	5
	Flexible Mineral Fiber	6
	Calcium Silicate/Perlite	6
	Cellular Glass	6
600 degrees F: Thickness necessary to limit the external temperature of the insulation to 120 F. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.		

3.4.3.2 Insulation of Boiler Stack and Diesel Engine Exhaust Pipe

Inside [boiler House] [mechanical Room], bevel insulation neatly around openings and provide sheet metal insulation stop strips around such openings. Apply a skim coat of hydraulic setting cement directly to insulation. Apply a flooding coat of adhesive over hydraulic setting cement, and while still wet, press a layer of glass cloth or tape into adhesive and seal laps and edges with adhesive. Coat glass cloth with adhesive. When dry, apply a finish coat of adhesive at can-consistency so that when dry no glass weave shall be observed. Provide metal jackets for [stacks] [and] [exhaust pipes] that are located above finished floor and spaces outside [boiler house] [mechanical room]. Apply metal jackets directly over insulation and secure with 3/4 inch wide metal bands spaced on 18 inch centers. Do not insulate name plates. Insulation type and thickness shall be in accordance with the following Table 7.

TABLE 7

Insulation and Thickness for
Boiler Stack and Diesel Engine Exhaust Pipe

Service & Surface Temperature Range (Degrees F)						
	Material	Outside Diameter (Inches)				
		0.25 – 1.25	1 – 1.67	3.5 5	6 – 10	> or = 11 – 36
Boiler Stack (Up to 400 degrees F)						
	Mineral Fiber ASTM C585 Class B-3, ASTM C547 Class 1, or ASTM C612 Class 1	N/A	N/A	3	3.5	4
	Calcium Silicate ASTM C533, Type 1	N/A	N/A	3	3.5	4
	Cellular Glass ASTM C552, Type II	1.5	1.5	1.5	2	2.5
Boiler Stack (401 to 600 degrees F)						
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	N/A	N/A	4	4	5

TABLE 7

Insulation and Thickness for
Boiler Stack and Diesel Engine Exhaust Pipe

Service & Surface Temperature Range (Degrees F)						
	Material	Outside Diameter (Inches)				
		0.25 - 1.25	1 - 1.67	3.5-5	6 - 10	> or = 11 - 36
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	4	4	4
	Mineral Fiber/Cellular Glass Composite:					
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	1	1	1	1	2
	Cellular Glass ASTM C552, Type II	2	2	2	2	2
Boiler Stack (601 to 800 degrees F)						
	Mineral Fiber ASTM C547 Class 3, ASTM C592 Class 1, or ASTM C612 Class 3	N/A	N/A	4	4	6
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	4	4	6
	Mineral Fiber/Cellular Glass Composite:					
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	2	2	2	3	3
	Cellular Glass ASTM C552, Type II	2	2	2	2	2

TABLE 7

Insulation and Thickness for
Boiler Stack and Diesel Engine Exhaust Pipe

Service & Surface Temperature Range (Degrees F)

	Material	Outside Diameter (Inches)				
		0.25 - 1.25	1 - 1.67	3.5-5	6 - 10	> or = 11 - 36
Diesel Engine Exhaust (Up to 700 degrees F)						
	Calcium Silicate ASTM C533, Type I or II	3	3.5	4	4	4
	Cellular Glass ASTM C552, Type II	2.5	3.5	4	4.5	6

3.4.3.2 Insulation of Pumps

Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing that does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

3.4.3.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and

joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

e. Exposed insulation corners shall be protected with corner angles.

f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 by 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.

g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.

h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.4 Equipment Handling Dual Temperature Media

Below and above 60 degrees F: equipment handling dual temperature media shall be insulated as specified for cold equipment.

3.4.5 Equipment Exposed to Weather

3.4.5.1 Installation

Equipment exposed to weather shall be insulated and finished in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

3.4.5.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for field applied insulation. Panels shall be the standard catalog product of a manufacturer of metal insulation panels. Fastenings, flashing, and support system shall conform to published recommendations of the manufacturer for weatherproof installation and shall prevent moisture from entering the insulation. Panels shall be designed to accommodate thermal expansion and to support a 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet shall be aluminum and exposed fastenings shall be stainless steel or aluminum.

-- End of Section --

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SECTION 23 08 00.00 20

COMMISSIONING OF MECHANICAL~~[~~ AND PLUMBING~~]~~ SYSTEMS
02/21, CHG 1: 05/21

PART 1 GENERAL

Total Building Commissioning (TBCx) is a systematic, quality-focused process for enhancing the delivery of a project that focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the project requirements. The purpose is to reduce the cost and performance risks associated with delivering facilities projects, and to increase value to owners, occupants, and users.

1.1 DEFINITIONS

Commissioning Process (Cx) - a quality-focused process for enhancing the delivery of a project. Refer to ASHRAE 202 for a comprehensive description of the commissioning process.

Commissioning Provider (CxC)- The entity ~~hired by the Government,~~ who leads, plans, and coordinates the Commissioning Team. The terms Commissioning Provider, Commissioning Firm, Lead Commissioning Specialist, Commissioning Specialist, and Commissioning Authority (CA or CxA) when used by sustainable Third Party Certification (TPC) programs, are interchangeable.

Commissioning Authority - The Government retains the authority for oversight and assurance of the entire commissioning process, and final approval of all commissioning deliverables.

Government Acceptance Testing Representatives - Government Acceptance Testing Representatives perform the inherently Governmental function of technical oversight and quality assurance for critical systems, and is distinctly separate from the commissioning process. Government Acceptance Testing Representatives witness final testing of critical systems and report systems' acceptance to the COR. Submittals to be surveilled and approved by Government Acceptance Testing Representatives are identified in Section 01 33 00 SUBMITTAL PROCEDURES. Testing required to be witnessed by Government Acceptance Testing Representatives are indentified in system level sections.

1.2 SEQUENCING AND SCHEDULING

Complete functional performance testing prior to performance verification testing required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Complete the following prior to starting Functional Performance Tests of mechanical systems:

a. All equipment and systems completed, cleaned, flushed, disinfected, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications

b. Final DALT Report submitted and approved in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

~~c. Performance Verification Tests of the controls systems have been~~

~~completed and the Performance Verification Test Report has been submitted and approved in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.~~

d. The Certificate of Readiness submitted and approved in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING

e. Pre-final Testing, Adjusting, and Balancing Report submitted in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

~~[f. Air Leakage Test Reports and Diagnostic Test Reports submitted and approved in accordance with Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS~~

~~][~~f~~g~~. Tests, Flushing, and Disinfection in accordance with Section ~~[22 00 00 PLUMBING, GENERAL PURPOSE]~~[22 00 70 PLUMBING FOR HEALTHCARE FACILITIES ~~]~~

~~][h. Inspection and Testing in accordance with Section 22 33 30.00 10 SOLAR WATER HEATING EQUIPMENT~~

~~]~~1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Test Equipment; G~~[, [_____]]~~

SD-06 Test Reports

Pipe Flushing, Testing, And Water Treatment Reports; G~~[, [_____]]~~

~~[~~ Seasonal Test Report; G~~[, [_____]]~~

~~]~~[Full-Load Test Report; G

~~]~~1.4 ACCESSIBILITY REQUIREMENTS

Equipment, systems, and devices for commissioned systems must be accessible. Make necessary modifications if systems and devices are not accessible for inspections and testing.

Assist commissioning team in testing by removing equipment covers, opening access panels, and other required activities that assist with visual oversight. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.

1.5 COORDINATION

Refer to Section ~~01 91 00.15 10~~ 01 91 00.15 20 TOTAL BUILDING COMMISSIONING for requirements pertaining to coordination during the commissioning process. Coordinate with the Commissioning Provider in

accordance with Section ~~01 91 00.15 10~~ 01 91 00.15 20 and in accordance with the Commissioning Plan to schedule inspections as required to support the commissioning process. Furnish additional information requested by the Commissioning Provider. Coordinate scheduling of Functional Performance Testing with the commissioning team. Upload plans, reports, notes, and other documentation to the Commissioning Provider's web-based commissioning software, or as specified in the commissioning plan, as it is completed.

1.6 PIPE FLUSHING, TESTING, AND WATER TREATMENT REPORTS

Test requirements are specified in Division ~~[~~22 and ~~]~~23 piping Sections. Prepare a pipe system cleaning, flushing, and hydrostatic testing log. Provide cleaning, flushing, testing, and water treatment log and final reports.

Include the following in the pipe system cleaning, flushing, and hydrostatic testing log:

a. Minimum flushing water velocity.

b. Water treatment reports.

c. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

1.7 CERTIFICATE OF READINESS DOCUMENTATION

Submit Certificate of Readiness documentation in accordance with Section ~~01 91 00.15 10~~ 01 91 00.15 20 TOTAL BUILDING COMMISSIONING for all equipment and systems including start-up reports; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; HVAC Controls Start-Up Reports. Do not schedule Functional Performance Tests for the system until the Certificate of Readiness for that system receives approval by the Contracting Officer. The Mechanical, Electrical, Controls, and TAB subcontractor representatives must sign and date the Certificate of Readiness.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Provide all testing equipment required to perform testing for the systems to be commissioned, except for equipment specific to and used by TAB as required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Provide a sufficient quantity of two-way radios for each subcontractor. Submit list of Test Equipment and instrumentation to be used for testing including equipment/instrument identification number, equipment application or planned use, manufacturer, make, model, and serial number, and calibration history with certificates. Also list special equipment and proprietary tools specific to a piece of equipment required for testing.

2.1.1 Proprietary Equipment

Provide manufacturer's proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not. Provide manufacturer test equipment, demonstrate its

use, and assist in the commissioning process as needed. Provide data logging equipment and software required to test equipment.

2.1.2 Calibration and Accuracy

Comply with equipment manufacturer's test equipment calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to Contracting Officer upon request.

Provide all testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, the following minimum requirements apply: Provide temperature sensors and digital thermometers with a certified calibration within the past year to an accuracy of 0.5 degrees F and a resolution of plus or minus 0.1 degrees F. Provide pressure sensors with an accuracy of plus or minus 2.0 percent of the value range being measured (not full range of meter) and calibrated within the last year.

PART 3 EXECUTION

3.1 MEETINGS

Attend all meetings in accordance with Section ~~01 91 00.15 10~~ 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.

Provide timely updates on construction schedule changes so Commissioning Provider has scheduling information needed to execute commissioning process efficiently. Notify Contracting Officer of anticipated construction delays to commissioning activities not yet performed or not yet scheduled.

3.2 PREFUNCTIONAL CHECKS

Complete and sign Pre-Functional Checklists using the Commissioning Provider's web-based commissioning software, or as specified by the commissioning plan. Provide manufacturer's installation manual for each type of unit. Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

3.3 STARTUP AND INITIAL CHECKOUT

Document start-up and initial testing procedures including:

a. Startup tests and factory testing reports.

b. Manufacturer's representative start-up, operating, troubleshooting and maintenance procedures.

~~f~~ c. Additional documentation necessary for third party certification programs.

~~j~~ d. Perform and clearly document system operational checks and quality control checks as they are completed, and providing a copy to the commissioning team.

e. Correct deficiencies and sign the Certificate of Readiness for each system before functional performance testing

3.4 COMMISSIONING TESTING

Conduct Functional Performance Testing in accordance with Section ~~01 91 00.15 10~~ 01 91 00.15 20 TOTAL BUILDING COMMISSIONING and requirements in this section. Prior to Functional Performance Testing, complete all prerequisites in accordance with paragraph SEQUENCING AND SCHEDULING.

3.4.1 Preparation

Put equipment and systems into operation and continue operation during each working day of commissioning, as required. Verify temperature and pressure taps in accordance with Contract Documents. Provide a pressure/temperature plug at each water sensor which is an input point to control system.

Perform minor adjustments to equipment and systems during Functional Performance Tests as deemed necessary by the commissioning team. Where calibrated DDC sensors cannot be used to record test data, provide measuring instruments, logging devices, and data acquisition equipment to record data for the complete range of test data for the required test period.

3.4.2 Test Setup

Perform each test under conditions that simulate actual conditions as close as is practically possible. Provide all necessary materials and system modifications to produce the necessary flows, pressures, temperatures, and other conditions necessary to execute the test according to the specified conditions. At completion of the test, return the affected building equipment and systems to their pre-test condition.

3.4.3 Manufacturer's Representative

Provide a factory trained representative authorized by the equipment manufacturer to perform Functional Performance Testing for the following equipment:

~~[~~ ~~Chillers~~

~~][~~ ~~Cooling towers and evaporatively cooled condensers~~

~~][~~ Boilers

~~][~~ ~~Packaged Direct-Expansion Refrigeration Equipment, including variable refrigerant flow (VRF) systems~~

~~][~~ ~~Packaged Computer Room [Air Handlers (CRAH)] [Air Conditioners (CRAC)]~~

~~][~~ ~~Booster Pumps~~

~~][~~ Packaged Air Compressors

~~][~~ Water Quality and Chemical Treatment Systems

~~][~~ ~~Solar Water Heating Systems~~

~~][~~ Ensure the test representative reviews, approves, and signs the completed field test report. Include person's name with signatures.

]3.4.4 Sample Strategy

Perform Functional Performance Tests using the sample strategy described in Section ~~01 91 00.15 10~~ 01 91 00.15 20 TOTAL BUILDING COMMISSIONING. Prepare and complete a Functional Performance Test for each item of equipment or system to be tested. During testing, Government representatives may select the specific equipment or system to be tested for sample sizes less than 100 percent.

3.4.5 Simulating Conditions

Functional performance testing is conducted by simulating conditions at control devices to initiate a control system response. Before testing, calibrate all sensors, transducers and devices. Over-writing control input values through the control system is not acceptable unless approved by the Contracting Officer. Specific examples of simulating conditions are provided below. Do not simulate conditions when damage to the system or building may result.

a. When varying static pressures inside ductwork cannot be simulated within the duct, and where a sensor signals the controls system to initiate sequences at various duct static pressures, it is acceptable to simulate the various pressures with a Pneumatic Squeeze-Bulb Type Signaling Device with gauge temporarily attached to the sensing tube leading to the transmitter. It is not acceptable to reset the various set-points, nor to simulate an electric analog signal (unless approved as noted above).

b. Dirty filter pressure drops can be simulated by partially blocking filter face.

c. Freeze-stat safeties can be simulated by packing portion of sensor with ice.

d. High outside air temperatures can be simulated with a hair blower.

e. Raising entering cooling coil temperatures by activating a heating/preheat coil can be used to simulate entering cooling coil conditions.

f. Do not use signal generators to simulate sensor signals unless approved by the Contracting Officer, as noted above, for special cases.

g. Control set points can be altered. For example, to see the air conditioning compressor lockout work at an outside air temperature below 55 degrees F, when the outside air temperature is above 55 degrees F, temporarily change the lockout set point to be 0 degrees F above the current outside air temperature. Caution: Set points are not to be raised or lowered to a point to cause damage to the components, systems, or the building structure and/or contents.

h. Test duct mounted smoke detectors in accordance with the manufacturer's recommendations. Perform the tests with air system at minimum airflow condition.

i. Test current sensing relays used for fan and pump status signals to control system to indicate unit failure and run status by resetting the set point on the relay to simulate a lost belt or unit failure

while the unit is running. Confirm that the failure alarm was generated and received at the control system. After the test is conducted, return the set point to its original set-point or a set-point as indicated by the Contracting Officer.

[3.4.6 Duct Air Leakage Test (DALT) Report Review

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. ~~The Commissioning Specialist is responsible for reviewing the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.~~ All deficiencies must be resolved prior to DALT Report approval.

]3.4.7 Duct Air Leakage Test (DALT) Report Verification

The Mechanical System Technical Commissioning Specialist must witness the DALT Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. ~~The Commissioning Specialist is responsible for witnessing the DALT Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.~~ All deficiencies must be resolved prior to DALT Report approval.

[3.4.8 Testing, Adjusting, and Balancing (TAB) Report Review

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. ~~The Commissioning Specialist is responsible for reviewing the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.~~ All deficiencies must be resolved prior to TAB Report approval.

]3.4.9 Testing, Adjusting, and Balancing (TAB) Report Verification

The Mechanical System Technical Commissioning Specialist must witness the TAB Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. ~~The Commissioning Specialist is responsible for witnessing the TAB Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.~~ All deficiencies must be resolved prior to TAB Report approval.

~~]~~[3.4.10 HVAC Controls Test Procedures, Reports, and Trends Review

The Mechanical System Technical Commissioning Specialist must review the Start-Up Testing Report, PVT Procedures and PVT Reports including endurance testing trend submittals required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC~~[and Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION]~~. The Mechanical System Technical Commissioning Specialist must review each submittal and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. ~~The Commissioning Specialist is responsible for reviewing the Start-Up Testing Report, PVT Procedures and PVT Reports including endurance testing trend data required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC[and Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION] and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.~~ All deficiencies must be resolved prior to final acceptance.

~~]~~3.5 RETESTING REQUIREMENTS

Abort tests if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Re-test only after all deficiencies identified during the original tests have been corrected.

If sequence of operation in any of Functional Performance Tests fails, the Government's costs for witnessing further demonstration of that test procedure may be assigned to the Contractor as a deduct to their contracted price, including salary, travel costs, and per diem for Government commissioning team members. Correct deficiencies as identified by the commissioning team and retest the systems to be commissioned.

3.6 SYSTEM ACCEPTANCE

Systems may be partially accepted prior to seasonal testing if they comply with all construction contract and accepted design requirements that can be tested during initial Functional Performance Tests. All test procedures must be successful completed prior to full systems acceptance.

~~[~~3.7 SEASONAL TESTS

Perform Initial Functional Performance Tests as soon as all contract work is completed, but prior to facility turnover, regardless of the season.

In addition to the Initial Functional Performance Tests, perform Functional Performance Tests of HVAC systems during season of maximum ~~[~~ heating~~]~~[and ~~]~~[cooling~~]~~ as defined by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Schedule Seasonal Functional Performance Tests in coordination with the Contracting Officer. Submit Seasonal Test Report within 14 days of test completion.

Execute seasonal functional performance testing, witnessed by the Contracting Officer. Correct deficiencies and make adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

~~][~~3.8 FULL-LOAD TESTS

Perform Initial Functional Performance Tests as soon as all contract work is completed, but prior to facility turnover. In addition to the Initial Functional Performance Tests, perform Functional Performance Tests of HVAC systems under full-load conditions.~~[Develop and implement means of artificial loading to demonstrate the ability of the process cooling systems to handle peak process loads.]~~ Schedule Full-Load Functional Performance Tests in coordination with the Contracting Officer. Submit Full-Load Test Report within 14 days of test completion.

Execute full-load functional performance testing, witnessed by the Contracting Officer. Correct deficiencies and make adjustments to O&M manuals and as-built drawings for applicable issues identified in any full load testing.

~~]~~3.9 TRAINING

The Mechanical Systems Technical Commissioning Specialist must review the training plan required by Section 01 78 00 OPERATION AND MAINTENANCE DATA and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.

~~The Commissioning Provider is responsible for overseeing and approving the training plan required by Section 01 78 00 OPERATION AND MAINTENANCE DATA and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.~~

Coordinate, schedule, and document all required training. At a minimum, include the following items in the training report for commissioned systems:

a. Complete commissioning documentation

b. Complete O&M data

c. Complete Training

d. Purpose of equipment.

e. Principle of how the equipment works.

f. Important parts and assemblies.

g. How the equipment achieves its purpose and necessary operating conditions.

h. Most likely failure modes, causes and corrections.

i. On site demonstration.

j. Provide updates to O&M manuals based on field modifications.

k. Provide training of the post-occupancy operations and maintenance staff.

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
02/19, CHG 3: 05/21

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End ~~which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION~~, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, ~~[Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL,]~~ ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, and~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and other referenced Sections.

~~[1.1.1 Control System Vendor Requirement~~

~~The control system provided under this Section must be [_____]. Configure the equipment as indicated in [attached configuration setting requirements][the configuration settings drawings][_____].~~

~~]~~1.1.1 Proprietary Systems

1.1.1.1 Proprietary Systems Exempted From Open Protocol Requirements

The following systems are specifically exempted from the open protocol requirements of ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS:

a. A simple split (DX) system consisting of a single indoor unit and a single outdoor unit from the same manufacturer.

b. Systems in Table I (previously approved by the designer in accordance with UFC 3-410-02).

TABLE I: Systems Approved to Use Proprietary Communications		
System	Type (Multi-Split/VRF or Chiller/Boiler Plant)	Proprietary Multi-Split Engineering Tool Software Required (for Multi-Split/VRF only)
CH-1 + 2	Chillers	

TABLE I: Systems Approved to Use Proprietary Communications		
System	Type (Multi-Split/VRF or Chiller/Boiler Plant)	Proprietary Multi-Split Engineering Tool Software Required (for Multi-Split/VRF only)
B-1 + 2	Boilers	

c. A system (not already shown Table I) of multiple boilers or multiple chillers communicating with a proprietary network for which an approved request has been obtained and for which: all units are from the same manufacturer, they are all co-located in the same room, the network connecting them is fully contained in that room, and the units are operating using a common "plant" sequence of operation which stages the units in a manner that requires operational parameters be shared between them and which cannot be accomplished with a single lead-lag command from a third-party controller.

1.1.1.2 Implementation of Proprietary Systems

For proprietary systems exempted from open protocol requirements, a proprietary network and DDC hardware communicating via proprietary protocol are permitted. For these systems a building control network meeting the requirements of ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS must also be provided, along with a gateway or interface to connect the proprietary system to the open building control network.

The proprietary system gateway or interface must provide the required functionaliality as shown on the points schedule. Scheduling, alarming, trending, overrides, network inputs, network outputs and other protocol related requirements must be met on the open protocol control system as specified in ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

~~1.1.1.3 Proprietary Multi-Split Engineering Tool Software~~

~~For each permitted proprietary systems in Table 1 shown as requiring Proprietary Multi-Split Engineering Tool Software, provide the software needed to replace a unit and configure the replacement. Submit hard copies of the software user manuals with the software submittal.~~

~~Submit Proprietary Multi-Split Engineering Tool Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.~~

1.1.2 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

a. The system implements the control sequences of operation ~~[~~shown in the Contract Drawings~~][___]~~ using DDC hardware to control mechanical and electrical equipment

b. The system meet the requirements of this specification as a

stand-alone system and does not require connection to any other system.

c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network~~, unless otherwise pre-approved by the Contracting Officer~~.

d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

g. Hardware is installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.

~~h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:~~

~~accept.station.in="*"~~
~~accept.station.out="*"~~
~~accept.wb.in="*"~~
~~accept.wb.out="*"~~

1.1.3 End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.4 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.5 Drawings

The Government will not indicate all offsets, fittings, and accessories

that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere:

a. ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LonWorks Systems using LNS or Niagara Framework or~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet systems with or without Niagara Framework.

b. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

~~c. Section 23 09 93 SEQUENCES OF OPERATIONS FOR HVAC CONTROLS~~

~~d. Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEMS TESTING~~

~~e. Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) FRONT END AND INTEGRATION~~

c~~f~~. Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

g~~d~~. ~~[~~Section ~~[01 91 00.15 10]~~[01 91 00.15 20~~]~~ TOTAL BUILDING COMMISSIONING ~~][_____]~~

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Errata 2021) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA

	20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-410-02	(2018; with Change 2, 2021) Direct Digital Control for HVAC and Other Building Control Systems

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness.The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface) - see paragraph ALARM ROUTING in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

~~1.4.2 Application Generic Controller (AGC) (LonWorks)~~

~~A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).~~

~~1.4.3 Application Specific Controller (ASC) (LonWorks)~~

~~A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.~~

1.4.2 Building Automation and Control Network (BACnet) (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall

technology related to the ASHRAE 135 protocol.

1.4.3 BACnet Advanced Application Controller (B-AAC) (BACnet)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming, but is not required to support as many BIBBs as a B-BC.

1.4.4 BACnet Application Specific Controller (B-ASC) (BACnet)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

1.4.5 BACnet Building Controller (B-BC) (BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.6 BACnet Broadcast Management Device (BBMD) (BACnet)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

1.4.7 BACnet/IP (BACnet)

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

1.4.8 BACnet Internetwork (BACnet)

Two or more BACnet networks, connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.9 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more ASHRAE 135 Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

The following is a list of some BIBBs used by this or referenced Sections:	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

1.4.10 BACnet Network (BACnet)

In BACnet, a portion of the control Internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

1.4.11 BACnet Operator Display (B-OD) (BACnet)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

1.4.12 BACnet Segment (BACnet)

One or more physical segments interconnected by repeaters (ASHRAE 135).

1.4.13 BACnet Smart Actuator (B-SA) (BACnet)

A simple actuator device with limited resources intended for specific applications.

1.4.14 BACnet Smart Sensor (B-SS) (BACnet)

A simple sensing device with limited resources.

1.4.15 BACnet Testing Laboratories (BTL) (BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.16 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile, in which case the listing indicates that the device supports the required capabilities for that profile, or may be listed as "other".

1.4.17 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

~~1.4.18 Binding (LonWorks)~~

~~The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent.~~

1.4.18 Broadcast (BACnet)

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.19 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.20 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

~~1.4.21 Channel (LonWorks)~~

~~A portion of the control network consisting of one or more segments~~

~~connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.~~

1.4.21 Commandable (All protocols)

See Overridable.

1.4.22 Commandable Objects (BACnet)

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.

1.4.23 Configurable (All protocols)

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

In a ~~non-Niagara Framework~~ BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:

1) via BACnet services (including proprietary BACnet services)
2) via hardware settings on the device

~~In a Niagara Framework BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:~~

~~1) via BACnet services (including proprietary BACnet services)~~
~~2) via hardware settings on the device~~
~~3) via the Niagara Framework~~

Note this is more stringent than the ASHRAE 135 definition.

~~1.4.24 Configuration Property (LonWorks)~~

~~Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see paragraph STANDARD CONFIGURATION PROPERTY TYPE (SCPT).~~

1.4.24 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.25 Device (BACnet)

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

1.4.26 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.27 Device Profile (BACnet)

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135. Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

1.4.28 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.29 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

~~1.4.30 Domain (LonWorks)~~

~~A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) See also Node Address.~~

~~1.4.31 Explicit Messaging (LonWorks)~~

~~A non-standard and often vendor (application) specific method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received.~~

~~1.4.32 External Interface File (XIF) (LonWorks)~~

~~A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.~~

1.4.30 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

~~1.4.31 Fox Protocol (Niagara Framework)~~

~~The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.~~

~~1.4.32 Functional Profile (LonWorks)~~

~~A standard description, defined by LonMark, of one or more LonMark Objects used to classify and certify devices.~~

1.4.31 Gateway (All protocols)

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

~~A Niagara Framework Supervisory Gateway is one type of Gateway.~~

~~1.4.32 General Purpose Programmable Controller (GPPC) (LonWorks)~~

~~Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.~~

1.4.32 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.33 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.34 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.35 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.36 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

~~1.4.37 JACE (Niagara Framework)~~

~~Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY~~

1.4.37 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.38 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

~~1.4.39 LonMark (LonWorks)~~

~~See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices.~~

~~1.4.40 LonMark International (LonWorks)~~

~~Standards committee consisting of numerous independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.~~

~~1.4.41 LonMark Interoperability Association (LonWorks)~~

~~See paragraph LONMARK INTERNATIONAL.~~

~~1.4.42 LonMark Object (LonWorks)~~

~~A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).~~

~~1.4.43 LonWorks (LonWorks)~~

~~The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.~~

~~1.4.44 LonWorks Network Services (LNS) (LonWorks)~~

~~A network management and database standard for CEA-709.1-D devices.~~

~~1.4.45 LonWorks Network Services (LNS) Plug-in (LonWorks)~~

~~Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a user friendly method to edit a device's configuration properties.~~

1.4.39 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies

a device on a Local Area Network.

1.4.40 Master-Slave/Token-Passing (MS/TP) (BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.41 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.42 Network Number (BACnet)

A site-specific number assigned to each network. This network number must be unique throughout the BACnet Internetwork.

~~1.4.43 Network Variable (LonWorks)~~

~~- See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT).~~

~~1.4.44 Network Configuration Tool (LonWorks)~~

~~- The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).~~

~~1.4.45 Niagara Framework (Niagara Framework)~~

~~A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.~~

~~1.4.46 Niagara Framework Supervisory Gateway (Niagara Framework)~~

~~DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-based user interface.~~

~~Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include (but are not limited to)"EC-BOS", "FX-40", "TMN", "SLX" and "UNC".~~

~~1.4.47 Node (LonWorks)~~

~~- A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.~~

~~1.4.48 Node Address (LonWorks)~~

~~- The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).~~

~~1.4.49 Node ID (LonWorks)~~

~~- A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.~~

1.4.43 Object (BACnet)

An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.44 Object Identifier (BACnet)

A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a number). Object Identifiers must be unique within a device.

1.4.45 Object Instance (BACnet)

See paragraph OBJECT IDENTIFIER

1.4.46 Object Properties (BACnet)

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.4.47 Operator Configurable (All protocols)

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

~~For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.~~

~~For LNS LonWorks systems, Operator Configurable is defined the same as Configurable. See paragraph CONFIGURABLE.~~

For non Niagara-based BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

a. a Writable Property of a Standard BACnet Object; or

b. a Property of a Standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

1.4.48 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation

where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.49 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.50 Packaged Unit (All protocols)

See packaged equipment.

1.4.51 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.52 Physical Segment (BACnet)

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

1.4.53 Polling (All protocols)

A device periodically requesting data from another device.

1.4.54 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

~~1.4.55 Program ID (LonWorks)~~

~~An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.~~

1.4.55 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.56 Proprietary (BACnet)

Within the context of BACnet, any extension of or addition to object types, properties, PrivateTransfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above are proprietary Properties.

1.4.57 Protocol Implementation Conformance Statement (PICS) (BACnet)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

1.4.58 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.59 Router (All protocols)

A device that connects two ~~CEA-709.1-D channels (in a LonWorks system) or two~~ ASHRAE 135 networks ~~(in a BACnet system)~~ and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a ~~LonWorks control network or a~~ BACnet internetwork and to limit network traffic.

1.4.60 Segment (All protocols)

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. ~~For example, in a LonWorks system a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.~~

~~1.4.61 Service Pin (LonWorks)~~

~~A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID.~~

1.4.61 Standard BACnet Objects (BACnet)

Objects with Object_Type values below 128 and specifically enumerated in Clause 21 of ASHRAE 135. Objects which are not proprietary. See paragraph PROPRIETARY.

1.4.62 Standard BACnet Properties (BACnet)

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not

proprietary. See Proprietary.

1.4.63 Standard BACnet Services (BACnet)

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

~~1.4.64 Standard Configuration Property Type (SCPT) (LonWorks)~~

~~Pronounced skip-it. A standard format type (maintained by LonMark International) for Configuration Properties.~~

~~1.4.65 Standard Network Variable Type (SNVT) (LonWorks)~~

~~Pronounced snivet. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.~~

~~1.4.66 Subnet (LonWorks)~~

~~Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also paragraph NODE ADDRESS.~~

~~1.4.67 TP/FT-10 (LonWorks)~~

~~A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.~~

~~1.4.68 TP/XF-1250 (LonWorks)~~

~~A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.~~

~~1.4.69 User-defined Configuration Property Type (UCPT) (LonWorks)~~

~~Pronounced u-keep-it. A Configuration Property format type that is defined by the device manufacturer.~~

~~1.4.70 User-defined Network Variable Type (UNVT) (LonWorks)~~

~~A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.~~

1.4.64 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems

connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.65 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.4.66 Writable Property (BACnet)

A Property is Writable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writable when the Out of Service Property is TRUE are not considered to be Writable.

1.5 PROJECT SEQUENCING

TABLE II: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE II does not specify overall project milestone and completion dates~~[; these dates are specified in the contract documents] [_____]~~.

a. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within ~~[~~14~~][_____]~~ days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE II the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE II. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Product Data	
4	S	Pre-construction QC Checklist	
5	E	Install Building Control System	AAO #1 thru #4
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	~~[[_____] days]~~ACO #6
8	S	Programming Software Configuration Software ~~Niagara Framework Engineering Tool~~ ~~Niagara Framework Wizards~~ ~~XIF Files~~ ~~LNS Plug Ins~~	~~[[_____] days]~~ACO #6
9	S	Draft As-Built Drawings ~~Draft LNS Database~~	~~[[_____] days]~~ACO #6
10	S	Start-Up Testing Report	~~[[_____] days]~~ACO #6
11	S	PVT Procedures	~~[[_____] days]~~before schedule start of #12 and AAO #10
12	S,E	Execute PVT PVT Testing Activities	AAO #9 and #11As indicated in PART 3 of this Section
13	S	PVT Report	~~[[_____] days]~~ACO #12 As indicated in PART 3 of this Section

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
14	S	Controller Application Programs Controller Configuration Settings ~~Niagara Framework Supervisory Gateway Backups~~ ~~Final LNS Database~~	~~[[_____] days]~~AAO #13
15	S	Final As-Built Drawings	~~[[_____] days]~~AAO #13
16	S	O&M Instructions	AAO #15
17	S	Training Documentation	AAO #10 and ~~[[_____] days]~~ before scheduled start of #18
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G~~[, [_____]]~~

Draft As-Built Drawings; G~~[, [_____]]~~

Final As-Built Drawings; G~~[, [_____]]~~

SD-03 Product Data

Programming Software; G~~[, [_____]]~~

Controller Application Programs; G~~[, [_____]]~~

Configuration Software; G~~[, [_____]]~~

Controller Configuration Settings; G[, [_____]]

Proprietary Multi-Split Engineering Tool Software; G[, [_____]]

Manufacturer's Product Data; G[, [_____]]

XIF files; G[, [_____]]

Draft LNS Database; G[, [_____]]

Final LNS Database; G[, [_____]]

LNS Plug-ins; G[, [_____]]

Niagara Framework Supervisory Gateway Backups; G[, [_____]]

[Niagara Framework Engineering Tool; G[, [_____]]]

Niagara Framework Wizards; G[, [_____]]

SD-05 Design Data

Boiler Or Chiller Plant Gateway Request

SD-06 Test Reports

Existing Conditions Report

Pre-Construction Quality Control (QC) Checklist; G[, [_____]]

Post-Construction Quality Control (QC) Checklist; G[, [_____]]

Start-Up Testing Report; G[, [_____]]

PVT Procedures; G[, [_____]]

PVT Report; G[, [_____]]

Control Contractor’s Performance Verification Testing Plan; G

Equipment Supplier’s Performance Verification Testing Plan; G

Endurance Testing Results; G

Performance Verification Test Report; G

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G[, [_____]]

Training Documentation; G[, [_____]]

SD-11 Closeout Submittals

Enclosure Keys; G~~[, [_____]]~~

Password Summary Report; G~~[, [_____]]~~

Closeout Quality Control (QC) Checklist; G~~[, [_____]]~~

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

~~1.8.1 Programming Software~~

~~For each type of General Purpose Programmable Controller (GPPC), provide the programming software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each type of Application Generic Controller (AGC) provided as part of without a configuration and programming Wizard, provide the programming and configuration software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of user manuals for each software with the software submittal.~~

~~Submit Programming Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.~~

~~1.8.2 Controller Application Programs~~

~~For each General Purpose Programmable Controller (GPPC), provide copies of the application program as source code compatible with the programming software for that GPPC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each Application Generic Controller (AGC), provide copies of the application program as source code compatible with the programming and configuration tool (LNS plug-in) for that AGC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device.~~

~~Submit [2][_____] copies of the Controller Application Programs CD-ROM.~~

1.8.1 Configuration Software

For each type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of the software user manuals for each software with the software submittal.

Submit Configuration Software on CD-ROM as a Technical Data Package. Submit 1~~[_____]~~ hard copies of the software user manual for each piece of software.

1.8.2 Controller Configuration Settings

For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit ~~[~~2~~][_____]~~ copies of the Controller Configuration Settings CD-ROM.

1.8.3 Programming Software

For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of software user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit 1~~[_____]~~ hard copies of the software user manual for each piece of software.

1.8.4 Controller Application Programs

For each programmable controller, provide copies of the application program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit ~~[~~2~~][_____]~~ copies of the Controller Application Programs CD-ROM.

~~1.8.5 LNS Plug-Ins (for LNS-based LonWorks systems)~~

~~Provide LNS Plug-ins in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for each Application Specific Controller and each Application Generic Controller. For LNS Plug-ins distributed under a license, license the Plug-In to the project site. Submit hard copy manuals, if available, for each plug-in provided as part of the LNS- Plug-Ins submittal.~~

~~Submit LNS Plug-ins on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are~~

~~associated with each device.~~

~~1.8.6 Niagara Framework Wizards (for Niagara LonWorks systems)~~

~~For each Application Generic Controller with a Niagara Framework Wizard and for each Application Specific Controller provide Niagara Framework Wizards in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copy manuals, if available, for each Wizard provided as part of the Niagara Framework Wizards submittal.~~

~~Submit Niagara Framework Wizards on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit [_____] hard copies of the software user manual, if available, for each Wizard.~~

~~1.8.7 Niagara Framework Supervisory Gateway Backups~~

~~For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.~~

~~Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.~~

~~[1.8.8 Niagara Framework Engineering Tool(for all Niagara Framework system)~~

~~Provide a Niagara Framework Engineering Tool in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.~~

~~Submit the Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for the Niagara Framework Engineering Tool.~~

~~]~~1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST

If requesting the use of a gateway to a boiler or chiller plant as indicated in paragraph Proprietary Systems Exempted From Open Protocol Requirements, submit a Boiler or Chiller Plant Gateway Request describing the configuration of the boilers or chillers including model numbers for equipment and controllers, the sequence of operation for the units, and a justification for the need to operate the units on a shared ~~non-LonWorks~~ non-BACnet network.

1.10 QUALITY CONTROL CHECKLISTS

~~The QC Checklist for LNS-Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.~~

~~The QC Checklist for Niagara Framework Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.~~

The QC Checklist for BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

~~The QC Checklist for Niagara Framework Based BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.~~

The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.10.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit ~~[~~four~~][_____]~~ copies of the Pre-Construction QC Checklist.

1.10.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit ~~[~~four~~][_____]~~ copies of the Post-Construction QC Checklist.

1.10.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit ~~[~~four~~][_____]~~ copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems,~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical,

including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS,~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

~~For all LonWorks hardware: for each manufacturer, model and version (revision) of DDC Hardware indicate the type or types of DDC Hardware the product is being provided as in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS~~

For all BACnet hardware: for each manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

~~2.2.1 XIF Files~~

~~Provide External Interface Files (XIF Files) for DDC Hardware in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit external interface files (XIF files) as a technical data package for each model of DDC Hardware provided under this specification. Submit XIF files on CD-ROM.~~

2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

(1) Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of ~~[~~ -35 to +151 degrees F~~]~~ ~~[_____]~~ and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

For products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate.

2.5 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.5.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 3R~~[Type 3][Type 4]~~ requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 ~~[~~Type 2~~][Type 4]~~ requirements.

2.5.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

~~[3.1 EXISTING CONDITIONS~~

~~3.1.1 Existing Conditions Survey~~

~~Perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For those items considered nonfunctional, document the deficiency in the report including explanation of the deficiencies and estimated costs to correct the deficiencies. As part of the report, define the scheduled need date for connection to existing equipment. Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.~~

~~Submit [four][_____] copies of the Existing Conditions Report.~~

~~3.1.2 Existing Equipment Downtime~~

~~Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.~~

~~3.1.3 Existing Control System Devices~~

~~Inspect, calibrate, and adjust as necessary to place in proper working order all existing devices which are to be reused.~~

~~]~~3.1 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, ~~Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems,~~ Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and this Section.

3.1.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.1.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

a. Label all Enclosures and DDC Hardware.

b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.

c. Tag duct static pressure taps at the location of the pressure tap

3.1.5 Surge Protection

3.1.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

3.1.5.2 Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay

time and a peak current of 500 amperes.

3.1.6 Basic Cybersecurity Requirements

3.1.6.1 Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with controls contractor[_____]. Provide a Password Summary Report documenting the password for each device and describing the procedure to change the password for each device.

Provide [two][_____] hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.1.6.2 Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3.1.6.3 IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

3.2 DRAWINGS AND CALCULATIONS

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on [ISO A1 34 by 22 inches][or][A3 17 by 11 inches] sheets, and electronic drawings in PDF and in AutoCAD or Autodesk Revit 2013[AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 1[_____] hard copies and 1 [_____] copies on CD-ROM.

b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: 1[_____] hard copies and 1[_____] copies on CD-ROM.

c. Submit Final As-Built Drawings consisting of each drawing indicated

updated with all final as-built data. Final As-Built Drawings as a single complete package: 1[_____] hard copies and 1[_____] copies on CD-ROM.

3.2.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00 These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.

3.2.2 Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

3.2.3 Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

3.2.4 Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

3.2.5 Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

3.2.6 Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a

single project equipment schedule for the entire project.

3.2.7 Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

3.2.8 Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

3.2.9 DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

3.2.9.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.2.9.2 HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

~~3.2.9.3 LonWorks Device Information~~

~~3.2.9.3.1 Network Address~~

~~The LonWorks Domain, Subnet and Node address for the device.~~

~~3.2.9.3.2 Unique Node ID~~

~~The Unique 48-bit Node ID associated with the device. (Also referred to as the Neuron ID for some devices)~~

3.2.9.3 BACnet Device Information

3.2.9.3.1 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.2.9.3.2 Network Number

The Network Number for the device.

3.2.9.3.3 MAC Address

The MAC Address for the device

3.2.9.3.4 BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

3.2.9.3.5 Proprietary Services Information

If the device uses non-standard ASHRAE 135 services as defined and permitted in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

a. read: interpret the data contained in the non-standard service and;

b. write: given similar data, generate the appropriate non-standard service request.

3.2.9.3.6 Alarming Information

Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

3.2.9.3.7 Scheduling Information

Indicate whether the device is used for scheduling.

3.2.9.3.8 Trending Information

Indicate whether the device is used for trending, and indicate if the device is used to trend local values, remote values, or both.

~~3.2.9.4 Niagara Station ID~~

~~The Niagara Station ID for each Niagara Framework Supervisory Gateway~~

3.2.10 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.

Points Schedule Columns must include:

3.2.10.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.2.10.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.2.10.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.2.10.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.2.10.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.2.10.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.2.10.7 Object and Property Information

The Object Type and Instance Number for the Object associated with the

point. If the value of the point is not in the Present_Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

~~3.2.10.8 Primary Point Information: SNVT Name~~

~~The name of the SNVT used for the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.~~

~~3.2.10.9 Primary Point Information: SNVT Type~~

~~The SNVT type used by the point. Provide this information whenever SNVT Name is required.~~

~~3.2.10.10 Niagara Station ID~~

~~The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.~~

3.2.10.8 Network Data Exchange Information (Gets Data From, Sends Data To)

Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

3.2.10.9 Override Information (Object Type and Instance Number)

For each point requiring an Override ~~and not residing in a Niagara Framework Supervisory Gateway~~, indicate if the Object for the point is Commandable or, if the use of a separate Object was specifically approved by the Contracting Officer, provide the Object Type and Instance Number of the Object to be used in overriding the point.

~~3.2.10.10 Override Information (SNVT Name and Type)~~

~~For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate the SNVT Name and SNVT Type of the network variable used for the override.~~

3.2.10.10 Trend Object Information

For each point requiring a trend, indicate if the trend is Local or Remote, the trend Object type and the trend Object instance number. For remote trends provide the DDC Hardware Identifier for the device containing the trend Object in the Points Schedule notes.

3.2.10.11 Alarm Information

Indicate the Alarm Generation Type, Event Enrollment Object Instance Number, and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have Event Enrollment Objects.)

~~For Niagara BACnet systems: Indicate the Alarm Generation Type and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have a Notification Class Object.)~~

3.2.10.12 Configuration Information

Indicate the means of configuration associated with each point. ~~For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:~~

a. For Operator Configurable Points indicate BACnet Object and Property information (Name, Type, Identifiers) containing the configurable value. Indicate whether the property is writable always, or only when Out_Of_Service is TRUE.

b. For Configurable Points indicate the BACnet Object and Property information as for Operator Configurable points, or identification of the configurable settings from within the engineering software for the device or identification of the hardware settings on the device.

~~a. Indicate "Plug-In" if the point is configurable via an LNS plug-in. Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.~~

~~b. If the point is not configurable through an LNS plug-ina Niagara Framework Wizard, indicate the network variable or configuration property used to configure the value.~~

3.2.11 Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

3.2.12 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.2.13 Sequences of Operation~~[~~ Including Control Logic Diagrams~~]~~

Provide HVAC control system sequence of operation and ~~[~~control logic diagrams~~]~~ in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation~~[~~ and control logic diagrams~~]~~ for each HVAC system

3.2.14 Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere

rating. Provide wiring diagrams for each HVAC system.

3.3 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.4 START-UP

3.4.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

3.4.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.4.1.1.1 Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel ~~[and each M&C Client]~~ to verify that all displays indicate shutdown conditions.

3.4.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if

not recalibrate or replace the device and repeat the calibration check.

3.4.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.4.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.4.2 Start-Up Testing Report

Submit ~~[~~4~~]~~ ~~[_____]~~ copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

~~3.4.3 Draft LNS Database~~

~~Upon completion of the Start-Up Test, submit the Draft LNS Database reflecting the system as installed and configured at the completion of the Start-Up and Start-Up-Testing. The Draft LNS Database must be a complete, fully commissioned LNS database for the complete control network provided under this specification. The Draft LNS database submittal must consist of the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, the provided LNS Database must include all device credits.~~

~~Submit two copies of the fully commissioned, valid draft LNS Database (including all LNS credits) as a Technical Data Package. Submit each copy on a CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.~~

3.5 PERFORMANCE VERIFICATION TEST (PVT)

3.5.1 PVT Procedures

Prepare PVT Procedures based on Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit ~~[~~4~~]~~ ~~[_____]~~ copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

3.5.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

~~3.5.1.2 Temporary Trending Hardware~~

~~Unless trending capability exists within the building control system or the building control system is connected to a UMCS or other system which can perform trending, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all commissioning activities.~~

3.5.1.2 Endurance Test

Include a ~~[~~one-week~~]~~ ~~[_____]~~ endurance test as part of the PVT during which the system is operated continuously.

Use the building control system BACnet Trend Log or Trend Log Multiple Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

~~Use the building control system Niagara Trend Log Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.~~

~~Use the existing trending capabilities or the Temporary Trending Hardware as indicated to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.~~

3.5.1.3 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.5.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written

permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.5.3 PVT Report

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit ~~[~~four~~][_____]~~ copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

~~3.5.4 Final LNS Database~~

~~Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.~~

~~Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.~~

3.6 PERFORMANCE VERIFICATION TESTING

3.6.1 General

PVT testing must demonstrate compliance of controls work with contract document requirements and must be performed by the Controls Contractor and Equipment Suppliers. No less than ~~[~~14~~][__]~~ calendar days prior to start of controls system installation, meet with the Contracting Office's technical representative (COTR) ~~[and the designing engineer of the HVAC systems]~~, the Contractor's QA representative, the Contractor's Controls Contractor representative,~~[and the control system Owner]~~ to develop a mutual understanding relate to the details of the PVT work requirements, including required submittals, work schedule, and field quality control.

3.6.2 Performance Verification Testing and Commissioning

PVT testing is a Government quality assurance function that includes systems trending and field tests. Commissioning is a quality control function that is the Commissioning Team’s responsibility to the extent required by this contract.

3.6.3 Performance Verification Testing of Equipment with Packaged Controls

Controls Contractor and Equipment Supplier(s) must share and coordinate PVT testing responsibilities for equipment provided with on-board factory packaged controls such as boiler controllers, dedicated outside air systems (DOAS's), and packaged pumping systems.

3.6.3.1 Controls Contractor Responsibilities

The Controls Contractor must provide a PVT Plan separate from Equipment Supplier's performance verification testing plan, perform endurance testing, and perform PVT testing concurrent with Equipment Suppliers' testing for equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment enabling and disabling.

b. Equipment standard and optional control points necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarms critical to safe operation regardless if specified in contract documents or not.

d. All control points added by Controls Contractor in addition to onboard factory packaged controls regardless if specified in contract documents or not.

Refer to paragraphs titled "Performance Verification Test Plan" and "Endurance Testing" for additional information.

3.6.3.2 Equipment Supplier Responsibilities

Each Equipment Supplier must provide PVT Plans separate from Controls Contractor's plans and perform PVT testing concurrent with Controls Contractor's testing for their equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment standard and optional control features necessary to accomplish functionality regardless if specified in contract documents or not.

b. Equipment standard and optional operation modes necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarm conditions for safe operation regardless if specified in contract documents or not.

Refer to all paragraphs under paragraph titled "Performance Verification Testing" except for section titled "Endurance Testing" for additional information.

3.6.4 Sequencing of Performance Verification Testing Activities

PVT activities must be sequenced with major activities listed below for Test and Balance (TAB) Contractor, Equipment Suppliers, Commissioning Specialists, and others to demonstrate fully functioning systems. Refer to Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS). Complete the items in TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES as

schedule activities or milestones.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
1	Submission, review, and approval of Control Contractors PVT Plans.
2	Submission, review, and approval of Equipment Suppliers PVT Plans.
3	Submission, review, and approval of certified final Test and Balance Report.
4	Conduct commissioning functional performance tests.
5	Submission, review, and approval of all of the Commissioning Specialists completed functional performance tests.
6	Request Contracting Officer to allow beginning of Government-witnessed PVT testing.
7	Contracting Officers approval to begin PVT testing.
8	Conduct PVT field work.
9	Governments verbal approval of PVT field work for all systems.
10	Conduct Test and Balance verification field work.
11	Governments written approval of Test and Balance verification field work.
12	Submission, review, and approval of endurance testing.
13	Governments written approval of PVT field work for all systems.
14	Facility acceptance recommendation.
15	Submission, review, and approval of Control Contractors PVT Report.
16	Submission, review, and approval of Equipment Suppliers PVT Report.
17	Conduct applicable re-testing and seasonal testing within 10 months of beneficial occupancy.

3.6.4.1 PVT Testing for Multi-Phase Construction

For air moving systems except outside air systems serving multiple phases, all major activities listed in TABLE III through Government’s verbal approval of Test and Balance verification field work can be completed by phase if all ductwork construction is completed for that phase.

For primary systems such as chilled water systems, HVAC heating hot water systems, and outside air systems serving multiple phases, all major activities listed listed in TABLE III through Government’s verbal approval of Test and Balance verification field work for all air moving systems served by that primary system for that phase must be completed prior to

conducting PVT field work for that primary system.

3.6.5 Control Contractor's Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed control systems testing in this contract for approval prior to its use. Develop and use a single PVT Plan for each system with a unique control sequence. Systems sharing an identical control sequence can be tested using copies of the PVT Plan intended for these systems.

PVT Plans must include system-based, step-by-step test methods demonstrating system performs in accordance with contract document requirements. The Government may provide sample PVT Plans upon request. PVT Plans must include the following:

a. Control sequences from contract documents segmented such that each control algorithm, operation mode, and alarm condition is immediately followed by numbered test methods required to initiate a response, expected response, space for comments, and “pass" or "fail” indication for each expected response.

b. PVT Plans with control sequences from contract documents that are not segmented into parts will not be accepted.

c. Indication where assisting personnel are required such as Mechanical Contractor.

d. Signature and date lines for the Contractor's PVT administrator, Contractor's quality assurance representative, and Contracting Officer's representative acknowledging completion of testing.

3.6.6 Performance Verification Testing Sample Size

PVT testing sample sizes will be as follows:

a. 100-Percent of the following systems:

(1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

(2) air handling unit systems including all associated fans except for remote exhaust air fans

(3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

(1) air terminal units

(2) exhaust air fans

(3) terminal equipment such as fan coil units and unit heaters

3.6.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if

previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.6.7 Conducting Performance Verification Testing

At least 15 days prior to preferred test date, request the Contracting Officer to allow the beginning of Government-witnessed PVT testing. Provide an estimated time table required to perform testing of each system. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of testing. Testing personnel must be regularly employed in the testing and calibration of control systems. After receipt of Contracting Officer’s approval to begin testing, perform PVT testing using project's as-built (shop) control system drawings, project's design drawings, and approved PVT Plans.

During testing, identify deficiencies that do not meet contract document requirements. Deficiencies must be investigated, corrected with corrections documented, and re-tested at a later date following procedures for the initial PVT testing. The Government may require re-testing of any control system components affected by the original failed test.

3.6.8 Endurance Testing

3.6.8.1 General

Conduct endurance testing in conjunction with the PVT to demonstrate control loop stability and accuracy. For all control loops tested, record trend data of the control variables over time, demonstrating that the control loop responds to a sudden change of the control variable set point without excessive overshoot or undershoot. Conduct endurance testing for each system subject to PVT testing. Systems must be operating as normally anticipated during occupancy throughout endurance testing.

Endurance testing results must clearly demonstrate control loop stability and accuracy. Controlled loop outputs must be stable and accurately maintain each setpoint.

3.6.8.2 Hardware

~~[~~Use hardware provided in this contract for testing.~~]~~ ~~[Use Government furnished hardware for testing if available when endurance testing begins. If unavailable, the Contractor must provide suitable hardware for required testing.]~~

If insufficient buffer capacity exists to trend the entire endurance test, upload trend data during the course of endurance testing to ensure all trend data is retained. Lost trend data will require retesting of all control points for affected system(s).

3.6.8.3 Endurance Testing Results Format

Submit endurance testing results for each tested system in a graphical format complete with clear indication of value(s) for y-axis, value for

x-axis, and legend identifying each trended control point. The number of control points contained on a single graph must be such that all control points can be clearly visible. Control points must be logically grouped such that related points appear on a single graph. In addition, submit a separate comma separated value (CSV) file of raw trend data for each trended system. Each trended control point in CSV file must be clearly identified.

For control points recorded based on change of value, change of value for recording data must be clearly identified for each control point.

3.6.8.4 Endurance Testing Start, Duration, and Frequency

Trending of all control points for a given system must start at an identical date and time regardless of the basis of data collection. Duration of all endurance tests must be at least ~~[~~one-week~~][_____]~~.

Unless specified otherwise for control points recorded based on time, frequency of data collection must be ~~[~~15-minutes~~] [_____]~~. Frequency of data collection for specific types of control points is as follows:

3.6.8.4.1 Points Trended at One Minute Intervals

a. Temperature for supply air, return air, mixed air, supply water, and return water

b. Temperature for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

c. Flow for supply air, return air, outside air, chilled water, and HVAC heating hot water

d. Flow for exhaust air associated with energy recovery

e. Relative humidity for outside air and return air

f. Relative humidity for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

g. Command and status for control dampers and control valves

h. Speed for fans and pumps

i. Pressure for fans and pumps

3.6.8.4.2 Points Trended at 15 Minute Intervals

a. Temperature and relative humidity for zones

b. Temperature and relative humidity for outside air not associated with energy recovery

c. Command and status for equipment

d. Pressure relative to the outside for facility

3.6.8.5 Trended Control Points

Trended control points for each system must demonstrate each system performs in accordance with contract document requirements. Trended control points must include, but not be limited to, control points listed in contract document points list.

Minimum control points that are required to be trended for selected systems are listed below. These control points must be trended as applicable to this contract in addition to control points necessary to demonstrate systems perform in accordance with contract document requirements and those listed in contract document's points list.

[3.6.8.5.1 Air-Cooled Chiller Chilled Water System.

a. Chiller(s) command and status

b. Chiller isolation valve(s) command and status

c. Chilled water pump(s) actual speed

d. Chilled water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system flow setpoint and actual flow

g. Chilled water supply setpoint and actual temperature

h. Chilled water return actual temperature

i. Chilled water actual flow

j. Outside air actual dry-bulb temperature

]]3.6.8.5.2 HVAC Heating Hot Water System with Boiler.

a. Boiler(s) command and status

b. Boiler(s) isolation valve command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

~~][3.6.8.5.3 HVAC Heating Hot Water System with Steam-to-Hot Water Heat Exchanger.~~

~~a. Steam control valve(s) command~~

~~b. Heat exchanger isolation valve(s) command and status~~

~~c. HVAC heating hot water pump(s) actual speed~~

~~d. HVAC heating hot water pump(s) setpoint and actual differential pressure~~

~~e. Minimum flow bypass control valve command~~

~~f. Minimum system setpoint and actual flow~~

~~g. HVAC heating hot water supply setpoint and actual temperature~~

~~h. HVAC heating hot water return actual temperature~~

~~i. HVAC heating hot water actual flow~~

~~j. Outside air actual dry-bulb temperature~~

~~][~~3.6.8.5.3 Air Handling Unit with Relief Air Fan

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air setpoint and actual airflow

d. Minimum outside air control damper command

e. Economizer outside air control damper command

f. Facility setpoint and actual relative pressure

g. Return air actual dry-bulb temperature

h. Return air actual relative humidity

i. Return air control damper command

j. Relief air control damper command

h. Relief air fan actual speed

i. Mixed air setpoint and setpoint and actual temperature

j. Preheat coil leaving air setpoint and actual temperature

k. Preheat coil control actuator command

l. Cooling coil leaving air setpoint and actual temperature

m. Cooling coil control valve command

n. Supply air fan actual speed

o. Discharge air actual temperature

p. Supply air fan setpoint and actual static pressure

~~][3.6.8.5.4 Dedicated Outside Air System (DOAS)~~

~~a. Outside air actual dry-bulb temperature~~

~~b. Outside air actual relative humidity~~

~~c. Outside air isolation damper command and status~~

~~d. Outside air setpoint and actual airflow~~

~~e. Energy recovery wheel command, status, and actual speed~~

~~f. Energy recovery wheel's OA bypass control damper command and status~~

~~g. Energy recovery wheel's defrost cycle command and status~~

~~h. Energy recovery wheel's OA discharge air actual dry-bulb temperature~~

~~i. Energy recovery wheel's OA discharge air actual relative humidity~~

~~j. Preheat coil leaving air setpoint and actual temperature~~

~~h. Preheat coil control actuator command~~

~~i. Cooling coil leaving air setpoint and actual temperature~~

~~j. Cooling coil control valve command~~

~~k. Supply air fan actual speed~~

~~l. Reheat coil control valve command~~

~~m. Discharge air setpoint and actual temperature~~

~~n. Supply air fan setpoint and actual static pressure~~

~~o. Facility setpoint and actual relative pressure~~

~~p. Return air actual dry-bulb temperature~~

~~q. Return air actual relative humidity~~

~~r. Energy recovery wheel's EA bypass control damper command and status~~

~~s. Energy recovery wheel's EA discharge air actual dry-bulb temperature~~

~~t. Energy recovery wheel's EA discharge air actual relative humidity~~

~~u. Exhaust air fan actual speed~~

~~v. Exhaust air isolation damper command and status~~

~~][~~3.6.8.5.4 Series ~~Fan-Powered~~ Supply Air Terminal Units

a. Zone setpoint and actual dry-bulb temperature

~~b. Zone actual relative humidity~~

b~~c~~. Control damper command

~~d. Fan command and status~~

c~~e~~. Heating coil valve command

~~f~~d. Airflow actual value

~~g~~e. Leaving air actual temperature

~~]~~3.6.8.6 Endurance Testing Sample Size

Endurance Testing sample sizes ware as follows:

a. 100-Percent of the following systems:

(1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

(2) air handling unit systems including all associated fans except for remote exhaust air fans

(3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

(1) air terminal units

(2) exhaust air fans

(3) terminal equipment such as fan coil units and unit heaters

3.6.8.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.6.9 Performance Verification Test Report

Submit a PVT Report after receiving Government’s written approval of PVT field work that is intended to document test results and final control system sequences and settings prior to turnover. The PVT Report must contain the following:

a. Executive summary that briefly discusses results of each system's endurance testing and PVT testing and conclusions for each system.

b. Endurance testing for each system.

c. Completed PVT Plan for each system used during testing that includes hand written field notes and participant signatures.

d. Blank PVT Plan for each system approved prior to testing that is edited to reflect changes occurring during testing. Edits must be typed and must reflect changes to control sequences from contract documents, must reflect changes to numbered test methods required to initiate a response, and must reflect changes to expected response. Only one blank PVT Plan is required for each set of systems sharing an identical control sequence, such as air terminal units, exhaust air fans, fan coil units and unit heaters.

e. Written certification that the installation and testing of all systems are complete and meet all contract document requirements.

~~3.7 FINAL LNS DATABASE~~

~~Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.~~

~~Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.~~

3.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the

frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

Submit [2] [_____] copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

[3.8 MAINTENANCE AND SERVICE

Provide services, materials and equipment as necessary to maintain the entire system in an operational state as indicated for a period of one year from the date of final acceptance of the project. Minimize impacts on facility operations.

a. The integration of the system specified in this section into a Utility Monitoring and Control System must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period. Integration into a UMCS includes but is not limited to establishing communication between devices in the control system and the front end or devices in another system.

b. The changing of configuration properties must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period.

3.8.1 Description of Work

Provide adjustment and repair of the system including the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

3.8.2 Personnel

Use only service personnel qualified to accomplish work promptly and satisfactorily. Advise the Government in writing of the name of the designated service representative, and of any changes in personnel.

3.8.3 Scheduled Inspections

Perform two inspections at six-month intervals and provide work required. Perform inspections in [June and December][_____]. During each inspection perform the indicated tasks:

a. Perform visual checks and operational tests of equipment.

b. Clean control system equipment including interior and exterior surfaces.

c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test

instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all binary inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining binary inputs and outputs during the second inspection. If more than 20 percent of checked inputs or outputs failed the calibration check during any inspection, check and recalibrate all inputs and outputs during that inspection.

d. Run system software diagnostics and correct diagnosed problems.

e. Resolve any previous outstanding problems.

3.8.4 Scheduled Work

This work must be performed ~~[~~during regular working hours, Monday through Friday, excluding Federal holidays~~][_____]~~.

3.8.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel must be available to provide service to the system. A telephone number where the service supervisor can be reached at all times must be provided. Service personnel must be at the site within 24 hours after receiving a request for service. The control system must be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

3.8.6 Operation

After performing scheduled adjustments and repairs, verify control system operation as demonstrated by the applicable tests of the performance verification test.

3.8.7 Records and Logs

Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. Maintain a continuous log for all devices, including initial analog span and zero calibration values and digital points. Keep complete logs and provide logs for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

3.8.8 Work Requests

Record each service call request as received and include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. Submit a record of the work performed within 5 days after work is accomplished.

3.8.9 System Modifications

Submit recommendations for system modification in writing. Do not make system modifications, including operating parameters and control settings, without prior approval of the Government.

]3.9 TRAINING

Conduct a training course for [_____] operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct [32] [_____] hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment)of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.9.1 Training Documentation

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the [Controls][HVAC][Electrical] shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

3.9.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.9.3 Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and [2][_____] additional copies for archive at the project site. Provide [2][_____] copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

This checklist is for (circle one:)

Pre-Construction QC Checklist Submittal

Post-Construction QC Checklist Submittal

Close-out QC Checklist Submittal

Items verified for Pre Construction, Post Construction and Closeout QC Checklist Submittals:

1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|

Items verified for Post Construction and Closeout QC Checklist Submittals:

4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|
6	All DDC Hardware is installed on a TP/FT 10 Channel.	|____|
7	All Application Specific Controllers (ASCs) are LonMark certified.	|____|
8	Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used.	|____|
9	Explicit messaging has not been used.	|____|
10	Scheduling is performed in DDC Hardware meeting the Simple Schedule Functional Profile	|____|

Items verified for Closeout QC Checklist Submittal:

	QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS	
11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
12	Programming software has been submitted for all programmable controllers.	|____|
13	All software has been licensed to the Government.	
14	O&M Instructions have been completed and submitted.	|____|
15	Training course has been completed.	|____|
16	LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system.	|____|
17	LNS Plug ins have been submitted for all Application Specific Controllers (ASCs).	|____|
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	|____|
	_____ _____	
	(QC Representative Signature) (Date)	

	QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS	
	This checklist is not all inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.	
	This checklist is for (circle one:) _____ Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal	
	Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:	
1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|

	QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS	
2	Signal lines on Control System Schematic are labeled with the signal type.	
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	
	Items verified for Post-Construction and Closeout QC Checklist Submittals:	
4	All sequences are performed as specified using DDC Hardware.	
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	
6	All DDC Hardware except Niagara Framework Supervisory Gateways is installed on a TP/FT 10 Channel.	
7	All Application Specific Controllers (ASCs) are LonMark certified.	
8	Except for communication between two Niagara Framework Supervisory Gateways, Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. Communication between Niagara Framework Supervisory Gateways is via Fox Protocol.	
9	Explicit messaging has not been used.	
10	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services.	
	Items verified for Closeout QC Checklist Submittal:	
11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	
12	Programming software has been submitted for all programmable controllers.	
13	All software has been licensed to the Government.	
14	O&M Instructions have been completed and submitted.	
15	Training course has been completed.	
16	The database in each Niagara Framework Supervisory Gateway is up to date and accurately represents the building control network beneath that Niagara Framework Supervisory Gateway.	
17	Niagara Wizards have been submitted for all Application Specific Controllers (ASCs) for which a Wizard is available and for all Application Generic Controllers (AGCs).	

	~~QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS~~	
~~18~~	~~Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).~~	~~|____|~~
	_____ _____	
	~~(QC Representative Signature) (Date)~~	

	QC CHECKLIST FOR BACNET SYSTEMS	
	This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.	
	This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal	
	Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:	
1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|
	Items verified for Post-Construction and Closeout QC Checklist Submittals:	
4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|
	Items verified for Closeout QC Checklist Submittal:	

QC CHECKLIST FOR BACNET SYSTEMS

6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
7	Programming software has been submitted for all programmable controllers.	|____|
8	All software has been licensed to the Government.	
9	O&M Instructions have been completed and submitted.	|____|
10	Training course has been completed.	|____|
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	|____|
12	All DDC Hardware is BTL listed.	|____|
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	|____|
14	Scheduling, Alarming, and Trending have been implemented using the standard BACnet Objects for these functions.	|____|
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	|____|

_____ _____

(QC Representative Signature) (Date)

~~**QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS**~~

~~This checklist is not all inclusive of the requirements of this specification and should not be interpreted as such.~~

~~Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.~~

~~This checklist is for (circle one:)~~

~~Pre-Construction QC Checklist Submittal~~

~~Post-Construction QC Checklist Submittal~~

~~Close-out QC Checklist Submittal~~

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

1	All DDC Hardware is numbered on Control System Schematic Drawings.	
2	Signal lines on Control System Schematic are labeled with the signal type.	
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	

Items verified for Post-Construction and Closeout QC Checklist Submittals:

4	All sequences are performed as specified using DDC Hardware.	
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	

Items verified for Closeout QC Checklist Submittal:

6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	
7	Programming software has been submitted for all programmable controllers.	
8	All software has been licensed to the Government.	
9	O&M Instructions have been completed and submitted.	
10	Training course has been completed.	
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	
12	All DDC Hardware is BTL listed.	
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	
14	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services, and BACnet Instrinsic Alarming as indicated.	
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	

_____ _____

	~~QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS~~
	~~(QC Representative Signature) (Date)~~

-- End of Section --

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
11/15, CHG 2: 05/21

PART 1 GENERAL

1.1 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 01 30 00 ADMINISTRATIVE REQUIREMENTS

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 05 15 COMMON PIPING FOR HVAC

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	((2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End

ASTM INTERNATIONAL (ASTM)

ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2021) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA/ANSI C12.10	(2011) Physical Aspects of Watthour Meters - Safety Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4)

National Electrical Code

NFPA 90A (2021) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 555 (2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers

UL 555S (2014; Reprint Oct 2020) UL Standard for Safety Smoke Dampers

UL 5085-3 (2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 SUBMITTALS

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.6 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

1.7 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph entitled CONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

2.1.2.3 Temperature

a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of ~~[~~-35 to +151 degrees F~~]~~ ~~[_____]~~ and temperature conditions outside this range normally encountered at the installed location.

2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

2.2 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

~~[2.3 TUBING~~

~~2.3.1 Copper~~

~~Provide ASTM B75/B75M or ASTM B88 rated tubing meeting the following requirements:~~

~~a. For tubing 0.375 inch outside diameter and larger provide tubing with minimum wall thickness equal to ASTM B88, Type M~~

~~b. For tubing less than 0.375 inch outside diameter provide tubing with minimum wall thickness of 0.025 inch~~

~~c. For exposed tubing and tubing for working pressures greater than 30 psig provide hard copper tubing.~~

~~d. Provide fittings which are ASME B16.18 or ASME B16.22 solder type using ASTM B32 95-5 tin-antimony solder, or which are ASME B16.26 compression type.~~

~~2.3.2 Stainless Steel~~

~~For stainless steel tubing provide tubing conforming to ASTM A269/A269M~~

~~2.3.3 Plastic~~

~~Provide plastic tubing with the burning characteristics of linear low-density polyethylene tubing which is self-extinguishing when tested in~~

~~accordance with ASTM D635, has UL 94 V-2 flammability classification or better, and which withstands stress cracking when tested in accordance with ASTM D1693. Provide plastic-tubing bundles with Mylar barrier and flame-retardant polyethylene jacket.~~

~~2.3.4 Polyethylene Tubing~~

~~Provide flame-resistant, multiple polyethylene tubing in flame-resistant protective sheath with mylar barrier, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Single, unsheathed, flame-resistant polyethylene tubing may be used where concealed in walls or above ceilings and within control panels. Do not provide polyethylene tubing for [systems indicated as critical and] smoke removal systems, or for systems with working pressures over 30 psig. Provide compression or brass barbed push-on type fittings. Provide extruded seamless polyethylene tubing conforming to the following:~~

~~a. Minimum Burst Pressure Requirements: 100 psig at 75 degrees F to 25 psig at 150 degrees F.~~

~~b. Stress Crack Resistance: ASTM D1693, 200 hours minimum.~~

~~c. Tensile Strength (Minimum): ASTM D638, 1100 psi.~~

~~d. Flow Rate (Average): ASTM D1238, 0.30 decigram per minute.~~

~~e. Density (Average): ASTM D792, 57.5 pounds per cubic feet.~~

~~f. Burn rate: ASTM D635~~

~~g. Flame Propagation: UL 1820, less than 5 feet ASTM D635~~

~~h. Average Optical Density: UL 1820, less than 0.15 ASTM D635~~

~~]~~2.3 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.3.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.3.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.3.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.3.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.4 AUTOMATIC CONTROL VALVES

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 ~~[~~Class III leakage rating~~]~~~~[Class IV leakage rating ~~]~~. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the Close-Off pressure and which are Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

2.4.1 Valve Type

2.4.1.1 Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.1.2 Liquid Service Above 150 Degrees F

a. Two-position valves: Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

b. Modulating valves: Use globe valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.1.3 Steam Service

Use globe valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.2 Valve Flow Coefficient and Flow Characteristic

2.4.2.1 Two-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide equal-percentage flow characteristic for liquid service except for butterfly valves. Provide linear flow characteristic for steam service except for butterfly valves.

2.4.2.2 Three-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide linear flow characteristic with constant total flow throughout full plug travel.

2.4.3 Two-Position Valves

Use full line size full port valves with maximum available (Cv).

2.4.4 Globe Valves

2.4.4.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.4.2 Liquid Service Not Exceeding 250 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Provide valves with non-metallic parts suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol

2.4.4.3 Hot water service 250 Degrees F and above

a. Provide valve bodies conforming to ASME B16.34 Class 300. For valves 1 inch and larger provide valves with bodies which are carbon steel, globe type with welded ends. For valves smaller than 1 inch provide valves with socket-weld ends. Provide valves with virgin polytetrafluoroethylene (PTFE) packing. Provide valve and actuator combinations which are normally closed.

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

2.4.4.4 Steam Service

For steam service, provide valves meeting the following requirements:

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: complete body of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: body of brass, bronze, or carbon steel

(3) valves 4 inches and larger: body of carbon steel. 2 inch valves with threaded connections; valves2-1/2 inches and larger with flanged connections.

b. Internal Trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Valve sizing: sized for ~~[~~15 psig~~]~~ ~~[_____]~~inlet steam pressure with a maximum ~~[~~12 psi~~]~~ ~~[_____]~~differential through the valve at rated flow, except where indicated otherwise.

2.4.5 Ball Valves

2.4.5.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 2 inch valves with threaded connections; valves from 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.6 Butterfly Valves

Provide butterfly valves which are threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies or with ductile iron bodies in accordance with ASTM A536. Provide butterfly valves with non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -20 to +250 degrees F. Provide valves with rated Cv of the Cv at 70 percent (60 degrees) open position. Provide valves meeting FCI 70-2 Class VI leakage rating.

~~2.4.7 Pressure Independent Control Valves (PICV)~~

~~Provide pressure independent control valves which include a regulator valve which maintains the differential pressure across a flow control valve. Pressure independent control valves must accurately control the flow from 0-100 percent full rated flow regardless of changes in the piping pressure and not vary the flow more than plus or minus 5 percent at any given flow control valve position when the PICV differential pressure lies between the manufacturer's stated minimum and maximum. The rated minimum differential pressure for steady flow must not exceed 5 psid across the PICV. Provide either globe or ball type valves meeting the indicated requirements for globe and ball valves. Provide valves with a flow tag listing full rated flow and minimum required pressure drop. Provide valves with factory installed Pressure/Temperature ports ("Pete's Plugs") to measure the pressure drop to determine the valve flow rate.~~

2.4.7 Duct-Coil and Terminal-Unit-Coil Valves

For duct or terminal-unit coils provide control valves with either flare-type or screw type~~[flare-type][screw type]~~ or solder-type ends. Provide flare nuts for each flare-type end valve.

2.5 DAMPERS

2.5.1 Damper Assembly

Provide single damper sections with blades no longer than 48 inches and which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness ~~[~~galvanized ~~][stainless]~~ steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.5.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.5.3 Damper Types

2.5.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 ~~[~~Class 1A ~~][Class 1][Class 2]~~ requirements. Outside air damper seals must be suitable for an operating temperature range of -40 to +167 degrees F. Dampers must be rated at not less than 2000 ft/min air velocity.

2.5.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide AMCA 511 class 3 dampers. Provide dampers rated at not less than 1500 ft/min air velocity.

2.5.3.3 Smoke Dampers

Provide smoke-damper and actuator assemblies which meet the current requirements of NFPA 90A, UL 555, and UL 555S. For combination fire and smoke dampers provide dampers rated for 250 degrees F Class II leakage per UL 555S.

2.6 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.6.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.6.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER

BUILDING CONTROL SYSTEMS when used in a Lonworks network, or the requirements of 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a BACnet network.

2.6.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.6.3.1 Sensor Accuracy and Stability of Control

2.6.3.1.1 Conditioned Space Temperature

Plus or minus 0.5 degree F over the operating range.

2.6.3.1.2 Unconditioned Space Temperature

a. Plus or minus 1 degree F over the range of 30 to 131 degrees F AND

b. Plus or minus 4 degrees F over the rest of the operating range.

2.6.3.1.3 Duct Temperature

Plus or minus 0.5 degree F

2.6.3.1.4 Outside Air Temperature

a. Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND

b. Plus or minus 1 degree F over the range of 30 to 130 degrees F.

2.6.3.1.5 High Temperature Hot Water

Plus or minus 3.6 degrees F.

2.6.3.1.6 Chilled Water

Plus or minus 0.8 degrees F over the range of 35 to 65 degrees F.

2.6.3.1.7 Dual Temperature Water

Plus or minus 2 degrees F.

2.6.3.1.8 Heating Hot Water

Plus or minus 2 degrees F.

~~2.6.3.1.9 Condenser Water~~

~~Plus or minus 2 degrees F.~~

2.6.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.25 degrees F per year.

2.6.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.6.3.4 Temperature Sensor Details

2.6.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.6.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.6.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

2.6.3.4.4 Pipe Immersion Type

For pipes with larger than 3 inch diameter, provide minimum 3 inch immersion. For pipes with less than 3 inch diameter, provide immersion at least half the diameter of the pipe. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

2.6.3.4.5 Outside Air Type

Provide the sensing element rated for outdoor use

2.6.4 Relative Humidity Sensor

Relative humidity sensors must use bulk polymer resistive or thin film capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors must include removable protective membrane filters. Where required for exterior installation, sensors must be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor must be capable of being exposed to a condensing air stream (100 percent relative humidity) with no adverse effect to the sensor's calibration or other harm to the instrument. The sensor must be of the wall-mounted or duct-mounted type, as required by the application, and must be provided with any required accessories. Sensors used in duct high-limit applications must have a bulk polymer resistive sensing element. Duct-mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Relative humidity (RH) sensors must measure relative humidity over a range of 0 percent to 100 percent with an accuracy of plus or minus ~~[~~2~~][3]~~ percent. RH sensors must function over a temperature range of 40

to 135 degrees F and must not drift more than 1 percent per year.

2.6.5 Carbon Dioxide (CO2) Sensors

Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersible infrared (NDIR) technology with an accuracy of plus or minus 50 ppm and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing). The sensor must have a maximum drift of 2 percent per year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Duct mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.6.6 Differential Pressure Instrumentation

2.6.6.1 Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2.6.6.2 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

2.6.7 Flow Sensors

2.6.7.1 Airflow Measurement Array (AFMA)

2.6.7.1.1 Airflow Straightener

Provide AFMAs which contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener must be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, must be constructed of 0.125 inch aluminum honeycomb and the depth of the straightener must not be less than 1.5 inches.

2.6.7.1.2 Resistance to Airflow

The resistance to air flow through the AFMA, including the airflow straightener must not exceed 0.085 inch water gauge at an airflow of 2,000 fpm. AFMA construction must be suitable for operation at airflows of up to 5000 fpm over a temperature range of 40 to 120 degrees F.

2.6.7.1.3 Outside Air Temperature

In outside air measurement or in low-temperature air delivery applications, provide an AFMA certified by the manufacturer to be accurate as specified over a temperature range of ~~[~~-20 to +120 degrees F~~]~~ ~~[_____]~~.

2.6.7.1.4 Pitot Tube AFMA

Each Pitot Tube AFMA must contain an array of velocity sensing elements. The velocity sensing elements must be of the multiple pitot tube type with averaging manifolds. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published installation instructions of the AFMA manufacturer.

a. Pitot Tube AFMAs for use in airflows over 600 fpm must have an accuracy of plus or minus 5 percent over a range of 500 to 2500 fpm.

b. Pitot Tube AFMAs for use in airflows under 600 fpm must have an accuracy of plus or minus 5 percent over a range of 125 to 2500 fpm.

2.6.7.1.5 Electronic AFMA

Each electronic AFMA must consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the AFMA manufacturer. Electronic AFMAs must have an accuracy of plus or minus 5 percent over a range of 125 to 5,000 fpm and the output must be temperature compensated over a range of 32 to 212 degrees F.

2.6.7.1.6 Fan Inlet Measurement Devices

Fan inlet measurement devices cannot be used unless indicated on the drawings or schedules.

2.6.7.2 Orifice Plate

Orifice plate must be made of an austenitic stainless steel sheet of 0.125 inch nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate must be flat within 0.002 inches. The orifice surface roughness must not exceed 20 micro-inches. The thickness of the cylindrical face of the orifice must not exceed 2 percent of the pipe inside diameter or 12.5 percent of the orifice diameter, whichever is smaller. The upstream edge of the orifice must be square and sharp. Where orifice plates are used, concentric orifice plates must be used in all applications except steam flow measurement in horizontal pipelines.

2.6.7.3 Flow Nozzle

Flow nozzle must be made of austenitic stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form must be elliptical and the nozzle throat must be the quadrant of an ellipse. The

thickness of the nozzle wall and flange must be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline must not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing must be such that the nozzle throat must be centered accurately in the pipe.

2.6.7.4 Venturi Tube

Venturi tube must be made of cast iron or cast steel and must have an accuracy of plus or minus 1 percent of full flow. The throat section must be lined with austenitic stainless steel. Thermal expansion characteristics of the lining must be the same as that of the throat casting material. The surface of the throat lining must be machined to a plus or minus 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2.6.7.5 Annular Pitot Tube

Annular pitot tube must be made of austenitic stainless steel with an accuracy of plus or minus 2 percent of full flow and a repeatability of plus or minus 0.5 percent of measured value. The unit must have at least one static port and no less than four total head pressure ports with an averaging manifold.

2.6.7.6 Insertion Turbine Flowmeter

Provide dual axial turbine flowmeter with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Insertion Turbine Flowmeter accuracy must be plus or minus 0.5 percent of rate at calibrated velocity., within plus or minus of rate over a 10:1 turndown and within plus or minus 2 percent of rate over a 50:1 turndown. Repeatability must be plus or minus 0.25 percent of reading. The meter flow sensing element must operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate. The flowmeter ,must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs. The turbine rotor assembly must be constructed of Series 300 stainless steel and use Teflon seals.

2.6.7.7 Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy must be within plus or minus 0.8 percent of the actual reading over the range of the meter. Steam meters must contain density compensation by direct measurement of temperature. Mass flow inferred from specified steam pressure are not acceptable. The flow meter body must be made of austenitic stainless steel and include a weather tight NEMA 4X electronics enclosure. The vortex shedding flowmeter body must not require removal from the piping in order to replace the shedding sensor.

2.6.7.8 Ultrasonic Flow Meter

Provide Ultrasonic Flow Meters complete with matched transducers, self aligning installation hardware and transducer cables. Ultrasonic transducers must be optimized for the specific pipe and process conditions for the application. The flow meter accuracy must plus or minus 1 percent

of rate from 0 to 40 ft/sec. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc output.

2.6.7.9 Insertion Magnetic Flow Meter

Provide insertion type magnetic flowmeters with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Flowmeter accuracy must be no greater than plus or minus 1 percent of rate from 2 to 20 feet/sec. Wetted material parts must be 300 series stainless steel. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

2.6.7.10 Positive Displacement Flow Meter

The flow meter must be a direct reading, gerotor, nutating disc or vane type displacement device rated for liquid service as indicated. A counter must be mounted on top of the meter, and must consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer must have a six digit register to indicate the volume passed through the meter in ~~[liters] [~~gallons~~]~~, and a sweep-hand dial to indicate down to 0.25 gallons. The pulse transmitter must have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter must have a bronze body with threaded or flanged connections as required for the application. Output accuracy must be plus or minus 2 percent of the flow range. The maximum pressure drop at full flow must be 5 psig.

2.6.7.11 Flow Meters, Paddle Type

Sensor must be non-magnetic, with forward curved impeller blades designed for water containing debris. Sensor accuracy must be plus or minus 1 percent of rate of flow, minimum operating flow velocity must be 1 foot per second. Sensor repeatability and linearity must be plus or minus 1 percent. Materials which will be wetted must be made from non-corrosive materials and must not contaminate water. The sensor must be rated for installation in pipes of 3 to 40 inch diameters. The transmitter housing must be a NEMA 250 Type 4 enclosure.

2.6.7.12 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.6.7.13 Gas Flow Meter

Gas flow meter must be diaphragm or bellows type (gas positive displacement meters) for flows up to 2500 SCFH and axial flow turbine type for flows above 2500 SCFH, designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter must have a minimum turndown ratio of 10 to 1 with an

accuracy of plus or minus 1 percent of actual flow rate. The meter index must include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. The electrical impulse dry contact output must not require field adjustment or calibration. The electrical impulse dry contact output must have a minimum resolution of 100 cubic feet of gas per pulse and must not exceed 15 pulses per second at the design flow.

2.6.8 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

2.6.8.1 Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus ~~[~~0.5~~]~~ ~~[2]~~ percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.6.8.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.6.8.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.6.8.4 Energy Metering

2.6.8.4.1 Watt or Watthour Transducers

Watt transducers must measure voltage and current and must output kW or kWh or both kW and kWh as indicated. kW outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1. kWh outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1.

2.6.8.4.2 Watthour Revenue Meter (with and without Demand Register)

All Watthour revenue meters must measure voltage and current and must be in accordance with ANSI C12.1 with an ANSI C12.20 Accuracy class of ~~[~~0.5~~]~~ ~~[0.2]~~ and must have pulse initiators for remote monitoring of Watthour consumption. Pulse initiators must consist of form C contacts with a current rating not to exceed two amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Meter sockets must be in accordance with NEMA/ANSI C12.10. Watthour revenue meters with demand registers must output instantaneous demand in addition to the pulse initiators.

2.6.8.4.3 Steam Meters

Steam meters must be the vortex type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal compatible with the DDC system.

2.6.8.4.4 Hydronic BTU Meters

The BTU meter is to be supplied with wall mount hardware and be capable of being installed remote from the flow meter. The BTU meter must include an LCD display for local indication of energy rate and for display of parameters and settings during configuration. Each BTU meter must be factory configured for its specific application and be completely field configurable by the user via a front panel keypad (no special interface device or computer required). The unit must output Energy Rate, Energy Total, Flow Rate, Supply Temperature, and Return Temperature. An integral transmitter is to provide a linear analog or configurable pulse output signal representing the energy rate; and the signal must be compatible with building automation system DDC Hardware to which the output is connected.

2.6.9 pH Sensor

The sensor must be suitable for applications and chemicals encountered in water treatment systems of boilers, chillers and condenser water systems. Construction, wiring, fittings and accessories must be corrosion and chemical resistant with fittings for tank or suspension installation. Housing must be polyvinylidene fluoride with O-rings made of chemical resistant materials which do not corrode or deteriorate with extended exposure to chemicals. The sensor must be encapsulated. Periodic replacement must not be required for continued sensor operation. Sensors must use a ceramic junction and pH sensitive glass membrane capable of withstanding a pressure of 100 psig at 150 degrees F. The reference cell must be double junction configuration. Sensor range must be 0 to 12 pH, stability 0.05, sensitivity 0.02, and repeatability of plus or minus 0.05 pH value, response of 90 percent of full scale in one second and a linearity of 99 percent of theoretical electrode output measured at 76 degrees F.

2.6.10 Oxygen Analyzer

Oxygen analyzer must consist of a zirconium oxide sensor for continuous sampling and an air-powered aspirator to draw flue gas samples. The analyzer must be equipped with filters to remove flue air particles. Sensor probe temperature rating must be 815 degrees F. The sensor assembly must be equipped for flue flange mounting.

~~2.6.11 Carbon Monoxide Analyzer~~

~~Carbon monoxide analyzer must consist of an infrared light source in a weather proof steel enclosure for duct or stack mounting. An optical detector/analyzer in a similar enclosure, suitable for duct or stack mounting must be provided. Both assemblies must include internal blower systems to keep optical windows free of dust and ash at all times. The third component of the analyzer must be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing devices must be provided. Unit must read parts per million (ppm) of carbon monoxide in the range of [_____] to [_____] ppm and the response~~

~~time must be less than 3 seconds to 90 percent value. Unit measurement range must not exceed specified range by more that 50 percent. Repeatability must be plus or minus 1 percent of full scale with an accuracy of plus or minus 1 percent of full scale.~~

2.6.11 Occupancy Sensors

Occupancy sensors must have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a setpoint of 15 minutes. Adjustments accessible from the face of the unit are preferred. Occupancy sensors must be rated for operation in ambient air temperatures ranging from 40 to 95 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches must have an auto-off switch. Wall switch sensors must be decorator style and must fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs must be UL listed. In addition to any outputs required for lighting control, the occupancy sensor must provide an output for the HVAC control system.

2.6.11.1 Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors must have a multi-level, multi-segmented viewing lens and a conical field of view with a viewing angle of 180 degrees and a detection of at least 20 feet unless otherwise indicated or specified. PIR Sensors must provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors must be immune to false triggering from RFI and EMI.

2.6.11.2 Ultrasonic Occupancy Sensors

Ultrasonic sensors must operate at a minimum frequency 32 kHz and must be designed to not interfere with hearing aids.

2.6.11.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors must meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

2.6.12 Vibration Switch

Vibration switch must be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit must have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range must be a true rms reading, suitable for the application. The unit must include either displacement response for low speed or velocity response for high speed application. The frequency range must be at least 3 Hz to 500 Hz. Contact time delay must be 3 seconds. The unit must have independent start-up and running delay on each switch contact. Alarm limits must be adjustable and setpoint accuracy must be plus or minus 10 percent of setting with repeatability of plus or minus 2 percent.

2.6.13 Conductivity Sensor

Sensor must include local indicating meter and must be suitable for measurement of conductivity of water in boilers, chilled water systems, condenser water systems, distillation systems, or potable water systems as

indicated. Sensor must sense from 0 to 10 microSeimens per centimeter (µS/cm) for distillation systems, 0 to 100 µS/cm for boiler, chilled water, and potable water systems and 0 to 1000 µS/cm for condenser water systems. Contractor must field verify the ranges for particular applications and adjust the range as required. The output must be temperature compensated over a range of 32 to 212 degrees F. The accuracy must be plus or minus 2 percent of the full scale reading. Sensor must have automatic zeroing and must require no periodic maintenance or recalibration.

2.6.14 Compressed Air Dew Point Sensor

Sensor must be suitable for measurement of dew point from -40 +80 degrees F over a pressure range of 0 to 150 psig. The transmitter must provide both dry bulb and dew point temperatures on separate outputs. The end to end accuracy of the dew point must be plus or minus 5 degrees F and the dry bulb must be plus or minus 1 degree F. Sensor must be automatic zeroing and must require no normal maintenance or periodic recalibration.

2.6.15 NOx Monitor

Monitor must continuously monitor and give local indication of boiler stack gas for NOx content. It must be a complete system designed to verify compliance with the Clean Air Act standards for NOx normalized to a 3 percent oxygen basis and must have a range of from 0 to 100 ppm. Sensor must be accurate to plus or minus 5 ppm. Sensor must output NOx and oxygen levels and binary output that changes state when the NOx level is above a locally adjustable NOx setpoint. Sensor must have normal, trouble and alarm lights. Sensor must have heat traced lines if the stack pickup is remote from the sensor. Sensor must be complete with automatic zero and span calibration using a timed calibration gas system, and must not require periodic maintenance or recalibration.

2.6.16 Turbidity Sensor

Sensor must include a local indicating meter and must be suitable for measurement of turbidity of water. Sensor must sense from 0 to 1000 Nephelometric Turbidity Units (NTU). Range must be field-verified for the particular application and adjusted as required. The output must be temperature compensated over a range of 32 to 212 degrees F. The accuracy must be plus or minus 5 percent of full scale reading. Sensor must have automatic zeroing and must not require periodic maintenance or recalibration.

2.6.17 Chlorine Detector

The detector must measure concentrations of chlorine in water in the range 0 to 20 ppm with a repeatability of plus or minus 1 percent of full scale and an accuracy of plus or minus 2 percent of full scale. The Chlorine Detector transmitter must be housed in a non-corrosive NEMA 250 Type 4X enclosure. Detector must include a local panel with adjustable alarm trip level, local audio and visual alarm with silence function.

2.6.18 Floor Mounted Leak Detector

Leak detectors must use electrodes mounted at slab level with a minimum built-in-vertical adjustment of 0.125 inches. Detector must have a binary output. The indicator must be manual reset type.

2.6.19 Temperature Switch

2.6.19.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2.6.19.2 Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) must have a field adjustable setpoint between 60 and 90 degrees F, an accuracy of plus or minus 3.6 degrees F and a 10 degrees F fixed deadband. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon change of temperature above or below setpoint as indicated.

2.6.20 Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.6.21 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor must monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor must automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

~~[2.7 INDICATING DEVICES~~

~~All indicating devices must display readings in [metric (SI)][English (inch-pound)] units.~~

~~2.7.1 Thermometers~~

~~Provide bi-metal type thermometers at locations indicated. Thermometers must have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.~~

~~2.7.1.1 Piping System Thermometers~~

~~Piping system thermometers must have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Piping system thermometers must have an accuracy of plus or minus 1 percent of scale range. Thermometers for piping systems must have rigid stems with straight, angular, or inclined pattern. Thermometer stems must have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem must be filled with a heat-transfer medium.~~

~~2.7.1.2 Air-Duct Thermometers~~

~~Air-duct thermometers must have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.~~

~~2.7.2 Pressure Gauges~~

~~Provide pipe-mounted pressure gauges at the locations indicated. Gauges must conform to ASME B40.100 and have a 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.~~

~~Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.~~

~~2.7.3 Low Differential Pressure Gauges~~

~~Gauges for low differential pressure measurements must be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and must have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus two percent of scale range.~~

~~[2.7.4 Pressure Gauges for Pneumatic Controls~~

~~Gauges must [have a 0 to 30 psi scale][sufficient scale to display the full range of expected pressures] with 1 psi graduations.~~

~~]]~~2.7 OUTPUT DEVICES

2.7.1 Actuators

Actuators must be electric (electronic) ~~[or pneumatic as indicated]~~. All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. ~~[Electric actuators must provide position feedback to the controller as indicated.]~~ Actuators must smoothly and fully open or close

the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. ~~[Pneumatic actuators must be rated for 25 psi operating pressure except for high-pressure cylinder-type actuators.]~~ All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section ~~[23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [~~23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS~~]~~.

2.7.1.1 Valve Actuators

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2.7.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

~~[2.7.1.3 Positive Positioners~~

~~Positive positioners must be a pneumatic relay with a mechanical position feedback mechanism and an adjustable operating range and starting point.~~

~~]~~2.7.1.3 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

~~[2.7.1.4 Pneumatic Actuators~~

~~Provide piston or diaphragm type actuators with replaceable diaphragm/piston.~~

~~]2.7.2 Solenoid-Operated Electric to Pneumatic Switch (EPS)~~

~~Solenoid-Operated Electric to Pneumatic Switches (EPS) must accept a voltage input to actuate its air valve. Each valve must have three-port operation: common, normally open, and normally closed. Each valve must have an outer cast aluminum body and internal parts of brass, bronze, or stainless steel. The air connection must be a 0.38 inch NPT threaded connection. Valves must be rated for 50 psig.~~

~~2.7.3 Electric to Pneumatic Transducers (EP)~~

~~Electric to Pneumatic Transducers (EPs) must convert either a 4-20 mAdc input signal, a 0-10 Vdc input signal to a proportional 0 to 20 psig pneumatic output. The EP must withstand pressures at least 150 percent of the system supply air pressure (main air). EPs must include independent offset and span adjustment. Steady state air consumption must not be greater than 0.05 scfm. EPs must have a manual adjustable override for the EP pneumatic output. EPs must have sufficient output capacity to provide full range stroke of the actuated device in both directions within [90][_____] seconds.~~

2.7.2 Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.8 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

2.9 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements

of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

2.9.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

2.9.2 Space Sensor Module

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

a. A temperature indicating device.

b. A User Input Device which must adjust a temperature setpoint output.

c. A User Input Momentary Contact Button and an output to the control system indicating zone occupancy.

d. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.

e. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system..

f. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

~~[2.10 COMPRESSED AIR STATIONS~~

~~2.10.1 Air Compressor Assembly~~

~~Air compressors for pneumatic control systems must be the tank-mounted, electric motor driven, air cooled, reciprocating type with integral [duplex motors and compressors][single motor and compressor], tank, controller, [alternator switch,]pressure switch, belt guard[s], pressure relief valve, automatic moisture drain valve and must be supported by a steel base mounted on an air storage tank. Compressor piston speeds must not exceed 450 fpm. Provide compressors with a dry-type combination intake air filter and silencer with baked enamel steel housing. The filter must be 99 percent efficient at 10 microns. The pressure switch must start the compressor[s] at 70 psig and stop the compressor[s] at 90 psig. The relief valve must be set for 10 to 25 psig above the control~~

switch cut-off pressure. Provide compressor capacity suitable for not more than a [33] [50] percent run time, at full system control load. Compressors must have a combination type magnetic starter with undervoltage protection and thermal-overload protection for each phase and must automatically restart after a power outage. Motors 0.5 hp and larger must be three-phase.[

A second (duplex arrangement) compressor of capacity equal to the primary compressor must be provided, with interlocked control to provide automatic changeover upon malfunction or failure of either compressor. A manual selector switch must be provided to index the lead compressor including the automatic changeover.]

2.10.2 Compressed Air Station Specialties

2.10.2.1 Refrigerated Air Dryers

Provide each air compressor tank with a refrigerant air dryer sized for continuous operation at full delivery capacity of the compressor. The air must be dried at a pressure of not less than 70 psi to a temperature not greater than 35 degrees F and an ambient air temperature between 55 and 95 degrees F. The dryer must be provided with an automatic condensate drain trap with manual override feature with an adjustable cycle and drain time. Locate each dryer in the air piping between the tank and the pressure-reducing station. The refrigerant used in the dryer must be one of the fluorocarbon gases and have an Ozone Depletion Potential of not more than 0.05. A five micron pre-filter and coalescing-type 0.03 micron oil removal filter with shut-off valves must be provided in the dryer discharge.

2.10.2.2 Compressed Air Discharge Filters

Provide a disposable type in-line filter in the incoming pneumatic main at each pneumatic control panel. The filter must be capable of eliminating 99.99 percent of all liquid or solid contaminants 0.1 micron or larger. Provide the filter with fittings that allow easy removal/replacement. Each filter bowl must be rated for 150 psi maximum working pressure. A pressure regulator, with high side and low side pressure gauges, and a safety valve must be provided downstream of the filter.

2.10.2.3 Air Pressure-Reducing Stations

Provide air compressors with a pressure-reducing valve (PRV) with a field adjustable range of 0 to 50 psig discharge pressure, at an inlet pressure of 70 to 90 psig. Provide a factory-set pressure relief valve downstream of the PRV to relieve over-pressure. Provide a pressure gage upstream of the PRV with range of 0 to 100 psig and downstream of the PRV with range of. For two-pressure control systems, provide an additional PRV and downstream pressure gage. Pressure regulators of the relieving type must not be used.

2.10.2.4 Flexible Pipe Connections

The flexible pipe connections must be designed for 150 psi and 250 degrees F service, and must be constructed of rubber or tetrafluoroethylene resin tubing with a reinforcing protective cover of braided corrosion-resistant steel, bronze, monel, or galvanized steel. The connectors must be suitable for the service intended and must have threaded or soldered ends. The length of the connectors must be as recommended by the manufacturer for the service intended.

~~2.10.2.5 Vibration Isolation Units~~

~~The vibration isolation units must be standard products with published loading ratings, and must be single rubber-in-shear, double rubber-in-shear, or spring type.~~

~~2.10.3 Compressed Air Tanks~~

~~The air storage tank must be fabricated for a working pressure of not less than 200 psi and constructed and certified in accordance with ASME BPVC SEC VIII D1. The tank must be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 20 psi. The tank must be provided with an automatic condensate drain trap with manual override feature. Provide drain valve and piping routing the drainage to a floor sink or other safe and visible drainage location.~~

~~]~~PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

3.1.1.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

3.1.2 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the

sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

3.1.3 Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, ~~[60][~~48~~]~~ inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

a. Space Sensor Modules for Fan Coil Units may be either unit or wall mounted but not mounted on an exterior wall.

b. Wall mount all other Space Sensor Modules.

3.1.4 Indication Devices Installed in Piping and Liquid Systems

Provide snubbers for gauges in piping systems subject to pulsation. For gauges for steam service use pigtail fittings with cock. Install thermometers and temperature sensing elements in liquid systems in thermowells. Provide spare Pressure/Temperature Ports (Pete's Plug) for all temperature and pressure sensing elements installed in liquid systems for calibration/testing.

3.1.5 Occupancy Sensors

Provide a sufficient quantity of occupancy sensors to provide complete coverage of the area (room or space). Occupancy sensors are to be ceiling mounted. Install occupancy sensors in accordance with NFPA 70 requirements and the manufacturer's instructions. Do not locate occupancy sensors within 6 feet of HVAC outlets or heating ducts, or where they can "see" beyond any doorway. Installation above doorway(s) is preferred. Do not use ultrasonic sensors in spaces containing ceiling fans. Install sensors to detect motion to within 2 feet of all room entrances and to not trigger due to motion outside the room. Set the off-delay timer to ~~[~~15 ~~][_____]~~ minutes unless otherwise indicated. Adjust sensors prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. For each controlled area, provide one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

3.1.6 Switches

3.1.6.1 Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature limit switches (freezestats) to provide complete coverage of the duct section but no less than 1 foot in length per square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

3.1.6.2 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.7 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer's instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.7.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors ~~[5 feet above the finished floor][~~48 inches above the floor to meet ADA requirements~~]][at the height[s] indicated]~~. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.7.2 Duct Temperature Sensors

3.1.7.2.1 Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions.Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

3.1.7.2.2 Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.7.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accommodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to

less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

3.1.7.4 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.8 Air Flow Measurement Arrays (AFMA)

Locate Outside Air AFMAs downstream from the Outside Air filters.

Install AFMAs with the manufacturer's recommended minimum distances between upstream and downstream disturbances. Airflow straighteners may be used to reduce minimum distances as recommended by the AFMA manufacturer.

3.1.9 Duct Static Pressure Sensors

Locate the duct static pressure sensing tap at 75 percent of the distance between the first and last air terminal units ~~[~~as indicated on the design documents~~]~~. If the transmitter output is a 0-10Vdc signal, locate the transmitter in the same enclosure as the air handling unit (AHU) controller for the AHU serving the terminal units. If a remote duct static pressure sensor is to be used, run the signal wire back to the controller for the air handling unit.

3.1.10 Relative Humidity Sensors

Install relative humidity sensors in supply air ducts at least 10 feet downstream of humidity injection elements.

3.1.11 Meters

3.1.11.1 Flowmeters

Install flowmeters to ensure minimum straight unobstructed piping for at least 10 pipe diameters upstream and at least 5 pipe diameters downstream of the flowmeter, and in accordance with the manufacturer's installation instructions.

3.1.11.2 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous demand/energy and other variables as indicated.

3.1.12 Dampers

3.1.12.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze

protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters nay be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.12.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.13 Valves

Install the valves in accordance with the manufacturer's instructions.

3.1.13.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and unit heaters are not required unless indicated otherwise.

3.1.14 Thermometers and Gauges

~~[3.1.14.1 Local Gauges for Actuators~~

~~Provide a pressure gauge at each pneumatic control input and output. Pneumatic actuators must have an accessible and visible pressure gauge installed in the tubing lines at the actuator as indicated.~~

~~]~~3.1.14.1 Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.15 Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges

from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways~~[, except low-voltage control and low-voltage network wiring may be installed as follows:~~

~~a. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways~~

~~b. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.]~~

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

3.1.16 Copper Tubing

Provide hard-drawn copper tubing in exposed areas and either hard-drawn or annealed copper tubing in concealed areas. Use only tool-made bends. Use only brass or copper solder joint type fittings, except for connections to apparatus. For connections to apparatus use brass compression type fittings.

3.1.17 Plastic Tubing

Install plastic tubing within covered raceways or conduit except when otherwise specified. Do not use plastic tubing for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. For fittings, use brass or acetal resin of the compression or barbed push-on type for instrument service. Except in walls and exposed locations, plastic multitube instrument tubing bundle without conduit or raceway protection may be used where a number of air lines run to the same points, provided the multitube bundle is enclosed in a protective sheath, is run parallel to the building lines and is adequately supported as specified.

~~[3.1.18 Pneumatic Lines~~

~~Run tubing concealed in finished areas, run tubing exposed in unfinished areas like mechanical rooms. For tubing enclosed in concrete, provide rigid metal conduit. Run tubing parallel and perpendicular to building walls. Use 5 foot maximum spacing between tubing supports. With the compressor turned off, test each tubing system pneumatically at 1.5 times the working pressure and prove it air tight, locating and correcting leaks as applicable. Caulking joints is not permitted. Do not run tubing and electrical power conductors in the same conduit.~~

~~a. Install pneumatic lines must such that they are not exposed to outside air temperatures. Conceal pneumatic lines except in mechanical rooms and other areas where other tubing and piping is exposed.~~

~~b. Install all tubes and tube bundles exposed to view in lines parallel to the lines of the building. Route tubing in mechanical/electrical so that the lines are easily traceable.~~

c. Purge air lines of dirt, impurities and moisture before connecting to the control equipment. Number-code or color-code air lines and key the coding in the As-Built Drawings for future identification and servicing the control system.

3.1.18.1 Pneumatic Lines In Mechanical/Electrical Spaces

In mechanical/electrical spaces, use plastic or copper tubing for pneumatic lines. Install horizontal and vertical runs of plastic tubing or soft copper tubing min raceways or rigid conduit dedicated to tubing. Support dedicated raceways, conduit, and hard copper tubing not installed in raceways every 6 feet for horizontal runs and every 8 feet for vertical runs.

3.1.18.2 Pneumatic Lines External to Mechanical/Electrical Spaces

External to mechanical/electrical spaces, use plastic tubing in raceways not containing power wiring or copper tubing with sweat fittings. Support raceways and tubing not in raceways every 8 feet. For pneumatic lines concealed in walls use hard-drawn copper tubing or plastic tubing in rigid conduit. Plastic tubing in a protective sheath, run parallel to the building lines and supported as specified, may be used above accessible ceilings and in other concealed but accessible locations.

3.1.18.3 Terminal Single Lines

For terminal single lines use hard-drawn copper tubing, except when the run is less than 12 inches in length, flexible polyethylene may be used.

3.1.18.4 Connection to Liquid and Steam Lines

Use [copper][Series 300 stainless steel] with [brass compression][stainless-steel compression] fittings for connection of sensing elements and transmitters to liquid and steam lines.

3.1.18.5 Connection to Ductwork

Use plastic tubing for connections to sensing elements in ductwork.

3.1.18.6 Tubing in Concrete

Install tubing in concrete in rigid conduit. Install tubing in walls containing insulation, fill, or other packing materials in raceways dedicated to tubing.

3.1.18.7 Tubing Connection to Actuators

For final connections to actuators use plastic tubing no more than 12 inches long and unsupported at the actuator.

]3.1.19 Compressed Air Stations

Mount the air compressor assembly on vibration eliminators, in accordance with ASME BPVC SEC VIII D1 for tank clearance. Connect the air line to the tank with a flexible pipe connector. Provide compressed air station specialties with required tubing, including condensate tubing to a floor drain. Compressed air stations must deliver control air meeting the requirements of ISA 7.0.01. Provide foundations and housekeeping pads for

~~the HVAC control system air compressors [in accordance with the air compressor manufacturer's instructions][as specified in Section 23 30 00 HVAC AIR DISTRIBUTION].~~

-- End of Section --

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
02/19, CHG 1: 02/20

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the front end ~~which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION~~, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

a. ~~Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 and Fox as the communications protocols. The system must use standard ASHRAE 135 Objects and Properties and the Niagara Framework. The system must use standard ASHRAE 135 Services and the Niagara Framework exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 or the Fox protocol exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two ASHRAE 135 devices on the Internetwork can communicate using standard ASHRAE 135 Services.~~

   Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 as the communications protocol. The system must use standard ASHRAE 135 Objects and Properties. The system must use standard ASHRAE 135 Services exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two devices on the Internetwork can communicate using standard ASHRAE 135 Services.

b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties ~~or Niagara Framework Objects~~as indicated and as needed to meet the requirements of this specification.

~~c. Use Niagara Framework hardware and software exclusively for scheduling, trending, and communication with a front end (UMCS). Use Niagara Framework or standard BACnet Objects and services for alarming. Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; use the ASHRAE 135 protocol for all other building communication. [Niagara Framework Supervisory Gateway must serve web pages as specified.]~~

~~d. Use Niagara Framework [AX][Version 4.0 or later][either AX or Version~~

~~4.0 or later].~~

1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Errata 2021) BACnet—A Data Communication Protocol for Building Automation and Control Networks

BACNET INTERNATIONAL (BTL)

BTL Guide	(v.49; 2017) BACnet Testing Laboratory Implementation Guidelines

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2018) Ethernet

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 916	(2015) Standard for Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1 NETWORK HARDWARE

2.1.1 BACnet Router

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware, and ~~except for Niagara Framework Supervisory Gateways, devices used as BACnet routers~~ must support the NM-RC-B BIBB.

2.1.2 BACnet Gateways

In addition to the requirements for DDC Hardware, the BACnet Gateway must ~~be a Niagara Framework Supervisory Gateway or must~~ meet the following requirements:

a. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.

b. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

c. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.

d. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements~~, except for Niagara Framework Supervisory Gateways,~~ they are not DDC Hardware and must not be used when DDC Hardware is required. ~~(Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)~~

2.1.3 Ethernet Switch

Ethernet Switches ~~[must be managed switches and]~~must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.2 CONTROL NETWORK WIRING

a. BACnet MS/TP communications wiring must be in accordance with ASHRAE 135. The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than

30 pF per foot.

b. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of IEEE 802.3 ~~[and [_____]]~~.

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

a. It must be locally powered and must incorporate a light to indicate the device is receiving power.

b. It must conform to the BTL Guide

c. It must be BACnet Testing Laboratory (BTL) Listed.

d. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

e. It must communicate and be interoperable in accordance with ASHRAE 135 and have connections for BACnet IP or MS/TP control network wiring.

f. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.

g. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.

h. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:

(1) Application programs must persist regardless of the length of time power is lost.

(2) Configured settings must persist for any loss of power less than 2,500 hours.

(3) Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.

i. Internal Clocks:

(1) Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

(2) DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.

j. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects ~~or Niagara~~

~~Framework Points~~ as specified and as indicated on the Points Schedule.

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).

l. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

m. ~~Except for Niagara Framework Supervisory Gateways,~~ Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION

n. User interfaces which allow for modification of Properties or settings must be password-protected.

o. Devices communicating BACnet MS/TP must meet the following requirements:

(1) Must have a configurable Max_Master Property.

(2) DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max_Info_Frames Property.

(3) Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".

(4) Must use twisted pair with reference and shield (3-wire media) wiring~~[, or twisted pair with shield (2-wire media) wiring and use half-wave rectification]~~.

p. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.

q. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.

r. ~~Except for Niagara Framework Supervisory Gateways,~~ DDC Hardware controlling a single terminal unit must have:

(1) Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.

(2) A configurable Device Object Name.

(3) A configurable Device Object Description Property at least 16 characters in length.

s. Except for Objects in ~~either Niagara Framework Supervisory Gateways or~~ DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:

(1) Have a configurable Object Name Property of at least 12 characters in length.

(2) Have a configurable Object Description Property of at least 24 characters in length.

t. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

u. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

2.3.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.2.2 Analog Outputs

DDC Hardware analog outputs (AOs) must be implemented using ASHRAE 135 Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output ~~[~~to 0 percent and to 100 percent ~~][through the range of 0 percent to 100 percent]~~

2.3.2.3 Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using ASHRAE 135 Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

2.3.2.4 Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using ASHRAE 135 Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the

output open or closed.

2.3.2.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.5 Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an ASHRAE 135 Accumulator Object or an ASHRAE 135 Analog Value Object where the Present_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against
transients of 50 VAC, and accept rates of at least 20 pulses per second.

2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of ASHRAE 135 objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

~~[2.3.2.7 Integrated H-O-A Switches~~

~~Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via the Niagara Framework or via any valid BACnet method, including the use of proprietary Objects, Properties, or Services.~~

~~]~~2.3.3 Local Display Panel (LDP)

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of ~~Niagara Framework points or~~ ASHRAE 135 Properties as indicated on the Points Schedule and as specified. LDPs must be either BTL Listed as a B-OD, B-OWS, B-AWS, or be an integral part of another piece of DDC Hardware listed as a B-BC. For LDPs listed as B-OWS or B-AWS, the hardware must be BTL listed and the product must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

2.3.4 Expansion Modules and Tethered Hardware

A single piece of DDC Hardware may consist of a base unit and also:

a. An unlimited number of hardware expansion modules, where the

individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.

b. A single piece of hardware connected (tethered) to a base unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

2.3.5 Supervisory Control Requirements

2.3.5.1 Scheduling Hardware

DDC Hardware used for scheduling must meet the following requirements:

a. It must be BTL Listed as a B-BC and support the SCHED-E-B BIBB.

b. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Calendar and Schedule Objects, such that a front end BTL listed as a B-AWS may create or delete Calendar and Schedule Objects. It is also preferred but not required that devices supporting the DM-OCD-B BIBB accept any valid value for properties of Calendar and Schedule Objects. Note that there are additional requirements in the EXECUTION Part of this Section for Devices which do not support the DM-OCD-B BIBB as specified.

c. The Date_List property of all Calendar Objects must be writable.

d. The Present_Value Property of Schedule must support the following values: 1, 2, 3, 4.

2.3.5.2 Alarm Generation Hardware

~~Non-Niagara Framework~~ DDC Hardware used for alarm generation must meet the following requirements:

a. Device must support the AE-N-I-B BIBB

b. The Recipient_List Property must be Writable for all Notification Class Objects used for alarm generation.

c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writable:

(1) Time_Delay
(2) High_Limit
(3) Low_Limit
(4) Deadband

(5) Event_Enable
(6) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.

~~d. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.~~

d. For Event Enrollment Objects used for alarm generation, the following Properties must be Writable:

(1) Event_Parameters
(2) Event_Enable
(3) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.

e. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects and Event Enrollment Objects, such that a front end BTL listed as a B-AWS may create or delete Notification Class Objects and Event Enrollment Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects and Event Enrollment Objects. Note that there are additional requirements in the EXECUTION Part of this Section for devices which do not support the DM-OCD-B BIBB as specified.

f. Devices provided to meet the the requirements indicated under "Support for Future Alarm Generation" in the EXECUTION part of this specification must support the AE-N-E-B BIBB.

2.3.5.3 Trending Hardware

DDC Hardware used for collecting trend data must meet the following requirements:

a. Device must support Trend Log or Trend Log Multiple Objects.

b. Device must support the T-VMT-I-B BIBB.

c. Devices provided to meet the EXECUTION requirement for support of Future Trending must support the T-VMT-E-B BIBB.

d. The following properties of all Trend Log or Trend Log Multiple Objects must be present and Writable:
Start_Time
Stop_Time
Log_DeviceObjectProperty
Log Interval Log interval must support an interval of at least 60 minutes duration.

e. Trend Log Objects must support using Intrinsic Reporting to send a BUFFER_FULL event.

f. The device must have a Notification Class Object for the BUFFER_FULL event. The Recipient_List Property must be Writable.

g. Devices must support values of at least 1,000 for Buffer_Size Properties.

h. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Trend Log Objects, such that a front end BTL listed as a A-AWS may create or delete Trend Log Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Trend Log Objects. Note that there are additional EXECUTION requirements for devices which do not support the DM-OCD-B BIBB as specified.

~~2.3.6 Niagara Framework Supervisory Gateway~~

~~Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:~~

~~a. Be direct digital control hardware.~~

~~b. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.~~

~~c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components, regardless of the manufacturer of the other components.~~

~~d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:~~

~~(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects~~

~~(2) Alarm generation and routing using the Niagara Alarm Service~~

~~(3) Trending using the Niagara History Service and Niagara Trend Log Objects~~

~~(4) Integration of field control networks using the Niagara Framework Engineering Tool~~

~~(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system~~

~~e. Meet the following minimum hardware requirements:~~

~~(1) [One][Two] 10/100/1000 Mbps Ethernet Port(s)~~

~~(2) One or more MS/TP ports.[~~

~~(3) Central Processing Unit of 600 Mhz or higher.][~~

~~(4) Embedded operating system.]~~

~~f. Provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on all~~

projects.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 NIAGARA FRAMEWORK ENGINEERING TOOL

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software must:

a. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. Be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. Be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. Be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

Monitoring and Control Software is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION3.1.1 Niagara Framework Engineering Tool

[The project site currently has the [_____] Niagara Framework Engineering Tool. If this software is not adequate for programming the Niagara Framework Supervisory Gateways provided under this project, provide a Niagara Framework Engineering Tool.][Provide a Niagara Framework Engineering Tool.]

3.1.1 Building Control Network (BCN)

Install the Building Control Network (BCN) as a single BACnet Internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except for the IP Network and as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

3.1.1.1 Building Control Network IP Backbone

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection

(FPOC) location ~~[~~as indicated~~][_____]~~. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network. ~~(Note that in a Niagara Framework system there may not be BACnet traffic on the IP Network)~~

3.1.1.2 BACnet MS/TP Networks

When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2012 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

a. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.

b. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.

c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.

d. For 18 AWG cable, use segments with a maximum length of 4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.

e. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.

f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.

g. Connect each MS/TP network to the BCN backbone via ~~a Niagara Framework Supervisory Gateway configured as~~ a BACnet Router.

h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.

i. Configure the Max_Master Property of all devices to be 31.

3.1.1.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

a. Install all DDC Hardware connected to the Building Control Network.

b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.

c. Traffic between BACnet networks must be exclusively via BACnet routers.

~~d. Use the Fox protocol for all traffic both originating and terminating at Niagara Framework components. Use the Fox protocol for all traffic originating or terminating at a Niagara Framework UMCS (including traffic to or from a future UMCS). All other traffic, including traffic between ASHRAE 135 devices and traffic between Niagara Framework Supervisory Gateways and ASHRAE 135 devices must be in accordance with ASHRAE 135.~~

3.1.2 DDC Hardware

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in ~~[~~ lockable ~~]~~enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

a. Except for zone sensors (thermostats), install all Tethered Hardware within 6 feet of its base unit.

b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.

c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

3.1.2.1 Device Identifiers, Network Addresses, and IP addresses

a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. ~~[~~Coordinate Device IDs and Network Numbers with the installation. ~~The installation POC is [_____]] [Use Device IDs within the range of [_____] to [_____] and Network Numbers in the range of [_____] to [_____]].~~

b. ~~[Use IP addresses within the range of [_____] to [_____]] [~~Coordinate device IP addresses with installation. ~~The installation POC is [_____]].~~

3.1.2.2 ~~ASHRAE 135~~ Object Name Property and Object Description Property

Configure the Object_Names and Object_Descriptions properties of all ~~ASHRAE 135~~ Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

a. Except for DDC Hardware controlling a single terminal unit, configure the Object_Name and Object_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.

b. In DDC Hardware controlling a single terminal unit, configure the Device Object_Name and Device Object_Description as indicated on the Points Schedule and as specified.

When Points Schedule entries exceed the length limitations in the device, notify the installation~~[_____]~~ and provide recommended alternatives for

approval.

~~3.1.2.3 Niagara Framework Point Names and Descriptions~~

~~Configure the names and descriptions of all Points in Niagara Framework Supervisory Gateways as indicated on the Points Schedule and as specified.~~

~~3.1.2.4 Niagara Station IDs~~

~~Ensure that Niagara Station IDs of new Niagara Framework Supervisory Gateways are maintained as unique within UMCS front-end, including ensuring they do not conflict with any existing Niagara Station ID.~~

3.1.2.3 Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches ~~[~~for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units, ~~]~~as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.

c. For eternal H-O-A switches used for analog outputs, provide for overriding ~~[~~to 0 percent or 100 percent~~][through the range of 0 percent to 100 percent]~~.

3.1.2.4 Local Display Panels

Provide LDPs to display and override values of ~~points in a Niagara Framework Supervisory Gateway or~~ ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units ~~[~~in a mechanical room central to the group of terminal units it serves~~][_____]~~. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 9.

3.1.2.5 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

3.1.2.6 Change of Value (COV) and Read Property

a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.

b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

3.1.2.7 Engineering Units

~~[Configure devices to use SI (Metric) units as follows:~~

~~a. Temperature in degrees C~~

~~b. Air or natural gas flows in Liters per Second (LPS)~~

~~c. Water flow in Liters per Second (LPS)~~

~~d. Steam flow in kilograms per second (kg/s)~~

~~e. Differential Air pressures in Pascals (Pa)~~

~~f. Water, steam and natural gas pressures in kiloPascals (kPa)~~

~~g. Enthalpy in kiloJoules per kilogram (kJ/kg)~~

~~h. Heating and Cooling Energy in kilowatt-hours (kWh)~~

~~i. Heating and Cooling load in kilowatts (kW)~~

~~j. Electrical Power: kilowatts (kW)~~

~~k. Electrical Energy: kilowatt-hours (kWh)]~~[Configure devices to use English (Inch-Pound) engineering units as follows:

a. Temperature in degrees F

b. Air or natural gas flows in cubic feet per minute (CFM)

c. Water in gallons per minute (GPM)

d. Steam flow in pounds per hour (pph)

e. Differential Air pressures in inches of water column (IWC)

f. Water, steam, and natural gas pressures in PSI

g. Enthalpy in BTU/lb

h. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU))

i. Cooling load in tons (1 ton = 12,000 BTU/hour)

j. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)

k. Electrical Power: kilowatts (kW)

l. Electrical Energy: kilowatt-hours (kWh)~~]~~

3.1.2.8 Occupancy Modes

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

a. OCCUPIED mode: a value of one
b. UNOCCUPIED mode: a value of two
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

3.1.2.9 Use of BACnet Objects

~~Except as specifically indicated for Niagara Framework Objects,~~ Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O) .

b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.

c. Use Analog Value Objects for analog setpoints.

d. Use Accumulator Objects or Analog Value Objects for pulse inputs.

e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.

f. Use Schedule Objects and Calendar Objects for all scheduling. Use Trend Log Objects or Trend Log Multiple Objects for all trending and Notification Class Objects for trend log upload. Use a combination of Event Enrollment Objects,Intrinsic Alarming, and Notification Class Objects for alarm generation.

~~f. Use a combination of Niagara Framework Alarm Extensions and Alarm Services, Intrinsic Alarming, and Notification Class Objects for alarm generation.~~

g. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

~~3.1.2.9.1 Niagara Framework Objects~~

~~Points in the Niagara Framework Supervisory Gateway, even if used in a sequence or are shown on the Points Schedule, are not required to be exposed as BACnet Objects unless they are required to be available on the network by another device or sequence of operation (i.e. there is some other reason they are needed).~~

~~Use a Niagara Framework Supervisory Gateway as specified for all scheduling and trending. Use a Niagara Framework Supervisory Gateway as specified for all alarming except for intrinsic alarming.~~

3.1.2.10 Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware ~~(including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware)~~ use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

3.1.2.11 Device Application Configuration

a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) BACnet services (including proprietary services)

(2) Hardware settings on the device

~~(3) The Niagara Framework~~

b. For every property, setting or value ~~in non-Niagara Framework Hardware~~ shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) A Writable Property of a standard BACnet Object

(2) A Property of a standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

~~(3) Using some other method supported by a Niagara Framework Supervisory Gateway~~

~~c. Configure Niagara Framework Supervisory Gateways such that the property, setting or value is configurable from a Niagara Framework Front End.~~

~~d. For every property, setting or value in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule or otherwise indicated as Operator Configurable, configure the value to be configurable from within the Niagara Framework such that it can be configured from a system graphic page at a Niagara Framework Front End.~~

~~3.1.2.12 Niagara Framework Engineering Tool~~

~~Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway. Ensure that all points on the points schedule are available to the front end via the Fox protocol.~~

~~[3.1.2.13 Graphics and Web Pages~~

~~Configure Niagara Framework Supervisory Gateways to use web pages to provide a graphical user interface including System Displays[using the project site sample displays], including overrides, as indicated on the Points Schedule and as specified. Label all points on displays with [full English language descriptions][the point name as indicated on the Points Schedule][the point description as indicated on the Points Schedule][_____]. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with [the~~

~~[Controls] [HVAC] [Electrical] shop supervisor][_____]. Configure the web server to use HTTPS based on the Transport Layer Security (TLS) protocol in accordance with RFC 5246 using a Government furnished certificate.~~

~~]~~3.1.3 Scheduling, Alarming, Trending, and Overrides

3.1.3.1 Scheduling

Configure schedules in BACnet Scheduling Objects to schedule systems as indicated on the Points Schedule and as specified using the indicated correspondence between value and occupancy mode. If no devices supports both the SCHED-E-B and DM-OCD-B BIBBS for Schedule Objects, provide ~~[~~5 ~~][_____]~~ blank Schedule Objects in DDC Hardware BTL listed as B-BCs and supporting the SCHED-E-B BIBB for later use by the site.
~~Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use the indicated correspondence between value and occupancy mode.~~

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service)~~[or group of stand-alone Terminal Units acting according to a common schedule[as indicated]]~~.

~~3.1.3.2 Alarm Configuration~~

~~Configure alarm generation and management as indicated on the Points Schedule and as specified. Configure alarm generation in Niagara Framework Supervisory Gateways using Niagara Framework Alarm Extensions and Alarm Services or in other DDC Hardware (not Niagara Framework Supervisory Gateways) using ASHRAE 135 Intrinsic Alarming. Configure alarm management and routing for all alarms, including those generated via intrinsic alarming in other devices, in the Niagara Framework Supervisory Gateway such that the alarms are able to be accessed from the Niagara Framework Front End.~~

~~Where Intrinsic Alarming is used, configure intrinsic alarming as specified in paragraph "Configuration of ASHRAE 135 Intrinsic Alarm Generation". Configure a Niagara Framework Supervisory Gateway to provide a means to configure the intrinsic alarm parameters such that the Intrinsic Alarm is configurable from the front end via the Niagara Framework.~~

3.1.3.2 Configuration of ~~ASHRAE 135 Intrinsic~~ Alarm Generation

~~Intrinsic alarm generation must meet the following requirements:~~

~~Configure alarm generation as indicated on the Points Schedule and as specified using Intrinsic Alarming in accordance with ASHRAE 135 or Algorithmic Alarming in accordance with ASHRAE 135. Alarm generation must meet the following requirements:~~

a. Send alarm events as Alarms (not Events).

b. Use the ConfirmedNotification Service for alarm events.

c. For alarm generation, support two priority levels for alarms: critical

and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

(1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.

(2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.

(3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).

(4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

(1) Notification_Class to point to the non-Critical Notification Class Object in that device.

(2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

(3) Notify_Type to Alarm

g. Use of alarm generation types:

(1) Only use algorithmic alarm generation when intrinsic alarm generation is not supported by the device or object, or when the specific alarm conditions cannot be implemented using intrinsic alarm generation.

(2) Only use remote alarm generation when the alarm cannot be generated using intrinsic or local algorithmic alarm generation on the device containing the referenced property. If remote alarm generation is used, use the same DDC Hardware for all remote alarm generation within a single sequence.

~~g. Configure the Recipient_List Property of the Notification Class Object to point to the Niagara Framework Supervisory Gateway managing the alarm.~~

3.1.3.3 Support for Future Alarm Generation

For every piece of DDC Hardware, support future alarm generation capabilities by supporting either intrinsic or additional algorithmic alarming. Provide one of the following:

a. Support intrinsic alarming for every Object used by the application in that device.

b. Support additional Event_Enrollment Objects. For DDC hardware controlling a single terminal unit, support at least one additional object. Otherwise, support at least ~~[4][_____]~~ additional Objects. Support additional Event_Enrollment Objects via one of the following:

(1) Provide unused Event_Enrollment Objects on that device.

(2) Support the DM-OCD-B BIBB and the creation of sufficient Event_Enrollment Objects on that device.

(3) Provide one or more devices in the IP network that support the AE-N-E-B BIBB and have unused Event_Enrollment Objects.

(4) Provide one or more devices on the IP network that support the AE-N-E-B BIBB, the DM-OCD-B BIBB, and the creation of sufficient Event_Enrollment Objects.

The total number of Event_Enrollment Objects required by the project is the sum of the individual device requirements, and the distribution of Event_Enrollment Objects among devices is not further restricted. (Note this allows a single device to contain many Event_Enrollment Objects satisfying the requirements for multiple devices.)

3.1.3.4 Trend Log Configuration

a. Configure trends in Trend Log or Trend Log Multiple Objects as indicated on the Points Schedule and as specified.

b. Configure all trend logs (including any provided to support future trends) to save data on regular intervals using the BUFFER_FULL event to request trend upload from the front end.

c. Configure Trend Log Objects with a minimum Buffer_Size property value of 1,000 and Trend Log Multiple Objects with a minimum Buffer_Size property value of 1,000 per point trended (for example, a Trend Log Multiple Object used to trend 3 points must have a Buffer_Size Property value of at least 3,000).

d. Configure a Notification Class Object in devices doing trending (including devices supporting future trends) to handle the BUFFER_FULL event.

e. When possible, trend each point using an Object in the device containing the point. When it is necessary to trend using a an Object in another device, all trends not on the same Device as the Object being trended must be on a singe device (i.e. all Trend Log and Trend Log Multiple Objects used for remote trending within a sequence must be on the same device).

f. For each trend log, including any trend logs provided to support

future trending, configure the following properties as specified:

(1) Logging_Type: Set to Polling

(2) Stop_When_Full: Set to Wrap Around

(3) Buffer_Size: Set to 400 or greater.

(4) Notification_Threshold: Set to 90 percent of full

(5) Notification_Class: Set to the Notification Class Object in that device

(6) Event_Enable: Set to TRUE

(7) Log_Interval: Set to 15 minutes.

g. Future Trending support. Provide support for future trending:

(1) Provide one or more devices on the Building Control Network Backbone IP network which support both the T-VMT-E-B and DM-OCD-B BIBBs for Trend Log Objects. Provide sufficient devices to support the creation of at least ~~[[_____] additional Trend Log Objects]~~[one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit~~]~~.

(2) Provide ~~[[_____] additional Trend Log Objects]~~[one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit~~]~~ in one or more devices on the Building Control Network Backbone IP network that support the T-VMT-E-B BIBB for later use by the site.

(3) A combination of these two methods is permitted provided the total required number of Trend Log Objects is met.

~~3.1.3.5 Trending~~

~~Perform all trending using a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and Niagara Framework History Service exclusively.~~

3.1.3.5 Overrides

Provide an override for each point shown on the Points Schedule as requiring an override. ~~Use the Niagara Framework for all overrides to points in Niagara Framework Supervisory Gateways. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified.~~

Unless otherwise approved, provide Commandable Objects to support all Overrides ~~in non-Niagara Framework Supervisory Gateway DDC Hardware~~. With specific approval from the Contracting Officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

a. Where Commandable Objects are used, ensure that WriteProperty service

requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.

b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

3.1.4 BACnet Gateways

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under another section. Only use gateways to connect to pre-existing control devices, and to proprietary systems specifically permitted by Section 23 09 00.

3.1.4.1 General Gateway Requirements

Provide BACnet Gateways to connect non-BACnet control hardware in accordance with the following:

a. Configure gateways to map writable data points in the controlled equipment to Writable Properties of Standard Objects~~, or to Niagara Framework points,~~ as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects~~, or to Niagara Framework points,~~ as indicated in the Points Schedule and as specified.

c. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

d. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. ~~(Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.)~~

e. Do not use non-BACnet control hardware for system scheduling functions.

f. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit or a single non-BACnet system specifically permitted by Section 23 09 00.

g. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment or the non-BACnet system specifically permitted by Section 23 09 00..

h. For gateways to existing package units or simple split systems,

non-BACnet network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) or split system interface and the gateway.

-- End of Section --

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SECTION 23 11 20

FACILITY GAS PIPING
05/20

PART 1 GENERAL

1.1 SUMMARY

This specification section applies to gas piping installed within buildings incidental underground piping under building, above ground steel piping and corrugated stainless steel tubing (CSST) both outside (up to 5 feet beyond exterior walls) and within buildings in compliance with NFPA 54 /AGA Z223.1, "National Fuel Gas Code" NFPA 58, "Fuel Gas Piping".

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.4	(2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service
AGA Z223.1	(2012) National Fuel Gas Code

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.15/CSA 9.1	(2009; Addenda A 2012, Addenda B 2013; R 2019) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves
ANSI Z21.18/CSA 6.3	(2007; R 2017) Gas Appliance Pressure Regulators
ANSI Z21.21/CSA 6.5	(2015) Automatic Valves for Gas Appliances
ANSI Z21.24/CSA 6.10	(2015; R 2020) Connectors for Gas Appliances
ANSI Z21.41/CSA 6.9	(2014; R 2019) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.69/CSA 6.16	(2015; R 2020) Connectors for Movable Gas Appliances
ANSI Z21.78/CSA 6.20	(2010; R 2020) Standard Specification for Combination Gas Controls for Gas Appliances

ANSI Z21.80/CSA 6.22	(2019) Line Pressure Regulators

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Std 598	(2009) Valve Inspecting and Testing
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2015~~15~~20) Scheme for the Identification of Piping Systems
ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.33	(2012; R 2017) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psi, (Sizes NPS 1/2 - NPS 2)

ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.9	(2017) Building Services Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193/A193M	(2020a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2020a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

CSA GROUP (CSA)

ANSI LC 1/CSA 6.26	(2019) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2018) National Fuel Gas Code
NFPA 58	(2020) Liquefied Petroleum Gas Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

UNDERWRITERS LABORATORIES (UL)

UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.3 SYSTEM DESCRIPTION

The gas piping system includes ~~[~~natural gas~~]~~ ~~[and] [liquid petroleum]~~ piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein. ~~[~~Provide cathodically protected insulating joints connecting aboveground piping from the meter to the building, with ~~[~~lightning arrestors~~]~~ ~~[zinc grounding cells]~~ conforming to API RP 2003, installed where indicated.~~]~~

1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markers~~[and cathodic protection system]~~; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different). Submit Data package No. 4.

1.3.2 Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer. Submit Data Package No.4.

1.3.3 Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other

equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide. Submit Data Package No. 3.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for ~~[~~Contractor Quality Control approval.~~]~~ ~~[information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System~~; G[, [_____]]~~

SD-03 Product Data

~~Pipe and Fittings; G[, [_____]]~~

Gas Equipment Connectors~~; G[, [_____]]~~

~~LPG Containers and Accessories; G[, [_____]]~~

Gas Piping System~~; G[, [_____]]~~

Pipe Coating Materials
~~; G[, [_____]]~~

Pressure Regulators~~; G[, [_____]]~~

~~Risers; G[, [_____]]~~

~~Transition Fittings; G[, [_____]]~~

Valves~~; G[, [_____]]~~

Warning and Identification Tape
~~; G[, [_____]]~~

SD-06 Test Reports

Testing~~; G[, [_____]]~~

Pressure Tests~~; G[, [_____]]~~

~~Pressure Tests for Liquified Petroleum Gas; G[, [_____]]~~

Test with Gas~~; G[, [_____]]~~

SD-07 Certificates

Welders Procedures and Qualifications; G[, [_____]]

Assigned Number, Letter, or Symbol; G[, [_____]]

SD-08 Manufacturer's Instructions

PE Pipe and Fittings; G[, [_____]]

Pipe Coating Materials; G[, [_____]]

SD-10 Operation and Maintenance Data

Gas Facility System and Equipment Operation; G[, [_____]]

Gas Facility System Maintenance; G[, [_____]]

Gas Facility Equipment Maintenance; G[, [_____]]

1.5 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

1.5.1 Welding Qualifications

a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Contracting OfficerQC Manager at least 24 hours in advance of tests, and perform at the work site if practicable.

b. Submit a certified copy of welders procedures and qualifications metal and PE in conformance with ASME B31.9 for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the Contracting Officer QC Manager.[Weld all structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING, and in conformance with AWS A5.8/A5.8M, and AWS WHB-2.9.]

1.5.2 Jointing Thermoplastic and Fiberglass Piping

Perform all jointing of piping using qualified joiners and qualified procedures in accordance with AGA XR0603. Furnish the Contracting Officer with a copy of qualified procedures and list of and identification symbols of qualified joiners. Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart, including all PE pipe and fittings.

1.5.2 Shop Drawings

Submit drawings for complete Gas Piping System, within ~~[~~30~~]~~ ~~[_____]~~ days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports. Include LP storage tank, pad, and mounting details.

~~1.6 DELIVERY, STORAGE, AND HANDLING~~

~~1.6.1 Plastic Pipe~~

~~Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe and fittings ends during transportation or storage to minimize dirt and moisture entry. Do not subject piping to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.~~

~~1.6.2 CSST Tubing~~

~~Handle, transport and store CSST tubing on the wooden spool or shipping container provided by the manufacturer. Insure tubing ends are capped during transportation and storage to minimize dirt and moisture entry. Discard any tubing segment and fitting that has been damaged.~~

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54NFPA 58 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

~~[~~2.2.1 Steel Pipe, Joints, and Fittings

a. Pipe: Black carbon steel in accordance with ASTM A53/A53M, Schedule ~~[~~40~~]~~ ~~[80]~~, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: ASME B16.39, black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1, with flange faces having integral grooves of rectangular cross sections

which afford containment for self-energizing gasket material.

~~Provide steel pipe conforming to ASME B36.10M; and malleable-iron threaded fittings conforming to ASME B16.1 and ASME B16.3. Provide steel pipe flanges and flanged fittings, including bolts, nuts, and bolt pattern in accordance with ASME B16.5 and ASTM A105/A105M. Provide wrought steel buttwelding fittings conforming to ASME B16.9. Provide socket welding and threaded forged steel fittings conforming to ASME B16.11[and ASTM A181/A181M, Class 60].~~

~~][2.2.2 Aluminum Alloy Pipe and Tubing, Joints, and Fittings~~

~~Provide aluminum alloy pipe conforming to ASTM B241/B241M, except that alloy 5456 is not allowed. Mark the ends of each length of pipe indicating it conforms to NFPA 54 NFPA 58. Thread, flange, braze, or weld pipe joints. Provide aluminum alloy tubing conforming toASTM B210/B210M, Type A or B, or ASTM B241/B241M, Type A or equivalent, with joints made up with gas tubing fittings recommended by the tubing manufacturer.~~

~~][2.2.3 Copper Tubing, Joints and Fittings~~

~~Provide copper tubing conforming to ASTM B88, Type K or L, or ASTM B280, with tubing joints made up with tubing fittings recommended by the tubing manufacturer. Provide copper and copper alloy press fittings, with sealing elements of Hydrogenated Nitrile Butadiene Rubber (HNBR), factory installed, or an alternative supplied by the fitting manufacturer.~~

~~][2.2.4 Steel Tubing, Joints and Fittings~~

~~Provide steel tubing conforming to ASTM 01.01, and ASTM A513/A513M, with tubing joints made up with gas tubing fittings recommended by the tubing manufacturer.~~

~~][2.2.5 Thermoplastic Pipe, Tubing, Joints, and Fittings~~

~~Provide thermoplastic pipe, tubing,casing and joints and fittings conforming to ASTM D2513 and API Spec 5CT.~~

~~][2.2.6 Fiberglass Pipe, Joints, and Fittings~~

~~Provide fiberglass piping systems conforming to ASTM D2517 and API Spec 15LR.~~

~~][2.2.7 Corrugated Stainless Steel Tubing, Fittings and Accessories~~

~~Provide corrugated stainless steel tubing conforming to ANSI LC 1/CSA 6.26 (austenitic stainless steel of series 300) with tubing joints made with special mechanical fittings as supplied by the tubing manufacturer.~~

~~2.2.7.1 Tubing~~

~~Austenitic stainless alloy of series 300 with polyethylene jacket/coating in accordance with ANSI LC 1/CSA 6.26 for sizes 3/8-inch through 2-inch~~

~~2.2.7.2 Mechanical Fittings~~

~~Copper alloy with one end matched to the corrugated tubing and one end with NPT threads in accordance with ASME B1.20.1~~

~~2.2.7.3 Striker Plates~~

~~Hardened steel designed to protect tubing from mechanical damage in accordance with ANSI LC 1/CSA 6.26~~

~~2.2.7.4 Manifolds~~

~~Malleable iron, steel or copper alloy with threaded connections/ports in accordance with ASME B1.20.1~~

~~][~~2.2.2 Sealants for Steel Pipe Threaded Joints

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL FLAMMABLE & COMBUSTIBLE.

~~]~~2.2.3 Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

2.2.4 Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

2.2.5 Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

2.2.6 Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

~~2.2.7 Gas Transition Fittings~~

~~[a. Provide steel to plastic (PE) designed for steel-to-plastic with tapping tee or sleeve conforming to AGA XR0603 requirements for transitions fittings.. Coat or wrap exposed steel pipe with heavy plastic coating.]~~

~~[b. Plastic to Plastic: [Manufacturer's standard bolt-on (PVC to PE) plastic tapping saddle tee, UL listed for gas service, rated for 100 psig, and O-ring seals.] [Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support conforming to ASTM A666, O-ring seals, and rated for 150 psig gas service.] [Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.]]~~

~~[c.[Provide lever operated pressure lubricated plug type gas shut-off valve conforming to CGA 3.11-M88.][Provide lever operated non-lubricated gas shut-off valves conforming to CGA 3.16-M88][Provide manually operated shut-off valve conforming to CGA 9.2-M88]]~~

2.2.7 Insulating Pipe Joints

2.2.7.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.7.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.7.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. ~~[Provide lap joint flange pipe ends conforming to ASTM F2015.]~~

2.2.8 Flexible Connectors

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16.~~[~~ Provide combination gas controls for gas appliances conforming to ANSI Z21.78/CSA 6.20.~~]~~

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide lockable shutoff or service isolation valves ~~[as indicated in the drawings]~~conforming to the following:

2.3.1 Valves 2 Inches and Smaller

Provide valves 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used.~~[Provide manually operated household cooking gas appliance valves conforming to ANSI Z21.1/CSA 1.1 and ANSI Z21.15/CSA 9.1.]~~

~~[~~2.3.2 Valves 2-1/2 Inches and Larger

Provide valves 2-1/2 inches and larger of carbon steel conforming to API Spec 6D, Class 150.

~~][2.3.3 Valve Support on PE Piping~~

~~Provide valve support assembly in accordance with the PE piping maufacturer's requirements at valve terminations points.~~

~~]2.4 RISERS~~

~~Provide manufacturer's standard riser, transition from plastic to steel~~

~~pipe with 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide [remote bolt-on or bracket][or][wall-mounted] riser supports [as indicated].~~

2.4 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58.

~~[~~2.5 LINE AND APPLIANCE REGULATORS AND SHUTOFF VALVES

Provide regulators conforming to ~~[~~ANSI Z21.18/CSA 6.3 for appliances~~]~~ ~~[~~ ANSI Z21.78/CSA 6.20 for combination gas controls for gas appliances~~]~~ ~~[~~, and ANSI Z21.80/CSA 6.22 for line pressure regulators~~]~~. Provide shutoff valves conforming to ~~[~~ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves~~]~~ ~~[~~and~~]~~ ~~[~~ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances~~]~~.

~~]~~~~[~~2.6 NATURAL GAS SERVICE

2.6.1 Service Regulators

a. Provide ferrous bodied pressure regulators for individual service lines, capable of reducing distribution line pressure to pressures required for users. Provide service regulators conforming to AGA ANSI B109.4 CGA-6.18-M95 with full capacity internal relief ~~[and overpressure shutoff]~~. Set pressure relief at a lower pressure than would cause unsafe operation of any connected user.

b. Adjust regulators for liquified petroleum gas to 2.5 to 3 kPa 10 to 12 inches of water column, with pressure relief set at 4 kPa 16 inches of water column.

c. Provide regulator(s) having a single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas flow rate at the regulator inlet pressure. Provide regulator valve vent of resilient materials designed to withstand flow conditions when pressed against the valve port, capable of regulating downstream pressure within limits of accuracy and limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Provide a self-contained service regulator, and pipe not exceeding exceed 2 inch size.

2.6.2 Gas Meter

~~[AGA ANSI B109.1][AGA ANSI B109.2][AGA ANSI B109.3] [pipe][pedestal] mounted, [diaphragm] or [bellow][style], [cast-iron][enamel-coated steel][aluminum] case. [Provided with a strainer immediately upstream]. Provide [diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above] [rotary-type displacement meter conforming to AGA ANSI B109.3] as required by local gas utility supplier. Provide combined [odometer-type] register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that~~

~~are tamper-proof [with] [frost protection] [fungus protection][seismic protection]. Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 100 cubic feet of gas. Minimum service life must be 30,000,000 cycles.~~

2.6.2.1 Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control (EMCS) or Automatic Meter Reading Interfaces

Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS / EMCS for data gathering in units of cubic meters cubic feet. Provide meters that do not require power to function and deliver data. Output signal must be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor.

2.6.2.2 Measurement Configuration

For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter must be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

~~][2.7 SEISMIC PROVISIONS~~

~~Provide earthquake automatic gas shutoff valve conforming to ASCE 25-16, SMACNA 1981 or excess flow valve (EFV) conforming with ANSI Z21.93/CSA 6.30 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The earthquake valve may be either pendulum or ball construction with [remote [, pneumatic] [electronic] [or] [electric]] actuator. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).~~

~~]2.8 AUTOMATIC GAS SHUT-OFF~~

~~[Provide low pressure automatic gas shutoff or excess flow valve (EFV) downstream of the point of delivery after the [meter/regulator] [propane tank] conforming to ANSI Z21.93/CSA 6.30 and UL listed or CSA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).][Provide low pressure automatic gas shutoff or excess flow valve (EFV) at each branch to an appliance.]~~

~~2.9 LIQUIFIED PETROLEUM GAS - (LPG), LPG CONTAINERS AND ACCESSORIES~~

~~Provide NFPA 58, [DOT] [or] [ASME] compliant containers with appurtenances, system working pressure, minimum design pressure, that is LPG vapor pressure at 100 degrees F, and water capacity as indicated. Provide containers with piping and fittings,[fuse plugs,][hose and flexible hose connectors,][gas-air mixer,][strainer,] and marking conforming to NFPA 58, and[API MPMS 2.2A for upright cylindrical tanks] [API MPMS 2.2E for horizontal cylindrical tanks] Provide valves conforming to UL 125 and UL 842. Provide pipe unions conforming to UL 860.~~

2.7 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; ASTM A193/A193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194/A194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts must conform with ASME B18.2.1 and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs must extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts must have American Standard regular square or heavy hexagon heads; nuts must be American Standard heavy semifinished hexagonal.

2.8 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.9 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 3/4 inch od, provide brass identification tags 1 1/2 inches in diameter with legends in depressed black-filled characters.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the ~~Contracting Officer~~QC Manager of any discrepancy or areas of conflict before performing the work.

3.2 EXCAVATION AND BACKFILLING

Provide required excavation, backfilling, and compaction as specified in Section ~~31 00 00 EARTHWORK~~31 23 00.00 20 EXCAVATION AND FILL.

3.3 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the outlet of the ~~[~~meter set assembly~]~~ ~~[~~service regulator~]~~ ~~[~~shutoff valve~]~~, ~~[~~ as specified under "Gas Service" within this specification,~][as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES,]~~ to the connections to each gas utilization device that is in compliance with NFPA 54~~[NFPA 58]~~..

3.3.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

3.3.2 Workmanship and Defects

Piping, tubing and fittings must be clear and free of cutting burrs and defects in structure or threading and must be thoroughly brushed and

chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.4 PROTECTIVE COVERING

~~### 3.4.1 Underground Metallic Pipe~~

~~Protect buried metallic piping and tubing from corrosion by either: (1) applying protective coatings as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES; (2) encasement in a water tight plastic conduit; or (3) encasement in a protective system designed and listed by the manufacturer for this application. When dissimilar metals are joined underground, use gastight insulating fittings.~~

3.4.1 Aboveground Metallic Piping Systems

3.4.1.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed . Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances ~~[~~by power wire brushing~~]~~ ~~[~~or~~]~~ ~~[~~commercial sand blasted conforming to SSPC SP 6/NACE No.3~~]~~ and prime with ~~[~~ferrous metal primer~~]~~ ~~[~~or~~]~~ ~~[~~vinyl type wash coat~~]~~. Finish primed surfaces with two coats of exterior ~~[~~oil paint~~]~~ ~~[~~or~~]~~ ~~[~~vinyl paint~~]~~.

3.4.1.2 Nonferrous Surfaces

Except for aluminum alloy pipe, do not paint nonferrous surfaces. Paint surfaces of aluminum alloy pipe and fittings to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. Solvent-clean the surfaces and treat with vinyl type wash coat. Apply a first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel.

3.5 INSTALLATION

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54NFPA 58~~[~~ and ~~]~~ AGA XR0603, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

~~### 3.5.1 Metallic Piping Installation~~

~~Bury underground piping a minimum of 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.~~

~~3.5.2 Metallic Tubing Installation~~

~~Install metallic tubing using gas tubing fittings approved by the tubing manufacturer. CSST gas piping systems must be installed by contractors who have completed the manufacturer's training program as indicated on a certification card. Make branch connections with tees. Prepare all tubing ends with tools designed for that purpose. Do not use aluminum alloy tubing in exterior locations or underground. Maintain electrical continuity of gas piping system in accordance with NFPA 54 [NFPA 58], paragraph entitled 'Electrical Bonding and Grounding'.~~

~~3.5.3 Thermoplastic and Fiberglass Piping, Tubing, and Fittings~~

~~Installation of thermoplastic and fiberglass piping, tubing, and fittings is permitted only outside and underground. Bury piping a minimum of 18 inches below grade. Install the piping to avoid excessive stresses due to thermal contraction, and use only where indicated. Installations must be made using qualified procedures, by qualified installers, and in compliance with AGA XR0603 and NFPA 54 [NFPA 58], and must be inspected by a qualified inspector.~~

3.5.1 Connections Between Metallic and Plastic Piping

Connections between metallic and plastic piping are only allowed outside, underground, and with approved transition fittings.

~~3.5.2 Piping and Tubing Buried Under Buildings~~

~~Run underground piping and tubing installed beneath buildings in a steel pipe casing protected from corrosion with protective coatings as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES or installed within a water tight plastic conduit or as part of a listed encasement system. Extend casing or encasement system at least 4 inches outside the building, and provide the pipe with spacers and end bushings to seal at both ends to prevent the entrance of water and/or the escape of gas. Extend a vent line from the annular space above grade outside to a point where gas will not be a hazard, and terminate in a rain/insect-resistant fitting.~~

3.5.2 Concealed Piping in Buildings

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

3.5.2.1 Piping and Tubing in Partitions

Locate concealed piping and tubing in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels. Provide protection of concealed pipe and tubing in accordance with ANSI LC 1/CSA 6.26.

3.5.2.2 Piping in Floors

Lay piping in solid floors ~~[except where embedment in concrete is indicated]~~ in channels suitably covered to permit access to the piping with minimum damage to the building. ~~[Surround piping embedded in concrete by a minimum of 1-1/2 inches of concrete and do not allow~~

~~physical contact with other metallic items such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quickset additives or cinder aggregate.]~~

3.5.3 Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

3.5.4 Final Gas Connections

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. ~~[Make final connections to kitchen ranges using flexible connectors not less than 40 inch long[, to afford access to coupling] [and][to permit movement of equipment for cleaning].][~~ Flexible connectors may be used for final connections to residential dryers.~~]~~ ~~[~~Flexible connectors may be used for final connections to gas utilization equipment.~~]~~ ~~[~~In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet.~~]~~ Provide accessible gas shutoff valve and coupling for each gas equipment item.

~~3.5.5 Seismic Requirements~~

~~Support and brace piping and attached valves to resist seismic loads in conformance with ASCE 25-16[and][as specified in UFC 3-301-01, and Sections 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC][as indicated]. CSST tubing and fittings that are seismically qualified in accordance with the FM APP GUIDE: Flexible Piping Systems for Flammable Gases must meet the seismic requirements in accordance with the manufacturer's installation instructions.~~

3.6 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.6.1 Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.6.2 Welded Metallic Joints

Conform beveling, alignment, heat treatment, and inspection of welds to NFPA 54. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

~~3.6.3 Thermoplastic and Fiberglass Joints~~

~~3.6.3.1 Thermoplastic and Fiberglass~~

~~Conform jointing procedures to AGA XR0603. Do not make joints with solvent cement or heat of fusion between different kinds of plastics.~~

~~3.6.3.2 PE Fusion Welding Inspection~~

~~Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect, in conformance with API 570, 100 percent of all joints and re-inspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer to make first time inspection.~~

~~3.6.4 Flared Metallic Tubing Joints~~

~~Make flared joints in metallic tubing with special tools recommended by the tubing manufacturer. Use flared joints only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Do not use metallic ball sleeve compression-type tubing fittings for tubing joints.~~

3.6.3 Solder or Brazed Joints

Make all joints in metallic tubing and fittings with materials and procedures recommended by the tubing supplier. Braze joints with material having a melting point above 1000 degrees F, containing no phosphorous.

~~3.6.4 Joining Thermoplastic or Fiberglass to Metallic Piping or Tubing~~

~~When compression type mechanical joints are used, provide gasket material in the fittings compatible with the plastic piping and with the gas in the system. Use an internal tubular rigid stiffener in conjunction with the fitting, flush with end of the pipe or tubing, extending at least to the outside end of the compression fitting when installed. Remove all rough or sharp edges from stiffener. Do not force fit stiffener in the plastic. Split tubular stiffeners are not allowed.~~

~~3.6.5 Press Connections~~

~~Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Fully insert the tubing into the fitting and then mark at the shoulder of the fitting. Check the fitting alignment against the mark on the tubing to assure the tubing is fully inserted before the joint is pressed.~~

3.7 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with

each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas . Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPINGG.

3.8 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.9 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.10 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.11 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54NFPA 58.

3.12 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the ~~Contracting Officer~~QC Manager.

3.13 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54NFPA 58. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-58. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.14 ELECTRICAL BONDING AND GROUNDING

Provide a gas piping system within the building that is electrically continuous and bonded to a grounding electrode as required by NFPA 54, NFPA 58, and NFPA 70.

3.15 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled. Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally.~~[~~ Provide PE piping manufacturer bracket support assembly securely fastened to structure for valve connections to resist operating torque applied to PE pipes.~~]~~ Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

3.16 LINE AND APPLIANCE PRESSURE REGULATORS

Install line pressure regulators and appliance regulators in accordance with the manufacturer's requirements and in accordance with NFPA 54~~[NFPA 58]~~. Install each regulator in an accessible location and install shutoff valves ahead of each line and appliance regulator to allow for maintenance. Where vent limiting devices are not included in the regulators, install a vent pipe to the exterior of the building. Terminate all service regulator vents and relief vents in the outside air in rain and insect resistant fittings. Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

~~3.17 GAS SERVICE INSTALLATION~~

~~[Gas service line, service regulator and gas company meter must be installed in accordance with Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES.] Installations must be in accordance with 49 CFR 192 and ASME B31.8. Contractor must submit and use only tested and approved work procedures. Contractor must use only welders and jointers who have been recently qualified by training and test for joining and installing the gas pipe material used on this job. The finished product must be inspected by a person qualified to inspect joints made by the particular procedures used to make joints.~~

~~[3.17.1 Service Line~~

~~Install service line, branch connection to the main, and riser in accordance with 49 CFR 192 and ASME B31.8. Provide a minimum of 18 inches cover or encase the service line so that it is protected. Install service line so that no undue stress is applied to the pipe, connection, or riser. Install approved riser and terminate with an approved isolation valve, EFV and automatic shutoff device. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK.~~

~~Were steel pipe is used as service line, install corrosion prevention coating and cathodic protect for the steel service line. Where connected to an existing cathodically protected steel pipe, ensure electrical continuity from the riser to the branch connection to the main. Install a dielectric fitting on the riser to prevent electrical continuity to the~~

~~above ground piping.~~

~~Where plastic pipe is used as the service line, make joints in accordance with procedures qualified by test. Personnel joining plastic pipe must be qualified by making a satisfactory specimen joint that passes the required inspection and test listed in 49 CFR 192.285. Inspection must be made by inspectors qualified in evaluating joints made under the specific joining procedure, as required by 49 CFR 192.287.~~

~~3.17.2 Service Regulator~~

~~Install service regulator in accordance with 49 CFR 192 and ASME B31.8 and this specification ensuring that the customer's piping is protected from over pressurization should the service regulator fail. A 3/8 inch tapped fitting equipped with a plug must be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. For inside installations, route the regulator vent pipe through the exterior wall to the atmosphere, and seal building penetrations for service line and vent. Terminate the regulator vent so that it is protected from precipitation and insect intrusion, so that it is not submerged during floods, and so that gas escaping will not create a hazard or enter the building through openings.~~

~~3.17.3 Gas Meter~~

~~Install shutoff valve, meter set assembly, and service regulator on the service line [outside the building] [inside the building, a minimum of 3 feet from any potential ignition source], 18 inches above the [ground] [finished floor] on the riser. An insulating joint (dielectric connection) must be installed on the inlet side of the meter set assembly and service regulator and must be constructed to prevent flow of electrical current.~~

~~][3.18 CATHODIC PROTECTION~~

~~Provide cathodic protection for underground ferrous gas piping as specified in [Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)][Section 26 42 13.00 20 CATHODIC PROTECTION BY GALVANIC ANODES] [Section 26 42 19.00 20 CATHODIC PROTECTION BY IMPRESSED CURRENT].~~

~~]~~3.17 TESTING

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, purge the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the ~~Contracting Officer~~QC Manager. Do not use oxygen as a testing medium.

3.17.1 Pressure Tests

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54as specified in NFPA 58 without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 0.1 pound. Isolate the source of pressure before the pressure tests are made.

~~3.17.2 Pressure Tests for Liquified Petroleum Gas~~

~~Pressure test system as described above. When appliances are connected to the piping system, use fuel gas for testing appliances to withstand a pressure of not less than 10.0 inches nor more than 14.0 inches water column (0.36 nor more than 0.51 pounds per square inch) for a period of not less than 10 minutes without showing any drop in pressure. Measure pressure with a water manometer or an equivalent device calibrated to be read in increments of not greater than 0.1 inch water column. Isolate the source of pressure before the pressure tests are made.~~

3.17.2 Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of NFPA 54NFPA 58. If leakage is recorded, shut off the gas supply, repair the leak , and repeat the tests until all leaks have been stopped.

3.17.3 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. LPG piping tested using fuel gas with appliances connected does not require purging. Conform testing procedures to API RP 1110. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54NFPA 58 are followed.

3.17.4 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.18 PIPE COLOR CODE MARKING

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS, conforming to ASME A13.1.

-- End of Section --

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SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM
04/06, CHG 2: 11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2016) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2017) Valves - Flanged, Threaded and Welding End
ASME B16.36	(2015) Orifice Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300

ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.9	(2017) Building Services Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A194/A194M	(2020a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM F1007	(2018) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2019) Standard Specification for

	Circular Metallic Bellows Type Expansion Joints for Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved Backflow Prevention Assemblies

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017; Errata 1 2017) Butterfly Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-50560	(Basic) Pumps, Centrifugal, Water Circulating, Electric-Motor-Driven
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers,

	Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

Except as specified otherwise, equipment and piping components shall be suitable for use in low temperature water heating system. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications. Pressures in this specification are pressures in pounds per square inch above atmospheric pressure, and temperatures are in degrees Fahrenheit (F).

1.3.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

~~a. Unit heaters~~

~~b. Convectors~~

~~c. Finned tube radiators~~

~~d~~a. Pumps

~~e~~b. Valves

~~f~~c. Expansion tanks

~~g~~d. Flow measuring equipment

~~h~~e. Backflow preventer

~~i~~f. Air separating tank

~~[~~g~~j~~. Boilers~~]~~

~~[k. Hot water heat exchangers]~~

~~[l. Converters]~~

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that~~

~~will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCITON SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hot water heating system

SD-03 Product Data

~~Convectors~~

~~Finned tube radiators~~

Pumps

Include pump speed and characteristic curve for performance of impeller selected for each pump. Curves shall indicate capacity vs head, efficiency, and brake power for full range, from shut-off to free delivery.

Expansion tanks

Flow measuring equipment

Backflow preventers

External air separation tanks

Hot water heating pipe

SD-06 Test Reports

Hydrostatic test of piping system

Auxiliary equipment and accessory tests

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

SD-07 Certificates

Backflow preventer certification

~~Report of prior installations~~

Welding procedures

Welder's qualifications

~~SD-10 Operation and Maintenance Data~~

~~Convectors, Data Package 3; G[, [_____]]~~

~~Finned tube radiators, Data Package 3; G[, [_____]]~~

~~Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit a list of qualified service organizations which includes addresses and qualifications.~~

1.5 QUALITY ASSURANCE

1.5.1 Standard Commercial Product for Terminal Units

Terminal units provided shall comply with features called out in this specification and shall be the manufacturer's standard commercial product. Additional or better features which are not prohibited by this specification but which are a part of the manufacturer's standard commercial product, shall be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs, or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

1.5.2 Welding

~~#### 1.5.2.1 Report of Prior Installations~~

~~Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate shall be from the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, and shall attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval is not acceptable in lieu of the above.~~

1.5.2.1 Welding Procedures

Before performing welding, submit three copies of welding procedure specification for all metals to be used in the work, together with proof of welder's qualification as outlines in ASME B31.9.

1.5.2.2 Welder's Qualifications

Before welder or operator performs welding, submit three copies of Welder's Performance Qualification Record in conformance with ASME B31.9 showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder.

~~#### 1.5.2.3 Identification of Welder's Work~~

~~Ensure that each welder's assigned number, letter or symbol is affixed immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a requalification test. Upon failing to pass the test, do not permit welder to work in this contract.~~

1.5.2.3 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to the approval and provided that all the conditions specified in ASME B31.9 are met before a procedure can be used.

1.5.3 Brazing and Soldering

1.5.3.1 Brazing Procedure

ASME B31.9. Brazing procedure for joints shall be as outlined in CDA A4015.

1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints

ASME B31.9 and as outlined in CDA A4015.

1.5.4 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

1.6 SAFETY STANDARDS

1.6.1 Welding

Safety in welding and cutting of pipe shall conform to AWS Z49.1.

1.6.2 Guards

Couplings, motor shafts, gears and other moving parts shall be guarded, in accordance with OSHA 29 CFR 1910.219. Guards shall be cast iron or expanded metal. Guard parts shall be rigid and removable without disassembling the guarded unit.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Hot Water Heating Pipe (Supply and Return)

ASTM A53/A53M electric resistance welded or seamless Schedule 40[_____] steel pipe [or ASTM B88 Type L[_____] hard drawn Copper tubing].

2.1.2 Fittings

Provide fittings compatible with the pipe being provided and shall conform to the following requirements.

2.1.2.1 Steel or Malleable Iron Pipe

Sizes 1/8 to 2 inches. ASME B16.11 steel socket welding or screwed type or ASME B16.3 for screwed type malleable iron fittings.

2.1.2.2 Steel, Cast Iron, or Bronze

Sizes 2 1/2 inches and above. Steel fitting butt welding type ASME B16.9 or ASME B16.5 flanged type. Cast iron fittings flanged type ASME B16.1. Bronze fittings up to 8 inch size flanged type ASME B16.24.

2.1.2.3 Fittings for Copper Tubing

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type. Fittings may be flared or compression joint type.

2.1.3 Unions

2.1.3.1 Steel Pipe

Provide ASME B16.39, malleable iron unions, threaded connections.

2.1.3.2 Copper Tubing

Provide CID A-A-59617, bronze unions, solder joint end.

2.1.3.3 Dielectric Union

Provide insulated union with galvanized steel female pipe-threaded end and a copper solder joint end conforming with ASME B16.39, Class 1, dimensional, strength and pressure requirements. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test.

2.1.4 Flanges

Remove raised faces when used with flanges having a flat face.

2.1.4.1 Steel Flanges

ASME B16.5 forged steel, welding type.

2.1.4.2 Cast Iron Screwed Flanges

ASME B16.1.

2.1.4.3 Bronze Screwed Flanges

ASME B16.24.

2.1.5 Drains and Overflows

2.1.5.1 Steel Pipe

ASTM A53/A53M, ~~[~~Electric resistance welded~~]~~ or ~~[~~Seamless~~]~~ Schedule 40, Malleable iron or forged steel fittings, screwed or welded joints.

2.1.5.2 Copper Tubing

ASTM B88, Type ~~[K,] [~~L,~~] [M,]~~ hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

~~2.1.5.3 PVC Pipe~~

~~ASTM D1785, Schedule 40, [and Schedule 80 for sizes 8 inch and larger,] solvent weld joints.~~

2.1.6 Valves

Valves shall have rising stems and shall open when turned counterclockwise.

2.1.6.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, 2 inches and smaller, wedge disc, inside screw type not less than Class 150. Use solder joint ends with copper tubing.

b. Steel Gate Valves: ASME B16.34, provide with open stem and yoke type with solid wedge or flexible wedge disc and heat and corrosion-resistant steel trim.

c. Cast Iron Gate Valves: MSS SP-70, 2 1/2 inches and larger, open stem and yoke type with bronze trim.

2.1.6.2 Globe and Angle Valves

a. Bronze Globe and Angle Valves: MSS SP-80, 2 inches and smaller, Class 200, except use Class 150 with solder ends for copper tubing. Valves shall have renewable seat and discs except solder end valves which shall have integral seats.

b. Steel Globe and Angle Valves: ASME B16.34, provide with heat and corrosion-resistant trim.

c. Cast Iron Globe and Angle Valves: MSS SP-85, 2 1/2 inches and larger, with bronze trim, tapped drains and brass plug.

2.1.6.3 Check Valves

a. Bronze Check Valves: MSS SP-80, 2 inches and smaller, regrinding swing check type, Class 200.

b. Steel Swing Check Valves: ~~[~~ASME B16.34~~]~~, regrinding swing check type, Class 200.

(1) Swing check valves shall have bolted caps.

(2) Steel Lift check valves 2 inches and smaller shall have bolted caps. Lift check valves 2 1/2 inches and larger shall have pressure seal caps.

c. Cast Iron Check Valves: ASME B16.34, 2 1/2 inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

2.1.6.4 Temperature Regulating Valves

Provide ASSE 1017 copper alloy body with adjustable range thermostat.

2.1.6.5 Water Pressure-Reducing Valves

ASSE 1003.

~~2.1.6.6 Plug Valves~~

~~MIL-V-12003, except that a replaceable valve seat will not be required. [Type I - lubricated, tapered plug] [Type II - non-lubricated, lift-plug] valves.~~

2.1.6.6 Ball Valves

Flanged or butt-welding ends ball valve shall conform to MSS SP-72, ~~[~~bronze ~~]~~ ~~[steel]~~. Threaded, socket-welding, solder joint, grooved and flared ends shall conform to MSS SP-110.

~~2.1.6.7 Radiator Valves~~

~~Radiator valves shall be angle or straightway pattern, with packed or packless bonnet shutoff globe type, designed especially for hot water heating system. Valve shall be constructed of brass or bronze or copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.~~

2.1.6.7 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 125 psig at 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the gallons per minute flow for each differential pressure reading.

2.1.6.8 Butterfly Valves

Conform with MSS SP-67, Type I - Tight shut off valve, and ~~[flanged] [screwed] [single flange] [flangeless]~~ valve ends. Valve body material shall be ~~[cast iron] [steel] [~~bronze~~]~~ and shall be bubble tight for shutoff at 150 psig. Flanged and flangeless type valves shall have Type 300 series corrosion resistant steel stems and corrosion resistant or bronze discs with molded elastomer disc seals. Flow conditions shall be for the regulation from maximum flow to complete shutoff by way of throttling effect. Valves shall be provided in ~~[~~closed~~]~~ ~~[open]~~ system. Valves smaller than 8 inches shall have throttling handles. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and indicators. Valves shall have a minimum of 7 locking positions and shall be suitable for water temperatures up to 200 degrees F.

~~2.1.6.9 Butterfly Valves 2 Inches and Smaller~~

~~Valves shall be one-piece and three-piece design with male or female threaded or soldered end connections and shall be bubble tight for shutoff at 150 psig. Stem and disc assembly shall be of 300 series corrosion resistant steel. Disc seal assembly shall be of 300 series corrosion resistant steel. Disc seal shall be suitable for the liquid being used in the system in which the valve is to be installed. Valves shall be suitable for water temperature up to 200 degrees F and shall be capable of operating at the rated pressure of [_____] psig. Valves shall be designed for throttling service use by valve lever and indicator adjustment.~~

2.1.6.9 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.1.6.10 Valve Operating Mechanisms

Provide ~~[floor stands] [~~chainwheels~~]~~ ~~[power operators] [and extension stems]~~ where indicated and as specified.

~~a. Floor Stands: Construct for bolting to the floor and include an extension stem and an operating handwheel. Design an adequately supported and guided extension stems for connection to the valve stem by a sleeve coupling or universal joint. Floor stands shall be cast iron or steel. Handwheel shall identify rotation direction for closing the valve and shall be of such diameter as to permit operation of the valve with a force of not more than 40 pounds.~~

a~~b~~. Chainwheel Operator: Shall be fabricated of cast iron or steel and shall include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within 3 feet of the floor.

~~c. Power Operators: Shall be [electric] [pneumatic]. Power operated valves shall open and close at rates no slower than 10 inches per minute for gate valves and 4 inches per minute for globe and angle valves. Valves shall open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve shall cause the motor to automatically stop. Power operators shall be complete with all gearing and controls necessary for the size of valve being provided. Power operators shall be designed to operate on the [electric] [compressed air] power supply indicated.~~

b~~d~~. Extension Stem: Corrosion resisting steel designed for rising and non-rising stems. Provide in length required to connect the valve stem and the ~~[~~handwheel~~]~~ ~~[operating mechanism]~~ and of sufficient cross section to transfer the torque required to operate the valve.

2.1.6.11 Balancing Valves

Balancing valves shall be calibrated bronze body balancing valves with integral ball valve and venturi or valve orifice and valve body pressure taps for flow measurement based on differential pressure readings. Valve pressure taps and meter connections shall have seals and built-in check valves with threaded connections for a portable meter. Meter shall be provided by the same manufacturer and be capable of reading system pressures and shall meet the requirements of the paragraph entitled "Flow Measuring Equipment." Valves shall have internal seals to prevent leakage around rotating element and be suitable for full shut-off rated pressure. Valves shall have an operator with integral pointer and memory stop. Balancing valves shall be selected for the required flows as indicated on the plans.

2.1.7 End Connections

2.1.7.1 Flexible Connectors

Provide flexible pipe connectors on piping connected to equipment. Flexible section shall consist of rubber, tetrafluoroethylene resin, corrosion-resistant steel, bronze, monel, or galvanized steel. Material provided and configuration shall be suitable for ~~[~~pressure,~~]~~ ~~[vacuum,] [~~temperature,~~]~~ and circulating medium. Flexible section shall have ~~[~~

threaded or~~,~~ ~~[welding,] [soldering,] [~~flanged~~] [or] [socket-weld]~~ ends and shall be suitable for service intended. Flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts or with wire braid cover suitable for service intended.

2.1.7.2 Steel Piping

Screwed or socket welded for 2 inches and smaller and flanged or butt welded for 2 1/2 inches and larger.

a. Screwed Joints With Taper Threads: ASME B1.20.1.

b. Flanged Joints: Bolting and gaskets shall be as follows:

(1) Bolting: Bolt and stud material ASTM A307, Grade B, and nut material ASTM A194/A194M, Grade 2. Bolt, stud, and nut dimensions ASME B18.2.2 threads ASME B1.1 coarse type with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and shall have American Standard heavy semifinished hexagonal nuts conforming to ASME B18.2.2.

(2) Gaskets: ASME B16.21, Nonasbestos compressed material 1/16 inch thickness full face or self-centering flat ring type and suitable for pressure and temperature of the piping system.

c. Butt Weld Joints: ASME B31.9. Backing rings shall conform to ASME B31.9. Ferrous rings shall not exceed 0.05 percent sulfur; for alloy pipe, backing rings shall be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Provide continuous machined or split band backing rings.

d. Socket Weld Joints: ASME B31.9.

2.1.7.3 Joints for Copper Tubing

a. Solder conforming to ASTM B32 alloy grade Sb5 or Sn96. Solder and flux shall be lead free (less than 0.2 percent of lead).

b. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

2.1.8 Expansion Joints

2.1.8.1 Packless Type

Provide ASTM F1120, Type III with fabricated corrosion-resistant steel bellows.

2.1.8.2 Guided Slip-Tube Type

Provide ASTM F1007, Type IV internally-externally guided, injected semiplastic type packing.

2.1.9 Instrumentation

2.1.9.1 Pressure and Vacuum Gauges

Provide ASME B40.100 with restrictor.

2.1.9.2 Indicating Thermometers

Thermometers shall be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) shall have a nominal scale diameter of 5 inches. Construction shall be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem shall be straight, length as required to fit well. Bimetal thermometers shall have a scale diameter of 3 1/2 inches. Case shall be hermetic. Case and stem shall be constructed of stainless steel. Bimetal stem shall be straight and of a length as required to fit the well.

2.1.9.3 Pressure/Temperature Test Ports

Pressure/Temperature Test Ports shall have brass body and EPDM and/or Neoprene valve seals. Ports shall be rated for service between 35 and 275 degrees F and up to 500 psig. Ports shall be provided in lengths appropriate for the insulation thickness specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and installed to allow a minimum of 12 inches of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports shall be 1/4 inch NPT and accept 1/8 inch diameter probes.

2.1.10 Miscellaneous Pipeline Components

2.1.10.1 Air Vent

Provide float type air vent in hydronic systems. Vent shall be constructed of brass or semi-steel body, copper float, and stainless steel valve and valve seat. Design air vent to suit system operating temperature and pressure. Provide isolating valve to permit service without draining the system. Pipe discharge of vent to a drain.

2.1.10.2 Strainers

Strainers for classes 125 and 250 piping in IPS 1/2 to 8 inches, inclusive, FS WW-S-2739 and locate as indicated.

2.1.10.3 Hangers and Supports

Design and fabrication of pipe hangers, supports, and welding attachments shall conform to MSS SP-58 and ASME B31.9. Hanger types and supports for bare and covered pipe shall conform to MSS SP-69 for the temperature range. ~~[If ferrous materials are used, provide hot dipped galvanized hangers, inserts and supports.]~~

2.1.10.4 Pipe Sleeves

Sleeves in masonry and concrete walls, floors, and roof slabs shall be ASTM A53/A53M, Schedule 40 or Standard Weight, hot-dip galvanized steel ~~[ductile-iron or cast-iron]~~ pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than 0.906 pound per square foot.

2.1.10.5 Escutcheon Plates

Provide one piece or split hinge metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces and paint finish on metal plates in unfinished spaces.

2.2 CENTRAL MECHANICAL EQUIPMENT

2.2.1 ~~[~~Boilers

Provide as specified in ~~[Section 23 52 43.00 20 LOW PRESSURE WATER HEATING BOILERS UNDER 800,000 BTU/HR OUTPUT][~~Section 23 52 4~~6~~3.00 20 LOW PRESSURE WATER HEATING BOILERS OVER 800,000 BTU/HR OUTPUT~~]~~.

~~]2.2.2 [Hot Water Heat Exchangers~~

~~Provide as specified in Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS.~~

~~]2.2.3 [Converters~~

~~Steam to hot water converters shall conform to FS WW-H-191 and shall have capacity as indicated for the design conditions. The converters shall be designed for support by separate pipe hangers, and [temperature regulator] [vent valve] shall be provided.~~

~~]~~2.3 PIPING SYSTEM EQUIPMENT

2.3.1 Pumps

Provide hot water circulating pumps, CID A-A-50560, Service A. Pump casing and flange shall be made of close-grained cast iron. Shaft shall be carbon or alloy steel with lubricated bearings and impeller shall be bronze. Select pumps so that the operating point on selected impeller-curve will lie at or to the left of shutoff side of, and not more than 5 percent below, point of maximum efficiency for impeller. Provide motors of ~~[~~open or~~]~~ ~~[splash proof] [~~totally enclosed~~]~~ type conforming to NEMA MG 1 and suitable for electrical characteristic as indicated. ~~Motor starters shall conform to NEMA ICS 2 [manual] [across the line] [reduced-voltage-start] [part-wind] [wye-delta] type with NEMA ICS 6 [general purpose] [weather-resistant] [watertight] enclosure~~Motor shall be provided with variable frequency drives.

2.3.2 Expansion Tanks

Provide bladder-type expansion tank welded steel, constructed and tested hydrostatically in accordance with ASME BPVC SEC VIII D1 for a working prssure of 125 psi and precharged to the minimum operating pressure. Tank shall be equipped with all necessary fittings. The tank and fittings shall be pressure rated at least equal to the test pressure of the total

system. The tank's air chamber shall be fitted with an air charging valve and presssure gauge. Zinc coat the tank inside and out after fabrication by the hot dip process ASTM A123/A123M. All components shall be suitable for a maximum operating temperatuer of 250

2.3.3 External Air Separation Tanks

Provide tank constructed of steel, designed for not less than 75 psig, and constructed and tested in accordance with the requirements of ASME BPVC SEC VIII D1 for a working pressure of 125 psi. Air separation tank shall be the combination steel and sediment separator with internal coalescing medium to remove entrained air and suspended solids. Provide tangential inlet and outlet connections, flanged for sizes 2 1/2 inches and larger. Each unit shall have an internal design suitable for creating the required vortex and subsequent air separation. Provide with automatic air release device and galvanized steel strainer. Provide a blow down connection with a gate valve and piped to nearest floor drain.

2.3.4 Backflow Preventers

Reduced pressure principle type. Furnish proof that each make, model/design, and size of backflow preventer being furnished for the project is approved by and has a current "Certificate of Approval" from the ~~[~~FCCCHR List~~]~~ ~~[or] [local code]~~. Listing of a particular make, model/design, and size in the current ~~[~~FCCCHR List~~]~~ ~~[or] [local code]~~ will be acceptable as the required proof.

2.3.5 Flow Measuring Equipment

Orifice or venturi type. Flow metering equipment including pitot tubes, venturis, orifice plates, flanges, and indicating meters shall be the product of one and the same manufacturer. Provide flowmeters of ~~[~~ permanent type~~]~~ ~~[or] [portable type] [type indicated]~~. Flowmeters shall be suitable for service in which they are to be installed. Primary elements of flowmeters shall conform to ASME recommendations for flowmeters. Provide bronze, monel, or stainless steel materials for wetted parts of flow meters.

a. Orifices: Square-edge type, made of corrosion and erosion resistant metal and mounted between pipe flanges having factory-made pressure taps provided with shutoff valves. Orifice flanges shall conform to ASME B16.36.

b. Tubular Flowmeters: Flow measuring elements consisting of venturi tubes or pitot tubes where indicated. Locations and arrangement of piping, both upstream and downstream of flow measuring elements shall conform to the manufacturer's published literature. Provide each flow measuring element with an integral tab, or a metal tag on a corrosion-resistant steel wire, extending outside pipe covering, and stamped or printed in a visible position with manufacturer's name and address; serial number of meter to which it is to be connected; name, number, or location of equipment served; specified rate of flow; and multiplier to be applied to meter reading. Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double ferrule compression fittings for connection to tubing for permanently located meters or recorders. Tubes shall be calibrated in accordance with ASME recommendations.

(1) Venturi Tubes: Certified by the manufacturer for the actual

piping configuration and any necessary piping changes required for certification without additional cost to the Government. Throat diameter for each venturi tube shall be designed so that at specified rate of flow the scale reading will fall between 50 percent and 80 percent of full scale value. Select venturi tube sizes from the manufacturer's latest published tables of flow versus differential pressure. Unrecovered head loss at maximum flow shall not exceed 10 percent. Provide bronze or cast iron tubes with bronze-lined throats, with flanged, threaded, or welded ends to suit piping system. Provide bodies of fabricated steel and fittings of the same class as piping in which installed. Two integral meter taps shall be provided in each venturi tube. Connections for attachment to portable flow meter hoses shall be readily accessible and not over 6 feet above a floor or permanent platform.

(2) Pitot Tube Assemblies: Provide corrosion-resistant materials. Tubes shall be capable of measuring liquid flow through tube elements providing an averaged, interpolated flow measurement from a single, fixed position. Provide self cleaning elements and impact tube designed to rotate when turned by the operator to protect pressure-sensing elements of tube when not in use. Location and total amount of pitot tubes required for system flow measurement shall be as recommended by the manufacturer and as indicated.

c. Meters: Designed for a full scale pressure differential of 50 inches water gage for tubular type or 100 inches water gage for orifice type. Dials shall have square root or linear scales with developed length of not less than 12 inches. Provide flush mounted panel meters that read directly in gallons per minute. Dials of portable meters shall have square root scales reading from 0 to 100 gpm for use with multiplier stamped on orifice or tubular type. Provide meters designed for not less than 200 psi and protected against pressure surges. Meter bodies shall have taps for venting and draining.

(1) Permanently Mounted Meters: Each meter shall be connected completely ~~[~~as indicated~~]~~ ~~[~~and~~]~~ ~~[~~as specified~~]~~ and provided with the following: three valve manifold equalizer lines, two block valves, two vent and drain valves, and an integral pulsation damper. Overall accuracy of meters shall be plus or minus 2 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

~~(2) Portable Meters: Provide meter with a factory-fabricated carrying case with carrying handle. Provide case fitted to hold meter securely and to accommodate the following accessories:~~

~~(a) Two 15 foot lengths of connecting hose with suitable female connectors for connecting from meter to [venturi tube] [orifice flange] [pitot tube] pressure-tap nipples. Provide hose designed for a minimum service pressure of 125 psi or 150 percent of maximum system service pressure, whichever is greater.~~

~~(b) A completely assembled three-valve manifold with two block valves and vent and drain valves, piped and mounted on a base designed for use laying flat on a stationary surface.~~

~~(c) A bound set of descriptive bulletins, installation and~~

~~operating instructions, parts list, and a set of curves showing flow versus pressure differential for each orifice, venturi tube, or pitot tube with which meter is to be used.~~

~~(d) A metal instruction plate, secured inside cover, illustrating use of meter.~~

~~(e) Provide meters with overall accuracy of plus or minus 5 percent of full scale flow over a range from 20 to 100 percent of full scale flow.~~

2.4 TERMINAL UNITS

~~2.4.1 Finned Tube Radiators~~

~~[Steel tube and steel fin type FS S-R-2834]. [Copper tube and aluminum fin type CID A-A-50545, [shall have an adjustable damper].]~~

~~2.4.2 Convectors~~

~~CID A-A-50543 and CID A-A-50544, of design and capacity not less than that indicated.~~

2.4.1 Unit Heaters

Provide hot water unit heaters as specified in Section 23 82 00.00 20 TERMINAL HEATING UNITS.

2.4.2 Heating and Ventilating Units

Provide fan-coil units, induction units, unit ventilators, and gravity ventilators as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5 ELECTRICAL EQUIPMENT

Provide complete with motors, motor starters, thermal overload protection, and controls. Equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.6 CONTROLS

Provide controls as specified in Section 23 09 ~~53.00 20~~00.00 22 ~~SPACE TEMPERATURE CONTROL SYSTEMS~~INSTRUMENTATION AND CONTROL FOR HVAC.

2.7 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 ASBESTOS PROHIBITION

Asbestos and asbestos containing products are prohibited.

PART 3 EXECUTION

3.1 PREPARATION

Provide storage for equipment and material at the project site. All parts shall be readily accessible for inspection, repair, and renewal. Protect

material and equipment from the weather.

3.2 INSTALLATION

Piping fabrication, assembly, welding, soldering, and brazing shall conform to ASME B31.9. Piping shall follow the general arrangement shown. Route piping and equipment within buildings out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit welding of joints and application of insulation. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate until piping has been inspected, tested, and approved. Do not run piping concealed in walls, partitions, underground, or under the floor except as otherwise indicated. Where pipe passes through building structure, locate pipe joints and expansion joints where they may be inspected. Provide flanged joints where necessary for normal maintenance and where required to match valves and equipment. Furnish gaskets, packing, and thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and shall be free from appreciable flattening, wrinkling, or thinning of the pipe. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make branch connections over 2 inches with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.9 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Branch connections 2 inches and under can be threaded or welded. Run vertical piping plumb and straight and parallel to walls. Provide sleeves for lines passing through building structure. Provide a fire seal where pipes pass through fire wall, fire partitions, fire rated pipe chase walls, or floors above grade. Install piping connected to equipment with flexibility for thermal stresses and for vibration, and support and anchor so that strain from weight and thermal movement of piping is not imposed on the equipment.

3.2.1 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Band and secure insulation protection shields without damaging pipe insulation. Continuous inserts and expansion bolts may be used.

3.2.2 Grading of Pipe Lines

Unless otherwise indicated, install horizontal lines of hot water piping to grade down in the direction of flow with a pitch of not less than one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction.

3.2.3 Pipe Sleeves

Provide sleeves where pipes and tubing pass through masonry or concrete walls, floors, roof, and partitions. Annular space between pipe, tubing, or insulation and the sleeve shall not be less than 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire

thickness of walls, partitions, or slabs. Sleeves in floor slabs shall extend 2 inches above finished floor. Firmly pack space between pipe or tubing and sleeve with oakum and caulk on both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a ~~[mechanically adjustable]~~ segmented elastomeric seal. Seal both ends of penetrations through fire walls and fire floors to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3.2.4 Flashing for Buildings

Provide flashing where pipes pass through building roofs, and make outside walls tight and waterproof.

3.2.5 Unions and Flanges

Provide unions and flanges to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve shall have a union. Place unions and flanges no farther apart than 100 feet. Install unions downstream of valves and at equipment or apparatus connections. Provide unions on piping under 2 inches in diameter, and provide flanges on piping 2 inches and over in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous-to-non-ferrous connections.

3.2.6 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

3.2.7 Changes in Pipe Size

Provide reducing fittings for changes in pipe size; reducing bushings are not permitted. In horizontal lines, provide eccentric reducing fittings to maintain the top of the lines in the same plane.

3.2.8 Cleaning of Pipe

Thoroughly clean each section of pipe, fittings, and valves free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and tap along its full length to loosen sand, mill scale and other foreign matter. For pipe 2 inches and larger, draw wire brush, of a diameter larger than that of the inside of the pipe, several times through the entire length of pipe. Before making final connections to apparatus, wash out interior of piping thoroughly with water. Plug or cap open ends of mains during shutdown periods. Do not leave lines open where foreign matter might enter the pipe.

3.2.9 Valves

Install valves in conformance with ASME B31.9. Provide gate valves unless otherwise directed. Install valves with stems horizontal or above. Locate or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

3.2.9.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem

horizontal.

~~3.2.9.2 Radiators Valves~~

~~Provide radiator valves on water inlet and balancing valves on water outlet of terminal heating units such as radiation, unit heaters, and fan coil unit.~~

3.2.9.2 Relief Valves

Provide valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks. Select system relief valve so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Pipe relief valve outlet to the nearest floor drain.

3.2.10 Pressure Gage

Provide a shut-off valve or pet cock between pressure gages and the line.

3.2.11 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of flowing the fluid and minimize obstruction to flow.

3.2.12 Strainers

Provide strainers, with meshes suitable for the services, where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.2.13 Pumps

Select pumps for specified fluid temperatures, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve. Support piping adjacent to pump such that no weight is carried on pump casings. Install close coupled and base mounted pumps on concrete base, with anchor bolts, set and level, and grout in place and provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Lubricate pump before start-up.

3.2.14 Equipment Foundations

Locate equipment foundations as shown on the drawings. Size, weight, and design shall preclude shifting of equipment under operating conditions. Foundations shall meet the requirements of the equipment manufacturer. Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE, and grout shall be approved non-shrinking.

3.2.15 Equipment Installation

Install equipment in accordance with installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on the equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets.

3.2.16 Cleaning of Systems

As installation of the various system components is completed, fill, start, and vent prior to cleaning. Place terminal control valves in open position. Add cleaner to closed system at concentration as recommended by manufacturer. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed. Use neutralizer agents on recommendation of system cleaner supplier and approval of ~~Contracting Officer~~QC Manager. Remove, clean, and replace strainer screens. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Preliminary or final tests are not permitted until cleaning is approved.

3.2.17 Painting of Piping and Equipment

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.18 Identification of Piping

Identify piping in accordance with OSHA 29 CFR 1910.144, except that labels or tapes may be used in lieu of painting or stenciling. Spacing of identification marking on runs shall not exceed 50 feet. Materials for labels and tapes shall conform to CID A-A-1689, and shall be general purpose type and color class. Painting and stenciling shall conform to Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that piping and equipment, as installed, is in compliance with contract requirements. Start up and operate the system. During this time, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments to place them in proper operation and sequence.

3.3.1 Hydrostatic Test of Piping System

Test piping system hydrostatically using water not exceeding 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.9 and as follows. Test piping system after all lines have been cleaned and before applying insulation covering. Remove or valve off from the system, gages, and other apparatus which may be damaged by the test before the tests are made. Install calibrated test pressure gage in the system to observe any loss in pressure. Maintain test pressure for a sufficient length of time to enable an inspection of each joint and connection. Perform tests after installation and prior to acceptance. Notify the ~~Contracting Officer~~QC Manager in writing 7~~[ ]~~ days prior to the time scheduled for the tests.

3.3.2 Auxiliary Equipment and Accessory Tests

Observe and check pumps, accessories, and equipment during operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading.

3.3.2.1 Backflow Preventers

Backflow preventers shall be tested by locally approved and certified backflow assembly testers. A copy of the test report shall be provided to the ~~Contracting Officer~~QC Manager prior to placing the domestic water system into operation, or no later than 5 days after the test.

3.4 TESTING, ADJUSTING, AND BALANCING

~~[Except as specified herein, perform in accordance with SMACNA 1780, Chapter VIII "Hydronic System TAB Procedures," drawings and specifications; prepare complete report of final test results.]~~ ~~[~~Test, adjust, and balance the hydronic system in accordance with Section 23 05 93.00 22 TESTING, ADJUSTING AND BALANCING FOR ~~HVAC~~MECHANICAL SYSTEMS.~~]~~

3.4.1 Markings of Settings

Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at anytime.

~~3.4.2 Sound Level Tests~~

~~Upon completion of testing and balancing of hydronic systems, conduct sound level tests of conditioned spaces. Use sound level meter required by ASA S1.4, Type 2, calibrated in accordance with NBS standards and guidelines, and accompanied by a certificate of calibration. Record sound levels in dBA with heating systems off and with heating systems operating. Record the following data for each room and system:~~

~~a. Background sound level (systems off);~~

~~b. Total sound level corrected for background; and~~

~~c. Sound power rating by manufacturer of the respective outlet.~~

~~Test Locations: Take sound level reading at location 6 feet from face of each outlet on a line at 45 degrees with face of outlet. Remedial Action: If sound level at any observation point exceeds [20] [45] [_____] dBA, take remedial action as directed.~~

-- End of Section --

SECTION 23 21 23

HYDRONIC PUMPS
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(~~2014~~2014; ERTA 1-2 2015; ERTA 3-4 2017) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2016) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions
HI 1.3	(2013) Rotodynamic (Centrifugal) Pump Applications
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 2.1-2.2	(2014) Rotodynamic Vertical Pumps of Radial, Mixed, and Axial Flow Types for Nomenclature and Definitions

HI ANSI/HI 9.6.3	(2017) Rotodynamic Pumps - Guideline for Operating Regions - B120
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21	(1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)
SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

UNDERWRITERS LABORATORIES (UL)

UL 778	(2016; Reprint Jun 2020) UL Standard for Safety Motor-Operated Water Pumps

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

System Coordination~~; G[, [_____]]~~

SD-03 Product Data

Instructions~~; G[, [_____]]~~

Equipment Data~~; G[, [_____]]~~

Training Period~~; G[, [_____]]~~

SD-06 Test Reports

~~Factory Tests~~

Field Quality Control

SD-07 Certificates

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals~~; G[, [_____]]~~

Training~~; G[, [_____]]~~

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer Services

Provide the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, testing of the equipment, and conduct training.

Submit the names and qualifications of the manufacturer's representative and training engineers and written certification from the manufacturer that the representative and trainers are technically qualified.

1.3.2 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory HVAC operation at least 2 years prior to issuance of this solicitation. Support equipment with a service organization that is reasonably convenient to the jobsite. Pumps ~~[and] [motors]~~ of the same types must each be the product of one manufacturer.

1.3.3 Conformance with Agency Requirements

Where materials or equipment are specified to be an approved type, attach the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services. A written certificate from the testing agency must accompany the materials or equipment and be submitted stating that the items have been tested and that they conform to the applicable requirements of the specifications and to the standards listed herein. The certificate must indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement to the effect that the items are in accordance with the applicable requirements of the specifications and the referenced standards, will be considered and may be acceptable as evidence that the items conform with agency requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment, delivered and designated for storage, from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Hydronic pumps used for heating and air conditioning applications are defined by the type of impeller, number of impellers, type of casing, method of connection to the driver, and mounting position. Provide centrifugal water pumps of the types indicated and specified. Use an electric motor driving unit for each pump as indicated and specified.

2.1.1 Selection Criteria

Select pumps at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency in the construction design documents. Pumps having impeller diameters larger or smaller than manufacturer's published maximum and minimum impeller diameters for a given impeller casing combination will be rejected. Pump performance data, as shown in performance curves, must be based on factory tests using precision instrumentation and exacting procedures as detailed in HI ANSI/HI 14.6.

2.1.2 System Coordination

Submit drawings containing complete wiring and piping schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show the proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Provide a complete listing of equipment, materials and miscellaneous components including mechanical seals, bearings, and couplings.

2.1.3 Safety Requirements

Fully enclose or guard couplings, projecting set-screws, keys, and other rotating parts, that pose an entangling hazards..

2.2 MATERIALS AND EQUIPMENT

2.2.1 Nameplates

Securely affix a standard nameplate to pumps and motors in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, for each pump show the capacity in gpm at rated speed in rpm and total head in feet of water. For each electric motor show at least the minimum information required by NEMA MG 1. Show such other information as the manufacturer may consider necessary to complete identification on the nameplate. Pumps must be listed and labeled by UL, and comply with UL 778 for pumps not using universal motors rated more than 250 volts such as circulating pumps.

2.2.2 Framed Instructions

Submit proposed diagrams, instructions, and other sheets, prior to posting. Post approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, where directed. Provide condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

2.2.3 Pump Characteristic

Construct hydronic water pumps in accordance with HI 1.1-1.2 and HI ANSI/HI 2.1-2.2. The pumps must be capable of discharging quantities at total discharge heads measured at the discharge flange, between the following limits:

Operate pumps at optimum efficiencies to produce the most economical pumping system under the conditions encountered ~~[and size to make optimum match with the system head curve as shown]~~.~~[Suction lift on Pump No. [_____] must not be more than [_____] feet.] Pumps must furnish not less than 150 percent of rated capacity at a total discharge head of not less than 65 percent of total rated head.[The shutoff total head must not be greater than 120 percent of total rated head.]~~ Operate pumps at specified system fluid temperatures without vapor binding and cavitation. Operate pumps to HI ANSI/HI 9.6.3 standard for Preferred Operationg Region (POR).

2.2.4 Pump Drivers

Provide electric motors as indicated for each pump~~ and in compliance with Section [26 20 00 INTERIOR DISTRIBUTION SYSTEM] [26 60 13.00 40 LOW-VOLTAGE MOTORS]~~.

2.2.5 Equipment Data

Submit manufacturer's descriptive data and technical literature, performance charts and curves for all impeller sizes for a given casing, catalog cuts, and installation instructions. Provide spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3~~[_____]~~ months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and local source of supply with contact information.

Submit catalog information, certified pumps curves, rated capacities, final impeller dimensions, and accessories provided for the product indicated. Indicate operating point of each pump on curves. Furnish pump curves for each pump and combination of pumps designed to operate in parallel. The pump curve must show as a minimum; bhp, flow, total dynamic head, efficiency, NPSH, impeller diameter and system curve (individually and in combination for each pump operating in a parallel application). Select pumps operating in parallel operation to cross the system curve when operating individually.

2.3 HYDRONIC PUMPS

Provide centrifugal, ~~[~~single-stage type,~~][or][multi-stage type,]~~ designed for HVAC service in the ~~following~~ configurations~~:~~ specified on the design plans.

~~Configuration~~	~~Pump No.~~
~~Circulator~~	~~[_____]~~
~~Small In-Line~~	~~[_____]~~
~~Large In-Line~~	~~[_____]~~
~~Base-Mounted, Flexible Coupled, End Suction~~	~~[_____]~~
~~Base-Mounted, Close Coupled, End Suction~~	~~[_____]~~
~~Base-Mounted, Flexible Coupled, Double Suction, [Horizontally] [and] [Vertically] Split~~	~~[_____]~~
~~Vertical Lineshaft Turbine~~	~~[_____]~~
~~Automatic Cooling Coil Condensate Pump Units~~	~~[_____]~~

2.3.1 Circulator

Provide pumps with capacities as indicated of a horizontal, ~~[~~in-line, three piece oil lubricated~~]~~ ~~[wet rotor]~~ circulator type specifically designed for quiet operation. Suitable for 225 degrees F operation at ~~[~~125 ~~][_____]~~ psig working pressure. The pump must be single stage with ~~[flanged] [~~union~~]~~ piping connections. The pump internals must be capable of being serviced without disturbing piping connections.

~~[~~ a. The three piece pump must be composed of three separable components a motor, bearing assembly, and ~~[cast iron] [~~lead free bronze certified in accordance with NSF 372 pump end (wet end). The motor shaft must be connected to the pump shaft via a replaceable flexible coupler.~~]~~

~~]~~

~~[b. Wet rotor circulator for potable water service must be lead content certified in accordance with NSF 372.~~

~~]~~

2.3.1.1 Seal Assembly

Pump must be equipped with an internally flushed mechanical seal assembly. Seal assembly must have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

~~2.3.1.2 Motor Mount~~

~~To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to~~

assist in aligning the motor shaft with the pump shaft.

2.3.1.2 Motors

Motors must meet scheduled horsepower, speed, voltage, and enclosure design. Motors must be drip proof, maintenance free, premium efficiency and meet NEMA MG 1 specifications.

[Pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets must be time stable, non-toxic ceramic magnets. Drive the electrically commuted electrical motor by a frequency converter with an integrated PFC filter.
]

2.3.2 Small In-Line

Provide pumps with capacities as indicated,suitable for 225 degrees F operation at [175][_____] psig working pressure. The pump must be single stage, in-line design, in cast iron bronze fitted construction. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.2.1 Pump Shaft

The pump must have a solid steel shaft with a coupler between the pump and motor shafts. For non-stainless steel shafts, employ a non-ferrous shaft sleeve to completely cover the wetted area under the seal.

2.3.2.2 Bearing

The bearing assembly must house maintenance-free permanently lubricated bearings.

2.3.2.3 Seal Assembly

Equip the pump with an internal self-flushing mechanical seal assembly. Seal assembly must have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

2.3.2.4 Impeller

Provide impeller of cast bronze or brass material. Impeller must be hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to the shaft and secured by a locking capscrew or nut.

2.3.2.5 Volute

Pump volute must be of cast iron. The connection style on cast iron pumps must be flanged.

2.3.2.6 Motor Mount

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

2.3.2.7 Motors

NEMA MG 1; premium efficiency; non-overloading at any point on the pump

~~curve; maintenance free with permanently lubricated bearings; and resilient mounted for smaller sizes, rigid mounted otherwise.~~

2.3.2 Large In-Line

Provide pumps with capacities as indicated; ~~[split-coupled] [~~closed coupled ~~]~~, in-line, single stage, for installation in ~~[~~vertical or~~]~~ ~~[~~horizontal (where close coupled)~~]~~ position, and. suitable for 225 degrees F operation at ~~[~~175~~][_____]~~ psig working pressure. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.2.1 Casing

Provide pump casing complying with ASTM A48/A48M Class 30 cast iron, suitable for ~~[~~175~~][_____]~~ psig working pressure with integral cast iron flanges drilled for ASME B16.1 ~~[~~ANSI Class 125~~]~~ ~~[ANSI Class 250]~~ flanges, with an integrally-cast support ring matching an Class 125 flange for pump support. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.2.2 Pump Shaft

Provide carbon or stainless steel pump shaft, guided by a carbon graphite lower throttle bushing. Carbon steel pump shaft must have a bronze shaft sleeve that completely covers the wetted area under the seal.

2.3.2.3 Seal Assembly

Equip the pump with a mechanical seal assembly consisting of a carbon seal rotating ring, stainless steel spring, ceramic seat and flexible bellows and gasket. The liquid cavity must have a tapped flush line with manual valve to remove air from the seal chamber to allow fast initial start-up and insure mechanical seal cooling.

~~2.3.2.4 Spacer Coupling~~

~~The axially split spacer coupling must be of high tensile aluminum, split to allow the servicing of the seal without disturbing the pump or motor. Pump coupler must be aligned by the manufacturer before shipment. The motor bracket must contain a carbon steel coupler guard conforming to 29 CFR 1910.219 standards for safety.~~

2.3.2.4 Impeller

Hydraulically and dynamically balance the impeller to HI 9.6.4 balance grade G6.3, closed, single suction, fabricated from cast bronze, keyed to the shaft and secured by a locking capscrew.

2.3.2.5 Motor

Electric motors must meet NEMA MG 1 and the horsepower, speed, voltage, indicated. Motor enclosure must be open drip proof~~[~~, totally enclosed fan cooled~~]~~, with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide open drip proof motor efficiencies as shown in ASHRAE 189.1. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

Include one-piece combination motor bracket and volute coverplate in the assembly to ensure concentric alignment of the motor to the pump casing.

2.3.3 Base-Mounted, Flexible Coupled, End suction

Provide pumps with capacities as indicated; base mounted, separately-coupled, end suction designed with volute housing mounted to the frame to allow for pump service without relocating the motor or disturbing piping connections. Bearings and seals must be serviceable without disturbing piping. Pump must be factory hydrostatically tested in accordance with Hydraulic Institute standards and thoroughly cleaned.

2.3.3.1 Casing

Provide radially split pump casing ASTM A48/A48M Class 30 cast iron suitable for ~~[~~175~~][250][_____]~~ psig working pressure with integral cast iron flanges drilled for ASME B16.1 ~~[~~ANSI Class 125~~]~~ ~~[ANSI Class 250]~~ flanges, with an integrally-cast pedestal support foot. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.3.2 Pump Shaft

Carbon steel pump shaft with a replaceable ~~[bronze][~~stainless steel~~]~~ shaft sleeve completely covering the wetted area of the shaft under the seal.

2.3.3.3 Bearing

Incorporate maintenance free, permanently lubricated and sealed bearings in the pump bearing frame. ~~[Regreasable ball bearing type with provision for purging or flushing through the bearing surface and greased while running after start-up.]~~

2.3.3.4 Seal Assembly

Equip with an integrally flushed mechanical seal assembly or a positive pressure external seal flushing line. Provide a mechanical seal with ceramic seal seat and carbon seal ring. Seal assembly must be rated up to 225 degrees F.

2.3.3.5 Baseplate

Baseplate must be of steel construction fully enclosed at sides and ends with welded cross members and fully open grouting area for field grouting. Minimum base plate stiffness must conform to HI 1.3 for horizontal baseplate design standards.

2.3.3.6 Coupler

Provide a flexible-type coupler between the pump and motor, capable of absorbing torsional vibration and variable speed operation between the pump and motor. The coupler must allow replacement with no need to move the hubs. Coupler must have natural rubber or neoprene type element materials with a maximum misalignment capability of 4 degrees angular and 0.125 inches parallel. Provide donut shaped elastomer element with preassembled flanges mechanically clamped to reinforced element and preassembled spacer center assembly. Secure flexible donut shaped element of coupler in place with radial clamp ring screws. Couplers must be rated for required maximum rpm, horsepower and torque. The coupler must be

shielded by a coupler guard securely fastened to the base. Provide coupler guard in compliance with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Guards cannot have gaps greater than 0.250 inches, must be safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.3.3.7 Impeller

Hydraulically and dynamically balance to HI 9.6.4 balance grade G6.3, closed, overhung, single suction, fabricate from cast bronze, key to shaft and secured by a locking capscrew.

2.3.3.8 Motor

Electric Motors must meet NEMA MG 1 and be the horsepower, speed, and voltage indicated. Motor enclosure must be open drip proof ~~[~~totally enclosed fan cooled~~]~~. Motor must have heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Open drip proof motor efficiencies must comply with ASHRAE 189.1. ~~[~~Totally enclosed fan cooled motor efficiencies must comply with NEMA MG 1.~~]~~

~~2.3.4 Base-Mounted, Close Coupled, End Suction~~

~~Provide pumps with capacities as indicated. Pump must be base mounted, close coupled, single stage, end suction design capable of being serviced without disturbing piping connections.~~

~~2.3.4.1 Casing~~

~~Provide pump volute of Class 30 cast iron suitable for [175][_____] psig working pressure. Include vent, drain and gauge tappings.~~

~~2.3.4.2 Seal Assembly~~

~~Seal off the liquid cavity at the motor shaft by an internally flushed mechanical seal or a positive pressure external seal flushing line with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 degrees F. A replaceable shaft sleeve of bronze alloy must completely cover the wetted area under the seal.~~

~~2.3.4.3 Impeller~~

~~Provide cast bronze or 304 stainless steel impeller, enclosed type, hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to shaft and secured by a locking capscrew.~~

~~2.3.4.4 Motor~~

~~Electric Motors must comply with NEMA MG 1 and be the horsepower, and voltage indicated. Motor enclosure must be [open drip proof] [totally enclosed fan cooled]. provide with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor and pump impeller is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide open drip proof motor efficiencies in compliance with ASHRAE 189.1. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.~~

~~2.3.5 Base-Mounted, Flexible Coupled, Double Suction[,] [Horizontally Split][and][Vertically Split]~~

~~Provide pumps with capacities as indicated; base mounted, flexible coupled, double-suction, [horizontal] [and] [vertical] split case design, single stage centrifugal pump. Construction must be cast iron - bronze fitted, equipped with mechanical seals. Bearings and seals must be serviceable without disturbing piping or motor. Factory hydrostatically test the pump in accordance with Hydraulic Institute standards and thoroughly clean.~~

~~2.3.5.1 Casing~~

~~Provide ASTM A48/A48M Class 30 or ASTM A159 cast iron pump casing, suitable for [175][_____] psig working pressure, with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges. Supply the pump volute with plugged vent, drain, and gauge tappings.~~

~~2.3.5.2 Bearings~~

~~Incorporate maintenance free, permanently lubricated and sealed bearings with an L10 life of 60,000 hours minimum in the pump bearing frame.[~~

~~Incorporate regreasable ball bearing type pump bearing frame with provision for purging or flushing through the bearing surface and greased while running after start-up.]~~

~~2.3.5.3 Seal Assembly~~

~~Seal off liquid cavity by an internally-flushed seal assembly. Seal assembly must have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon face rotating against a stationary silicon carbide seat. Provide replaceable mechanical seals without disturbing the upper casing half and system piping. Seals must be suitable for continuous operation at 225 degrees F. Arrange to assure that seal leakage cannot enter the bearing housings.~~

~~2.3.5.4 Coupler~~

~~Provide a flexible-type coupler between the pump and motor capable of absorbing torsional vibration and variable speed operation. The coupler must allow replacement with no need to move the hubs. Coupler must have natural rubber or neoprene type element materials with a maximum misalignment capability of 4 degrees angular and 0.125 inches parallel. Provide donut shaped elastomer element and with preassembled flanges mechanically clamped to reinforced element and preassembled spacer center assembly. Secure flexible donut shaped element of coupler in place with radial clamp ring screws. Couplers must be rated for required maximum rpm, horsepower and torque. Shield the coupler by a coupler guard securely fastened to the base. Coupler guard must comply with current national safety standards including 29 CFR 1910.219, and NEMA Z535.4. Provide guards with gaps no greater than 0.250 inches, of safety orange in color, and have an NEMA Z535.4 compliant warning label.~~

~~2.3.5.5 Base Plate~~

~~Provide baseplate of steel construction fully enclosed at sides and ends with welded cross members and fully open grouting area for field grouting. Minimum base plate stiffness must conform to HI 1.3 for~~

horizontal baseplate design standards.

2.3.5.6 Impeller

Bronze or brass enclosed double suction type, both hydraulically and dynamically balanced to HI 9.6.4 grade G6.3, keyed to shaft and fixed in an axial position. Hub must have sufficient metal thickness to allow machining for installation of impeller rings.

2.3.5.7 Motor

Provide electric motor conforming to NEMA MG 1 and of the horsepower, and voltage indicated. Motor enclosure must be open drip proof [totally enclosed fan cooled]; with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Open drip proof motor efficiencies must be as shown in ASHRAE 189.1. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

2.3.5.8 Pump Shaft

Provide pump shaft of solid 416 stainless steel shaft or solid carbon steel shaft with replaceable bronze or 304 stainless steel shaft sleeve covering wetted area of shaft.

2.3.6 Vertical Lineshaft Turbine

Provide pumps with capacities as indicated. Pump must be vertical lineshaft turbine manufactured for lubrication of the line-shaft bearings by the water being pumped. Design and manufacture the pumping unit in accordance with HI ANSI/HI 2.1-2.2 standards AWWA E103.

2.3.6.1 Bowl Assembly

Flange type construct the intermediate bowls, discharge cases and suction bowls from ASTM A48/A48M Class 30 close grain cast iron. They must be free of defects and accurately machined and fitted to ASME B4.1 close tolerances. Epoxy enamel coat the intermediate bowls waterways for maximum efficiency. Thread all threaded discharge cases for water lubricated column assembly. All assembly bolting must be stainless steel. Provide intermediate bowl bearings.

2.3.6.2 Pump Shaft

Construct the bowl shaft from ASTM A582/A582M type 416 stainless steel, precision ground and polished with surface finish better than 40 RMS.

2.3.6.3 Lineshaft

Vertical pump lineshaft must be open and constructed from ASTM A582/A582M type 416 stainless steel. Straighten lineshaft sections to 0.0005inch/foot total runout. Lineshaft sections must not exceed 10 feet in length and must be coupled with threaded stainless steel couplings. Design the diameter of the lineshaft and coupling in accordance with AWWA E103.

2.3.6.4 Impeller

Provide impellers of ASTM B584 silicon bronze or stainless steel, the

~~enclosed type. They must be free from defects, machined, and balanced to HI 9.6.4 balance grade G6.3 for optimum efficiency and performance. Securely fasten to the bowl shaft with stainless steel taper lock collets. The impellers must be adjustable by means of a top shaft adjusting nut or adjustable solid shaft coupling.~~

~~2.3.6.5 Discharge Head~~

~~Construct the discharge head, sized for pump capacity, of ASTM A48/A48M Class 30 high grade ductile iron or fabricated steel of the high profile type with an integral motor base which allows the head shaft to be coupled to the top shaft above the stuffing box. A separate motor stand is not acceptable. The discharge head must have an ASME B16.1 (for cast iron) or Class 150 (for steel) discharge flange supplied with dual 1/4 inch NPT ports at the top. Thread the head to accept the column pipe.~~

~~2.3.6.6 Stuffing Box~~

~~Provide stuffing box of cast or ductile iron, ASTM A536 class 65, and containing a minimum of five rings of packing; with an available fitting for pressure relief. The packing follower gland must be stainless steel and secured in place by stainless steel studs and nuts. The packing box bearing must be bronze. Provide a water slinger to operate on the top shaft, above the packing gland.~~

~~2.3.6.7 Mechanical Seal~~

~~Provide a mechanical seal.~~

~~2.3.6.8 Column Pipe~~

~~Provide column pipe of ASTM A53/A53M grade B steel pipe not less than Schedule 30. Machine the column ends with threads and faced parallel to the threads to ensure proper alignment. Connect the pipe with threaded sleeve type ductile iron couplings or flanges that will accept 3/4 inch stainless steel or bonze bearing retainers. Lineshaft bearings must be fluted rubber retained in a centering spider retainer.~~

~~2.3.6.9 Basket Strainer~~

~~Provide and attach a stainless steel basket strainer of a suitable size to the pump suction with stainless steel fasteners. Strainer must have a net inlet area equal to at least three times the impeller inlet area. The maximum opening must not be more than 75 percent of the maximum opening of the water passage through the bowl or impeller.~~

~~2.3.6.10 Motor~~

~~Electric motor must meet NEMA MG 1 and be the size and voltage indicated. Provide [1800RPM] [_____] motor with NEMA Class B or Class F insulation. The motor must have a vertical hollow (or solid) shaft motor with space heaters and a non-reverse ratchet (or self-release coupling) to prevent reverse rotation. The motor must have an angular contact thrust bearing to meet the designed pump's hydraulic thrust load plus the weight of the rotating parts under operating conditions. Provide high efficiency motor with a weather protected WP-1 enclosure, [230/460] [_____] volt, [3] [1] phase, 60HZ, and a [1.15] [_____] service factor. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor with efficiencies in compliance with NEMA MG 1.~~

2.3.4 Cooling Coil Condensate Pump Units

Provide pumps with capacities as indicated. Cooling Coil Condensate Pump Unit must be a packaged unit including a corrosion-resistant pump, plastic tank with cover, and automatic controls. Include ~~[~~factory~~]~~ ~~[field]~~ installed check valve and a 72 inch minimum, electrical power cord with plug for 120V/1PH/60HZ electrical service.

2.3.4.1 Motor

Electric motor must comply with NEMA MG 1 and be the size, voltage and enclosure indicated. Provide heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed.

2.4 ELECTRICAL WORK

Provide electrical motor driven equipment specified herein complete with motors, motor starters, and controls. Provide electric equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics must be as indicated. Provide motor starters complete with properly sized thermal overload protection in each phase and other appurtenances necessary for the motor control specified. Each motor must be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage and frequency. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required for controls and devices but not indicated must be provided under this section of the specifications.

2.5 ELECTRICAL EQUIPMENT

Provide electrical equipment in conformance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment herein specified complete with motors, motor starters, and controls. Motor controls, equipment, and wiring must be in accordance with NFPA 70.

2.5.1 Electric Motors

Drive each electric motor-driven pump by a continuous-duty electric motor with enclosure type for specific service as defined in paragraph HYDRONIC PUMPS. Motor must have a ~~[~~1.5~~]~~ ~~[_____]~~ service factor. Provide ~~[~~ squirrel-cage induction or~~][~~synchronous~~]~~ motors having normal-starting-torque and low-starting-current characteristics, and of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1. Pump electric motor efficiencies must meet or exceed the requirements of ASHRAE 189.1, Table C-13. Motor bearings must provide smooth operations under the conditions encountered for the life of the motor. Provide adequate thrust bearing in the motor to carry the weight of all rotating parts plus the hydraulic thrust and be capable of withstanding upthrust imposed during pump starting~~[~~ and under variable pumping head conditions specified~~]~~. Motors must be rated 460~~[_____]~~ volts, 3~~[_____]~~ phase, 60 Hz and such rating must be stamped on the nameplate. Provide motors in conformance with NEMA MG 1.

2.5.2 Control Equipment

~~[Manually controlled pumps must have START-STOP pushbutton in cover.][~~ Automatically controlled pumps must have three-position "MANUAL-OFF-AUTOMATIC" selector switch in cover.~~]~~ Provide additional controls or protective devices as indicated. ~~[Install a pump low-water cutoff [in the well][on the suction pipe] and must shut the pump off when the water level in the well reaches the level shown.]~~

2.5.3 Variable Speed Control

The variable speed motor controllers must meet the requirements of UFGS 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.6 EQUIPMENT APPURTENANCES

2.6.1 Attachments

Furnish all necessary bolts, nuts, washers, bolt sleeves, and other types of attachments with the equipment for the installation of the equipment. Bolts conform to the requirements of ASTM A307 and hexagonal nuts of the same quality as the bolts used. Threads must be clean-cut and conform to ASME B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, must be zinc coated after being threaded, by the hot-dip process conforming to ~~[~~ASTM A123/A123M~~][~~ ~~ASTM A153/A153M]~~ as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel must be Type 316.

2.6.2 Equipment Guards

Provide equipment driven by open shafts, belts, chains, or gears with all-metal guards enclosing the drive mechanism. Secure guards in position with steel braces or straps that permit easy removal for servicing the equipment. Coupler guards must comply with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Provide guards with gaps no greater than 0.250 inches, safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.6.3 Tools

Furnish a complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Special tools must be high-grade, smooth, forged, alloy, tool steel. Furnish one pressure grease gun for each type of grease required. Deliver all tools at the same time as the equipment to which they pertain. Properly store and safeguard such tools until completion of the work, at which time deliver them to the ~~Contracting Officer~~QC Manager.

2.7 FINISHES

All motors, pump casings, and similar parts of equipment must be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Give ferrous surfaces not to be painted a shop coat of grease or other suitable rust-resistant coating.

~~[2.8 FACTORY TESTS~~

~~Pumps must be tested by the manufacturer or a nationally recognized testing agency in compliance with HI 1.3. Submit certified test results.~~

~~]~~PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the ~~Contracting Officer~~QC Manager of any discrepancy before performing the work.

3.2 INSTALLATION

Install each pump and motor in accordance with the written instructions of the manufacturer~~[and under the direct supervision of the manufacturer's representative]~~. Provide access space around the device for servicing no less than the minimum recommended by the manufacturer.

~~[3.2.1 Base Mounted, Long-Coupled Pumps~~

~~Set the pump baseplate as follows.~~

~~a. Place two sets of shims or wedges for each foundation bolt. Lower baseplate onto foundation bolts and level baseplate both lengthwise and across by adding or removing shims or mount wedges. A maximum difference of 0.125 inches lengthwise and 0.059 inches across is allowable.~~

~~b. Mount pump and driver on baseplate if not already mounted at factory. Pump and driver shafts must have initial cold (pump and driver at ambient temperature) alignment check and final hot (pump and driver at operating temperature) alignment check. Perform cold alignment check before baseplate is grouted, after baseplate is grouted, and after piping is connected. Perform final alignment check when pump and driver are at operating temperature. Move or shim only the driver to make adjustments to prevent strain on the piping installations. Initial alignment may be performed with scales, straight edges and calipers. Final alignment must be done with dial gauges or laser alignment devices. Final alignment misalignment may not exceed coupling manufacturer's maximum parallel and angular misalignment values. When using variable frequency drives, reduce the manufacturer's misalignment values by 50 percent. Remove flexible coupling when performing alignment.~~

~~c. Support the connecting piping to ensure that there are no piping loads at the pump flange connections and connecting piping is not forced into position. [Use concrete for equipment foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete foundations that are integral with and of the same class as that of the building floor unless otherwise indicated. Use concrete having a compressive strength of at least 2,500 psi in foundations that are entirely separated from the surrounding floor. Install a premolded filler strip between the foundation and floor slab as shown. Furnish foundation bolts, as required, for proper positioning during the placement of the concrete.]~~

~~]~~3.3 FIELD QUALITY CONTROL

After installation of the pumping units and appurtenances, including coupling guard, is complete, carry out operating tests to assure that the pumping installation operates properly.~~[Make arrangements to have the manufacturer's representatives present when field equipment tests are made.]~~ Give each pumping unit a running field test in the presence of the ~~Contracting Officer~~QC Manager for a minimum of 2 hours. Operate each pumping unit at its rated capacity or such other point on its head-capacity curve selected by the ~~Contracting Officer~~QC Manager. Provide an accurate and acceptable method of measuring the discharge flow. Tests must assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report must indicate the final position of controls.

3.4 FIELD PAINTING

Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.4.1 Touch-up painting

Factory painted items requiring touching up in the field must be thoroughly cleaned of all foreign material, and primed and topcoated with the manufacturer's standard factory finish.

3.4.2 Exposed Ferrous Surfaces

Paint exposed ferrous surfaces with two coats of enamel paint conforming to SSPC Paint 21. Solvent clean factory primed surfaces before painting. Surfaces that have not been factory primed must be prepared and primed with one coat of SSPC Paint 25 or in accordance with the enamel paint manufacturer's recommendations.

3.5 CLOSEOUT ACTIVITIES

3.5.1 Operation and Maintenance Manuals

Submit one complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Permanently bind each in a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the building, name of the Contractor, and contract number. Place flysheets before instructions covering each subject. Use 8-1/2 by 11 inches paper for instruction sheets, with large sheets of drawings folded in.

Include, but do not limit to, the following in the Instructions:

a. System layout showing piping, valves, and controls.

b. Approved wiring and control diagrams~~[~~ including variable frequency drives~~]~~.

c. A control sequence describing startup, operation, and shutdown.

d. Operating and maintenance instructions for each piece of equipment, including task list for routine maintenance, routine inspections, intermediate inspections, and annual inspections; lubrication instructions; and troubleshooting guide.

e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

3.5.2 Training

Upon completion of the work, and at a time designated by the Contracting Officer, provide the services of one or more competent engineers for a training period of not less than 8[ ] hours to instruct a representative of the Government in the contents of the operation and maintenance manuals for the equipment furnished under these specifications. These field instructions must cover all the items contained in the bound instructions. Submit the training course curriculum and training instructions 14 days prior to the start of training.

-- End of Section --

SECTION 23 22 26.00 20

STEAM SYSTEM AND TERMINAL UNITS
02/10, CHG 1: 05/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.20	(2017) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2016) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300

ASME B18.2.1 (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)

ASME B18.2.2 (2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B31.1 (2020) Power Piping

ASME B40.100 (2013) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASME BPVC SEC VIII D1 (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1 (2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A106/A106M (2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A194/A194M (2020a) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

ASTM A307 (2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

ASTM B32 (2020) Standard Specification for Solder Metal

ASTM B88 (2020) Standard Specification for Seamless Copper Water Tube

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (2016; 14/17) Copper Tube Handbook

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-45 (2020) Bypass and Drain Connections

MSS SP-58 (2018) Pipe Hangers and Supports -

	Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-18436	(2017; Rev G) Valves, Check, Bronze, Cast Iron, and Steel Body

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-50494	(Basic; Notice 1) Exhaust Head, Steam
CID A-A-50568	(Basic; Notice 1) Gages, Liquid Level Measuring, Tank
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
CID A-A-60001	(Rev A) Traps, Steam
FS F-V-2906	(Basic; Notice 1) Valves, Air Venting, Steam
FS QQ-B-654	(Rev A; Notice 1; Notice 2) Brazing Alloys, Silver
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

1.2 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein. This section includes steam and condensate piping, ~~[unit heaters,] [convertors,] [condensate return units,] [radiation units,] [and steam coils]~~ used for h~~eating~~umidification within the building. Steam boilers, feedwater treatment equipment, process steam terminal units, boiler feed piping, and blow-off piping are not covered in this section.

1.2.1 Classes and Maximum Working Pressures

Equipment, piping, and piping components shall be suitable for use under the maximum working pressure indicated. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications.

1.2.2 Standard Commercial Product

The terminal units provided shall, as a minimum, comply with the features specified herein and shall be the manufacturer's standard commercial product. Additional or better features which are not specifically prohibited herein but which are a part of the manufacturer's standard commercial product, shall be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

1.2.3 Welding Safety

AWS Z49.1.

1.2.4 Definitions

1.2.4.1 High Pressure Piping System

A system whose pressure is greater than 15 psig and shall conform to ASME B31.1.

1.2.4.2 Low Pressure Piping System

A system whose pressure is 15 psig or less.

1.2.4.3 Terminal Unit

An enclosed unit that provides heated air from a steam coil and includes natural convection units, radiation, and forced air units.

1.2.4.4 Piping and Piping System

Includes pipe, tubing, flanges, bolting, gaskets, valves, safety valves, fittings, and pressure containing parts of other piping components, hangers, supports, guides, expansion joints, anchors, and other equipment items necessary to prevent overstressing the pressure containing parts.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

~~Unit Heaters~~

~~Convertors~~

~~Condensate Return Pumping Units~~

~~Finned Tube Radiation Units~~

~~Cast Iron Baseboard Radiation Units~~

~~Convectors~~

~~Steam to Air Heating Coils~~

Valves

Valve Operating Mechanism

Steam Meters

Traps

Strainers

Flash Tanks

Expansion Joints

Instrumentation

SD-06 Test Reports

Steam Piping tests

Copper Tubing test

Valves tests

Expansion Joints tests

Instrumentation tests

Pipe and Pipe System

~~Unit Heaters tests~~

~~Convertors tests~~

~~Condensate Return Pumping Units tests~~

~~Radiation Units tests~~

~~Steam to Air Heating Coils tests~~

Submit reports of tests required by the reference specification and standards.

SD-07 Certificates

Welding Procedure

Welder's Performance Qualification Record

List of Welders and Welder's Symbols

~~SD-08 Manufacturer's Instructions~~

~~Unit Heaters~~

~~Convertors~~

~~Condensate Return Pumping Units~~

~~Include manufacturer's recommendations for equipment foundations.~~

1.4 QUALITY ASSURANCE

1.4.1 Welding Procedure

Submit welding procedure specification for metals included in the work, together with proof of the procedure's qualifications as outlined in ASME B31.1.

1.4.2 Welder's Performance Qualification Record

Submit ~~[to the Contracting Officer]~~ the Welder's Performance Qualification Record in conformance with ASME B31.1 for each welder, showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, the Contractor shall submit list of welders and welder's symbols, assigned number, or letter which shall be used to identify the work of the welder which shall be affixed immediately upon completion of the weld. Welders making defective welds after passing a qualification test shall be required to take a requalification test. Welders failing the requalification tests will not be permitted to work under this contract.

1.4.3 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to approval if the conditions specified in ASME B31.1 are met before a procedure can be used.

PART 2 PRODUCTS

2.1 PIPE AND PIPE SYSTEM

2.1.1 High Pressure Steam Piping System (Over 15 psig)

ASME B31.1 for a steam working pressure of 125~~[_____] psig and a temperature of [_____] degrees F, a condensate pressure f [_____] psig, and a temperature of [_____] degrees F.~~.

2.1.1.1 High Pressure Steam Piping

ASTM A106/A106M or ASTM A53/A53M, Grade B, Schedule 40~~[_____]~~, black steel, ~~[~~electric-resistance welded~~]~~ ~~[~~or~~]~~ ~~[~~seamless~~]~~. Use ASTM A53/A53M pipe for bending.

2.1.2 Low Pressure Steam Piping System

ASME B31.1 for a steam working pressure of 15 psig or less~~, a condensate pressure of [_____] psig, and a temperature of [_____] degrees F~~.

2.1.2.1 Low Pressure Steam Piping

a. Steel Piping: ASTM A53/A53M, Schedule 40, black, {electric-resistance welded} {or} {seamless}. Use ASTM A53/A53Mpipe for bending.

b. Copper Tubing: ASTM B88, Type K.

2.1.3 Condensate Return Piping (100 psig or Less)

2.1.3.1 Steel Piping

ASTM A106/A106M or ASTM A53/A53M, Grade B, Schedule 80, black, {electric-resistance welded} {or} {seamless}.

2.1.3.2 Copper Tubing (15 psig or Less)

ASTM B88, Type K.

2.1.4 Fittings

Provide fittings compatible in all respects (material, size, pressure, and temperature limitations) with the pipe being used and within any further limitations of ASME B31.1.

2.1.4.1 Fittings for Steel Pipe

a. Sizes 1/8 to 2 inches:

(1) Steel Fittings: ASME B16.11, socket welding or threaded. Where pressure exceeds 15 psig, provide socket-welding type only.

(2) Malleable Iron Fittings: ASME B16.3, threaded.

b. Sizes 2 1/2 inches and larger:

(1) Steel Fittings: ASME B16.9, buttwelding or ASME B16.5, flanged.

(2) Bronze Fittings: ASME B16.24, flanged. Sizes larger than 8 inches are not permitted.

2.1.4.2 Fittings for Copper Tubing

ASME B16.18, cast copper alloy or ASME B16.22, wrought copper, solder joint type. Flared or compression joint type fittings for tube sizes not exceeding 2 inches outside diameter (O.D.) may be provided as permitted in ASME B31.1.

2.1.5 Unions

2.1.5.1 Unions for Steel Pipe

ASME B16.39, threaded.

2.1.5.2 Unions for Copper Tubing

CID A-A-59617, solder joint end type.

2.1.6 Flanges

Remove the raised faces on flanges when used with flanges having a flat face.

2.1.6.1 Steel Flanges

ASME B16.5, forged steel, welding type.

2.1.6.2 Bronze Flanges

ASME B16.24, threaded.

2.1.7 Valves

Shall conform to the following paragraphs. End connections shall conform to paragraph END CONNECTIONS.

2.1.7.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, ~~[~~Type 1 (solid wedge, non-rising stem)~~]~~ ~~[~~or~~]~~ ~~[~~Type 2 (solid wedge, inside screw, rising stem)~~]~~, 3 inches and smaller, threaded or solder joint ends, and not less than Class 150.

b. Steel Gate Valves: ASME B16.34. Provide outside screw and yoke type with solid wedge or flexible wedge disc, and with trim suitable for the service temperature and pressure.

2.1.7.2 Globe and Angle Valves

a. Bronze Globe and Angle Valves: MSS SP-80, Type 1 (metal disc, integral seat) or Type 3 (metal disc, renewable seat), 3 inches and smaller, threaded or solder joint ends, Class 200 except that Class 150 with solder joint ends may be used for copper tubing. Valves shall have renewable seats and discs, except solder joint end valves which shall have integral seats.

b. Steel Globe and Angle Valves: ASME B16.34, with trim suitable for the service temperature and pressure.

2.1.7.3 Check Valves

a. Bronze Check Valves: MSS SP-80, Type 3 (swing check, metal disc to metal seat), 3 inches and smaller, threaded or solder joint ends, Class 200, regrinding type.

b. Steel Check Valves: MIL-DTL-18436, with trim suitable for the service temperature and pressure.

(1) Swing Check Valves: Shall have bolted caps.

(2) Lift Check Valves: Shall have threaded or bolted caps.

~~2.1.7.4 Steam Pressure Reducing Valves~~

~~CID A-A-50558, Type [_____], Class [_____], Construction [_____], Load Characteristics [_____], cast iron prohibited.~~

~~2.1.7.5 Temperature Regulating Valves~~

~~CID A-A-50559, Type [_____], Style [_____], Class [_____], cast iron prohibited.~~

2.1.7.4 Air Vent Valves

FS F-V-2906, ~~[~~with~~]~~ ~~[without]~~ vacuum holding device, pressure rated for the intended service, and with a ~~[capacity of [_____] cfm] [~~capacity based on manufacturer's standard for the connection size~~]~~, cast iron prohibited.

~~2.1.7.5 Radiator Valves~~

~~Provide angle or straightway pattern with packed or packless bonnet shutoff globe type designed especially for steam heating system. Valve shall be constructed of copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.~~

2.1.7.5 Valve Operating Mechanism

Provide chainwheels, power operators, and extension stems~~[floor stands] [chainwheels] [power operators] [and extension stems]~~ where indicated and as specified.

a. Floor Stands: Shall be cast iron or steel, constructed for bolting to the floor and shall include an extension stem, an operating handwheel, and a position indicator for non-rising stems. Floor stand shall be not less than 30 inches high. Handwheel shall identify rotation direction for closing the valve and shall be of such diameter as to permit operation of the valve with a force of not more than 40 pounds.

b. Chainwheel Operator: Shall be fabricated of cast iron or steel and shall include a wheel, an endless chain, and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within 3 feet of the floor.

c. Power Operators: Shall be ~~[~~electric~~]~~ ~~[pneumatic]~~. Power operated valves shall open and close at rates no slower than 10 inches per minute for gate valves and 4 inches per minute for globe and angle valves. Valves shall open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve shall cause the motor to automatically stop. Power operators shall be complete with all gearing and controls necessary for the size of valve being provided. Power operators shall be designed to operate on the ~~[~~electric~~]~~ ~~[compressed air]~~ power supply indicated.

d. Extension Stem: Shall be corrosion resisting steel designed for rising and non-rising stems, as applicable, and for connection to the valve stem by a sleeve coupling or universal joint. Provide in length required to connect the valve stem and the ~~[~~handwheel~~]~~ ~~[operating mechanism]~~ and of sufficient cross section to transfer the torque required to operate the valve.

2.1.7.6 Safety Valves

MIL-DTL-18436, Type 1, ~~Class [_____], Style [_____], and sized in accordance with ASME BPVC. Set point shall be as indicated, cast iron prohibited.~~per equipment manufacturer.

2.1.8 End Connections

2.1.8.1 Steel Piping

Sizes 2 inches and smaller threaded or socket welded; sizes 2 1/2 inches and larger flanged or butt welded.

a. Threaded Joints: ASME B1.20.1.

b. Flanged Joints: Flanges shall conform to paragraph entitled "Flanges." Bolting and gaskets shall be as follows:

(1) Bolting: Material used for bolts and studs shall conform to ASTM A307, Grade B; and material for nuts shall conform to ASTM A194/A194M, Grade 2. Dimensions of bolts, studs, and nuts shall conform to ASME B18.2.1 and ASME B18.2.2 with threads conforming to ASME B1.1coarse type, with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt-studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and shall have American Standard heavy semifinished hexagonal nuts, conforming to ASME B18.2.1 and ASME B18.2.2.

(2) Gaskets: Gaskets shall be as follows:

~~Working Conditions~~	~~Material~~
~~Saturation~~	
~~[_____] psig [_____] degrees F~~	~~Composition or Copper~~
~~Superheated Steam, Less Than 750 degrees F~~	
~~[_____] psig [_____] degrees F~~	~~Metal Jacketed Composition, Monel, Steel, or Soft Steel~~

Gaskets shall be as thin as the finish of surfaces will permit. Metal or metal-jacketed non-asbestos gaskets shall be used with small male and female or small tongue-and-groove flanges or flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, or raised faces. Full faced gaskets shall be used with flat-faced bronze flanges. Lapped steel flanges, or raised-face steel flanges shall have ring gaskets with an outside diameter extending to the inside of the bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints shall be equal to the widths of the male face or tongue. Gaskets shall have an inside diameter equal to or larger than the port openings. Rings for ring joints shall be in accordance with dimensions in ASME B16.20, suitable for the service conditions encountered, and shall be softer than the flanges. Dimensions for non-metallic gaskets shall be in

accordance with ASME B16.21.

c. Butt Weld Joints: ASME B31.1. The use of backing rings shall conform to ASME B31.1. Ferrous rings shall be of good weldable quality and shall not exceed 0.05 percent sulfur; for alloy pipe, backing rings shall be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Backing rings shall be continuous machined or split band type.

d. Socket Weld Joints: ASME B31.1.

2.1.8.2 Joints for Copper Tubing

a. Solder Joints: ASTM B32, alloy grade Sb5 solder for steam pressure 15 psig or less.

b. Brazed Joints: FS QQ-B-654 for steam pressure 120 psig or less.

~~2.1.9 Expansion Joints~~

~~2.1.9.1 Packless Type~~

~~MIL-DTL-17813, Type [_____], Class [_____], located as indicated. Bellows material shall be [_____]. Expansion joint shall be designed for [_____] cycles of movement.~~

~~2.1.9.2 Guided Slip-Tube Type~~

~~MIL-E-17814, Type [_____], Style [_____], Class [_____], locate as indicated. Expansion joint material shall be [_____].~~

2.1.9 Instrumentation

2.1.9.1 Pressure and Vacuum Gages

ASME B40.100 with restrictor, locate as indicated. Provide scale range for intended service. Scale range not to exceed two times (2X) the indicated pressure of piping.

2.1.9.2 Tank Gages

CID A-A-50568, locate as indicated.

2.1.9.3 Indicating Thermometers

Thermometers shall be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) shall have a nominal scale diameter of 5 inches. Construction shall be stainless-steel case with molded glass cover, stainless-steel stem, and bulb. Stem shall be straight, length as required to fit well. Bimetal thermometers shall have a scale diameter of 3 1/2 inches. Case shall be hermetic. Case and stem shall be constructed of stainless steel. Bimetal stem shall be straight and of a length as required to fit the well.

2.1.10 Miscellaneous Pipeline Components

~~2.1.10.1 Steam Meters~~

~~[a. Rotary Axial-Turbine Steam Meter~~

~~(1) Provide rotary axial-turbine totalizing type designed for mounting directly in the steam line (for sizes up to 4 inches inclusively) or in a bypass piping arrangement with orifice plate in the main line (for sizes 5 inches and up). Bypass meter shall be furnished for horizontal or vertical upward flow or vertical downward flow.~~

~~(2) The meter shall be self-contained and self-operating requiring no mercury, pressure piping, compressed air, or electrical connections except for operation of accessory contacts where required or desired. The meter shall include a dampened fan shaft assembly, fixed internal orifice, and magnetically driven counter of [dial and pointer type] [cyclometer type]. Stuffing box shall not be allowed.~~

~~(3) Materials of construction shall be [cast iron body with 250 pounds flanged ends for pressures up to 250 psig and temperatures up to 450 degrees F] [cast steel body with 300 pounds flanged ends for pressures up to 300 psig and temperatures up to 750 degrees F]. Wear parts shall be of monel or stainless steel with graphite top bearing and jewelled bottom bearing.~~

~~(4) Meter shall be direct reading in pounds of steam over a 10 to 1 range, with continuous overload capability up to 150 percent of rated capacity and temporary overload capability up to 200 percent of rated capacity.~~

~~(5) Accuracy shall be within plus or minus 2 percent of actual flow over the entire 10 to 1 range at flow rates and pressures within the limits set forth in the capacity tables.~~

~~[(6) Meter shall be equipped with pressure compensating counter for automatically and continuously correcting meter readings to compensate for line pressure variations. The counter shall be self-contained and self-operating and require no connections other than a single tap to the steam main. Pressure compensation range shall be [_____] to [_____] psi.]~~

~~[(7) Meter counter shall be equipped with electric contactor to operate a remote totalizer, or for providing impulses for interfacing with an energy monitoring system. Contacts or impulses to be proportional to pressure compensated steam flow.]]~~

~~[b. Variable Orifice Steam Meters~~

~~(1) Provide spring loaded variable orifice principle type steam meters, density compensated, to ensure accuracy within plus or minus 2 percent of actual flow rate independent of line pressure changes.~~

~~(2) Provide a computer to display totalized flow, flow rate, temperature, pressure, time, and date.~~

~~(3) The computer shall be capable of providing high and low flow rate~~

~~and temperature alarm set points, four independent timers to store peak flow rate and total flow, a 4 to 20 mA output and a communication port for energy management interface.]~~

2.1.10.1 Air Traps

CID A-A-60001 for float-operated steam traps (non-thermostatic), except that the valve mechanism shall be inverted so as to be closed, not opened, by rising water. Arrange float-controlled valves to close promptly when water enters the traps. Locate traps as indicated.

2.1.10.2 Steam Traps

CID A-A-60001, ~~Type [_____], Style [_____],~~ thermostatic and non-thermostatic steam traps. Provide traps with separate strainers and locate as indicated.

2.1.10.3 Strainers

FS WW-S-2739, Style Y (Y pattern) for Class 125 and 250 piping in sizes 1/2 to 8 inches, inclusive, locate as indicated, cast iron prohibited.

2.1.10.4 Exhaust Heads

CID A-A-50494, for atmospheric discharge of exhaust steam.

2.1.10.5 Hangers, Supports, Spacing Requirements, and Attachments

MSS SP-58 and ASME B31.1 for materials, design, and manufacture. MSS SP-69 for selection and application.

2.1.10.6 Flash Tanks

Construct of steel for a minimum working pressure of 125 psig. Provide the tank with a vent and valved drain.

~~2.2 UNIT HEATERS~~

~~FS S-U-2833, [propeller] [centrifugal] fan type with [horizontal] [vertical] air delivery and with capacity as indicated for the design conditions. Fans shall be dynamically balanced only.~~

~~2.3 CONVERTORS~~

~~FS WW-H-191, steam to hot water convertors, with capacity as indicated for the design conditions. Design convertor for support by [system piping] [separate pipe hangers], and provide [temperature regulator] [air vent valve] [air and steam trap].~~

~~2.4 CONDENSATE RETURN UNITS~~

~~[2.4.1 Condensate Return Pumping Units~~

~~FS F-P-2908, with [hexahedral, floor-mounted receiver,] [horizontal, cylindrical, stand-mounted receiver,] [vertical, cylindrical, underground receiver], and a [single] [duplex] pump unit, with capacity as indicated.~~

~~]2.4.2 Pump Motors~~

~~NEMA MG 1, suitable for the electrical characteristics as indicated. Motors shall be [open] [splash proof] [totally enclosed] type.~~

~~2.4.3 Motor Starters~~

~~NEMA ICS 2, [manual] [across-the-line magnetic,] [reduced voltage-start] [part-winding] [wye-delta] type with NEMA ICS 6 [general purpose] [weather-resistant] [water tight] enclosure.~~

~~2.5 RADIATION UNITS~~

~~2.5.1 Finned Tube Radiation Units~~

~~[FS S-R-2834, steel tube with steel fins,] [CID A-A-50545, copper tube with aluminum fins,] [with an adjustable damper,] size and capacity not less than indicated.~~

~~2.5.2 Cast Iron Baseboard Radiation Units~~

~~CID A-A-50545, size and capacity not less than indicated.~~

~~2.5.3 Convectors~~

~~CID A-A-50543, CID A-A-50544, design and capacity not less than indicated.~~

~~2.6 STEAM TO AIR HEATING COILS~~

~~Heating and ventilating units for steam system shall be as specified in [Section 23 30 00 HVAC AIR DISTRIBUTION,] except that steam coils shall be provided in lieu of water coils. Coils for factory fabricated air handlers and reheat coils shall be constructed as follows: Construct steam distribution (nonfreeze type) coils of cast semi-steel, welded-steel, or copper headers, red brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered or helically wound to tubes. Roll and bush, braze, or weld tubes into headers. Condensing tubes shall be not less than 5/8 inch outside diameter. Distributing tubes shall be not less than 3/8 inch outside diameter, with orifices to discharge steam to condenser tubes and shall be held securely in position. The maximum length of a single coil shall be limited to 120 times the outside diameter of the tube. Coil casings and tube support sheets, with collars of ample width, shall be not lighter than 16 gage 0.0635 inch thick galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. The finned tube and header section shall float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Factory test coils at 250 psig hydrostatic test pressure or under water at 250 psig air pressure. Coils shall be suitable for 200 psig steam working pressure. Test rate coils in accordance with AHRI 410.~~

PART 3 EXECUTION

3.1 INSTALLATION

Work material and equipment into a complete, convenient, and economical system or systems; and provide apparatus, parts, materials, and accessories which are necessary to accomplish this result.

3.1.1 Piping

Fabricate, assemble, weld, solder, braze, and install piping and pipe system in accordance with ASME B31.1 and as further qualified herein. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established, for the work shown, by the Contractor, and work into place without springing or forcing, except where cold-springing is indicated. Locate piping and equipment within buildings entirely out of the way of lighting fixtures, conduit, and doors, windows, and other openings. Run overhead piping in buildings in the most inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit the welding of joints; at least 6 inches for pipe sizes 4 inches and smaller, 10 inches for pipe sizes larger than 4 inches, and in corners provide sufficient clearance to permit the welder to work between the pipe and one wall. Make provision for expansion and contraction of pipe lines. Do not bury, conceal, or insulate piping until it has been inspected, tested, and approved. Do not conceal piping in walls, partitions, underground, or under the floor except as indicated. Where pipe passes through building structure, do not conceal pipe joints, but locate where they may be readily inspected and not weaken building structure. Run insulated pipe as shown and as required with sufficient clearance to permit application of insulation. Use flanged joints only where necessary for normal maintenance and where required to match valves and equipment. Gaskets, packing, and thread compounds shall be suitable for the service. Apply joint compound or tape on male thread only. Use long radius ells wherever possible to reduce pressure drops. Pipe bends may be used in lieu of welding fittings where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and shall be free from any appreciable flattening, wrinkling, or thinning of the pipe. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction shall not be used. Make branch connections with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Run piping as indicated, and avoid interference with other piping, conduit, or equipment. Run vertical piping plumb and straight and parallel to walls, except where specifically shown otherwise. Do not trap lines, except where indicated. Use reducing fittings for changes in pipe sizes. The use of bushings is prohibited. In horizontal lines 2 1/2 inches and larger, use reducing fittings of the eccentric type to maintain the bottom of the lines in the same plane for steam lines and to maintain the top of the lines in the same plane for condensate lines except where a trap or pocket would result. Provide suitable size sleeves for lines passing through building structure. Install piping connected to equipment to provide flexibility for thermal stresses and for vibration. Support and anchor pipe so that strain from weight and thermal movement of piping is not imposed on the equipment. Thoroughly clean each section of pipe, fittings, and valves of foreign matter before erection. Before placing in position, clean the inside of black steel pipe by rapping along its full length to loosen sand, mill scale, and other foreign matter; pipe 2 inches and larger shall have a wire brush of a diameter larger than that of the inside of the pipe drawn through its entire length several times. Before final connections are made to the apparatus, thoroughly wash out the piping interior with water. Blow out steam piping with high-pressure steam, if available, or compressed air, removing rust, oil, chips, sand, and other material. Plug or cap open ends of mains during shutdown periods. Do not leave lines open at any place where any foreign matter might accidentally enter pipe.

3.1.1.1 Welding

a. Welding of Piping: Welding of joints in piping, butt welds, fillet welds, bends, loops, offsets, and preparation and cleaning of pipe shall be in accordance with ASME B31.1. Welds shall be visually examined and meet acceptance standards indicated in Chapter VI of ASME B31.1.

b. Quality of Welds: Quality of welds, correction of defects, stress relieving, and preheating shall be in accordance with ASME B31.1.

c. Arc Welding and Gas Welding: In accordance with ASME BPVC SEC IX.

3.1.1.2 Brazing and Soldering

a. Brazing and soldering procedure qualification shall conform to ASME B31.1. Brazing procedure for joints shall be as outlined in the CDA A4015.

b. Soldering, soldering preparation, and procedures for joints shall be in accordance with ASME B31.1 and as outlined in the CDA A4015.

c. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to ensure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

3.1.1.3 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Continuous inserts and expansion bolts may be used.

3.1.1.4 Grading and Venting of Pipe Lines

Unless otherwise indicated, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction. When counterflow of condensate within the steam pipe occurs in a portion of a pipeline, pitch up in the direction of steam flow a minimum of 6 inches per 100 feet and increase pipe diameters by one standard pipe size. Steam mains pitched away from the boiler shall contain drip connection and air vent valves at the extreme end. Air vents shall be provided at the highest point of any vertical riser. Drip connections shall not be interconnected above the water line of the boiler.

3.1.1.5 Pipe Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Use Schedule 40 galvanized steel pipe sleeves in outside walls below and above grade, in floor, and in roof slabs. Sleeves in partitions shall be zinc-coated sheet steel having a weight of not less than 0.907 psf. Space between pipe, tubing,

or insulation and the sleeve shall be not less than 1 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs shall extend 2 inches above the finished floor. Pack space between the pipe or tubing and the sleeve firmly with oakum and caulk both ends of the sleeve with elastic cement. ~~[Furnish sleeves in waterproofed construction with flanges and clamping rings]~~.

3.1.1.6 Floor, Wall, and Ceiling Plates

Secure plates to the pipe with enough clearance for thermal expansion of pipe. Use chromium-plated steel or nickel-plated cast iron plates on pipes passing through floors and partitions of toilet rooms and where indicated; use painted cast iron, malleable iron, or steel for all other plates.

3.1.1.7 Flashing for Buildings

Provide tight waterproof flashing where pipes pass through building roofs and outside walls.

3.1.1.8 Unions and Flanges

Provide unions and flanges where necessary to permit easy disconnection of piping and apparatus, and as indicated. Provide a union for each threaded end valve. ~~[~~Place unions or flanges no farther apart than 100 feet.~~]~~ ~~[Place unions or flanges as indicated.]~~ Use unions on piping smaller than 2 inches in diameter, and use flanges on piping 2 inches and larger in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections. Dielectric fittings shall utilize a non-metallic filler which will prevent current flow. The spacer shall be suitable for the pressure and temperature of the service. The fittings shall otherwise conform to the requirements of paragraph entitled "Fittings."

3.1.1.9 Traps and Connections

Traps shall be of the type and capacity for the service and shall be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket and strainer between it and the piping or apparatus it drains. When necessary to maintain in continuous service apparatus or piping which is to be drained, provide a three-valve bypass so that the trap may be removed and repaired and condensate may drain through the throttled bypass valve. Provide a check valve on the discharge side of the trap whenever the trap is installed for lift or operating against a back pressure, or discharges into a common return line. When a thermodynamic trap is used, a check valve is not required or recommended. Provide test connections on the discharge side of the high and medium pressure traps when they are specifically required. The test connection shall include a 1/2 inch globe valve with uncapped nipple.

3.1.1.10 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

3.1.2 Valves

3.1.2.1 General

Install valves in conformance with ASME B31.1, ASME BPVC SEC VIII D1, and as required herein, at the locations indicated and elsewhere as required for the proper functioning of the system. Use gate valves unless otherwise directed. Install stop valves in the supply lines equipped or located so as to permit operation from floor level, or provided with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair. Provide gate valves 8 inches and larger with globe-valved bypass in accordance with MSS SP-45.

3.1.2.2 Globe Valves

Install globe valves so that the pressure shall be below the disk. Install globe valves with the stems horizontal on steam and exhaust lines.

3.1.2.3 Steam Pressure-Reducing Valves

Provide the steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two cutout valves and with a globe or angle bypass valve and bypass piping. Provide each pressure-reducing valve unit with an indicating steam gage to show the reduced pressure, and a safety valve on the low pressure side with sufficient capacity to relieve the high pressure steam.

~~3.1.2.4 Valves for Radiators~~

~~Install a radiator valve on each radiator.~~

3.1.2.4 Safety Valves

Provide with drip pan elbows.

3.1.3 Pressure Gages

Install a shutoff valve or petcock between each pressure gage and the line, and gages on steam lines shall have a syphon installed ahead of the gage.

3.1.4 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of the flowing fluid and minimize obstruction to flow.

~~3.1.5 Steam Meters~~

~~Provide steam meters with a suitable three-valve bypass to permit dismantling and inspection without interference with the service.~~

3.1.5 Strainers

Provide strainers with meshes suitable for the services where indicated, and where dirt might interfere with the proper operation of valve parts, orifices, and moving parts of equipment.

3.1.6 Equipment Foundations

Design equipment foundations of sufficient size and weight to provide isolation and to preclude shifting of equipment under operating conditions. Foundations shall meet the requirements of the equipment manufacturer. When required by the Contracting Officer, the equipment manufacturer's approval of the foundation design and construction for the equipment involved shall be obtained.

3.1.7 Equipment Installation

Install equipment as specified and in accordance with the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before piping is installed. Install piping in such a manner as not to place a strain on any of the equipment. Do not bolt flanged joints tight unless they match. Adequately extend expansion bends before installation. Grade, anchor, guide, and support piping without low pockets.

3.1.8 Cleaning of System

As installations of the various system components are completed, clean before final closing. Remove foreign matter from equipment and surrounding areas. Preliminary or final tests shall not be performed until the cleaning is approved.

3.1.9 Cleaning and Painting of Piping and Equipment

Clean and paint piping and equipment in accordance with Section ~~[~~09 90 00 PAINTS AND COATINGS~~]~~.

3.1.10 Identification of Piping

Labels for pipes 3/4 inch diameter and larger shall bear printed legends to identify contents of pipes and arrows to shown direction of flow. Labels shall have color coded background to signify levels of hazard in accordance with ASME A13.1. Legends and type and size of characters shall also conform as ASME A13.1. Make labels of plastic sheet CID A-A-1689 with pressure sensitivity suitable for the intended applications, or they may be premolded of plastic to fit over pipe. For pipe smaller than 3/4 inch diameter, provide brass identification tags 1 1/2 inches in diameter with legends in depressed black filled characters.

3.2 FIELD TESTS AND INSPECTIONS

Field ~~[inspections, field]~~ tests, and trial operations specified in this section shall be performed by the Contractor. The Contractor shall provide gas, oil, labor, equipment, and incidentals required for testing~~[~~, except that in accordance with Division 1 the Government will provide water or electric power required for tests~~]~~. The Contractor shall give the Contracting Officer 7~~[_____]~~ days' advance written notice of the dates and times scheduled for tests and trial operations.

3.2.1 Field Inspections

Inspect piping system prior to initial operation, for conformance to drawings, specifications, and ASME B31.1. Equipment, material, or work rejected because of defects or non-conformance with drawings, specifications, and ASME B31.1 shall be replaced or corrected by the Contractor, as directed by the Contracting Officer.

3.2.2 Field Tests

Conduct the following tests after completion of the piping installation and prior to initial operation.

3.2.2.1 Piping System

Test piping system hydrostatically using water not exceeding 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.1 and as follows. Test the piping system after the lines have been cleaned as herein specified and before any insulation covering has been applied. Test piping system at 1 1/2 times the system pressure or 50 psig whichever is greater. Before performing tests, remove or valve off from the system, gages, traps, and other apparatus which may be damaged by the test pressure. Install a calibrated test pressure gage in the system to observe any loss in pressure. Maintain the required test pressure for a sufficient length of time to enable an inspection to be made of joints and connections. Perform tests after installation and prior to acceptance.

3.2.2.2 Start-Up and Operational Test

Start-up the system and initially operate with components operating. During the test, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of ~~[water] [~~steam~~]~~ occur when strainers are cleaned. Adjust safety and automatic control instructions as necessary to place them in proper operation and sequence.

3.2.2.3 Extent of Field Tests

After installation and before acceptance, subject the work of this section to necessary field tests, including those herein specified, and in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

-- End of Section --

SECTION 23 30 00

HVAC AIR DISTRIBUTION
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 260 I-P	(2012) Sound Rating of Ducted Air Moving and Conditioning Equipment
AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 880 I-P	(2011) Performance Rating of Air Terminals
AHRI 885	(2008; Addendum 2011) Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2010) Ventilation for Acceptable Indoor Air Quality
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct
ASHRAE 70	(2006; R 2011) Method of Testing for Rating the Performance of Air Outlets and Inlets

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A924/A924M	(2020) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B766	(1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation

ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2016	(2020) Standard Specification for Industrial Woven Wire Cloth

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2010; Version 1.1) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for

	Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 701	(2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition
SMACNA 1884	(2003) Fibrous Glass Duct Construction Standards, 7th Edition
SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

U.S. DEPARTMENT OF ENERGY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

PL-109-58	(1992; R 2005) Energy Efiicient Procument Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 181	(2013; Reprint Apr 2017) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 555S	(2014; Reprint Oct 2020) UL Standard for Safety Smoke Dampers
UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Oct 2018) UL Standard for

	Safety Power Ventilators
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015) Standard for Air Filter Units
UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Electrical Construction	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

~~[1.2.1.2 Diagrams~~

~~Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.~~

~~]~~1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - [_____]
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - [_____]
VAV Box Number	VAV - [_____]
Fan Coil Unit Number	FC - [_____]
Terminal Box Number	TB - [_____]
Unit Ventilator Number	UV - [_____]

Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels must be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

1.2.3 Color Coding

Color coding of all piping systems must be in accordance with [ASME A13.1] [MIL-STD-101].

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that

~~will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G~~[, [_____]]~~

SD-03 Product Data

Metallic Flexible Duct

Insulated Nonmetallic Flexible Duct Runouts

Duct Connectors

Duct Access Doors; G~~[, [_____]]~~

Fire Dampers

Manual Balancing Dampers; G~~[, [_____]]~~

Automatic Smoke-Fire Dampers

Automatic Smoke Dampers

Sound Attenuation Equipment

Acoustical Duct Liner

Diffusers

Registers and Grilles

Louvers

Air Vents, Penthouses, and Goosenecks

Centrifugal Fans

In-Line Centrifugal Fans

~~Axial Flow Fans~~

~~Panel Type Power Wall Ventilators~~

~~Centrifugal Type Power Wall Ventilators~~

~~Centrifugal Type Power Roof Ventilators~~

~~Propeller Type Power Roof Ventilators~~

~~Air-Curtain Fans~~

Ceiling Exhaust Fans

PL-109-58 label for ceiling exhaust fan product; S

Air Handling Units; G~~[, [_____]]~~

Room Fan-Coil Units; G[, [_____]]

Coil Induction Units; G[, [_____]]

Constant Volume, Single Duct Terminal Units; G[, [_____]]

Variable Volume, Single Duct Terminal Units; G[, [_____]]

Variable Volume, Single Duct, Fan-Powered Terminal Units; G[, [_____]]

Dual Duct Terminal Units; G[, [_____]]

Ceiling Induction Terminal Units; G[, [_____]]

Reheat Units; G[, [_____]]

Unit Ventilators

Energy Recovery Devices; G[, [_____]]

Hydronic Modular Panels; G[, [_____]]

Prefabricated Radiant-Heating Electric Panels; G[, [_____]]

Test Procedures

Diagrams; G[, [_____]]

Indoor Air Quality for Duct Sealants; S

SD-06 Test Reports

Performance Tests; G[, [_____]]

Damper Acceptance Test; G[, [_____]]

SD-07 Certificates

Bolts

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[, [_____]]

Fire Dampers; G[, [_____]]

Manual Balancing Dampers; G[, [_____]]

Automatic Smoke-Fire Dampers; G[, [_____]]

Automatic Smoke Dampers; G~~[, [_____]]~~

Centrifugal Fans; G~~[, [_____]]~~

In-Line Centrifugal Fans; G~~[, [_____]]~~

~~Axial Flow Fans; G[, [_____]]~~

~~Panel Type Power Wall Ventilators; G[, [_____]]~~

~~Centrifugal Type Power Wall Ventilators; G[, [_____]]~~

~~Centrifugal Type Power Roof Ventilators; G[, [_____]]~~

~~Propeller Type Power Roof Ventilators; G[, [_____]]~~

~~Air-Curtain Fans; G[, [_____]]~~

Ceiling Exhaust Fans; G~~[, [_____]]~~

Air Handling Units; G~~[, [_____]]~~

Room Fan-Coil Units; G~~[, [_____]]~~

~~Coil Induction Units; G[, [_____]]~~

Constant Volume, Single Duct Terminal Units; G~~[, [_____]]~~

Variable Volume, Single Duct Terminal Units; G~~[, [_____]]~~

~~Variable Volume, Single Duct, Fan-Powered Terminal Units; G[, [_____]]~~

~~Dual Duct Terminal Units; G[, [_____]]~~

~~Ceiling Induction Terminal Units; G[, [_____]]~~

~~Reheat Units; G[, [_____]]~~

~~Unit Ventilators; G[, [_____]]~~

Energy Recovery Devices; G~~[, [_____]]~~

~~Hydronic Modular Panels; G[, [_____]]~~

~~Prefabricated Radiant-Heating Electric Panels; G[, [_____]]~~

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as

sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://femp.energy.gov/procurement. Equipment having a lower efficiency may be specified if the designer determines such equipment to be more life-cycle cost effective.

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations. Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and

static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.5 Test Procedures

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

~~2.1 STANDARD PRODUCTS~~

~~Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.~~

2.1 STANDARD PRODUCTS

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units",
provide components and equipment that are standard products of manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers.

a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.

b. Prior to this two year period, these standard products must have been sold on the commercial market using advertisements in manufacturers'

catalogs or brochures. These manufacturers' catalogs, or brochures must have been copyrighted documents or have been identified with a manufacturer's document number.

c. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates that are 1-1/2-inches high and smaller must be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high must be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.3 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section 08 31 00 ACCESS DOORS AND PANELS.

2.4 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.5 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.6 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.7 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing. Paint in accordance with Section 09 96 00 HIGH-PEFORMANCE COATINGS.

2.8 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.9 DUCT SYSTEMS

2.9.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

a. Construct ductwork meeting the requirements for the duct system static pressure specified in APPENDIX D of Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or

square elbows with factory fabricated turning vanes are allowed.

~~c. Provide ductwork that meets the requirements of Seal Class [A][C]. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.~~

d. Provide ductwork that meets the requirements of Seal Class A. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.

e. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table). Provide validation of indoor air quality for duct sealants.

f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.

g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.9.1.1 Metallic Flexible Duct

a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 2 inches water gauge positive and 1.5 inches water gauge negative. Provide flexible round duct length that does not exceed 5 feet. Secure connections by applying adhesive for 2 inches over rigid duct, apply flexible duct 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.

c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.9.1.2 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is

indicated on the drawings, and is not to exceed 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.9.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

2.9.1.4 High Temperature Service Duct Connections

Provide material that is approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

2.9.1.5 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.9.1.6 Copper Sheets

ASTM B152/B152M, light cold rolled temper.

2.9.1.7 Corrosion Resisting (Stainless) Steel Sheets

ASTM A167

2.9.2 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.9.3 Fire Dampers

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies in conformance with UL Fire Resistance. Provide ~~[~~curtain type with damper blades~~]~~ ~~[in the air stream] [~~out of the air stream~~][or][single blade type][or][multi-blade type]~~ fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph Fire Damper Acceptance Test and NFPA 90A.

~~2.9.4 Manual Balancing Dampers~~

~~Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.~~

2.9.4 Manual Balancing Dampers

a. Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators.

b. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide access doors or panels in hard ceilings, partitions and walls for access to all concealed damper operators and damper locking setscrews. Coordinate location of doors or panels with other affected contractors.

c. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.4.1 Square or Rectangular Dampers

2.9.4.1.1 Duct Height 12 inches and Less

2.9.4.1.1.1 Frames

Width	Height	Galvanized Steel Thickness	Length
Maximum 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches
More than 19 inches	Maximum 12 inches	Minimum 16 gauge	Minimum 3 inches

2.9.4.1.1.2 Single Leaf Blades

Width	Height	Galvanized Steel Thickness	Length
Maximum 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches
More than 19 inches	Maximum 12 inches	Minimum 16 gauge	Minimum 3 inches

2.9.4.1.1.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

Width	Height	Material	Square Shaft
Maximum 19 inches	Maximum 12 inches	Galvanized Steel	Minimum 3/8 inch
More than 19 inches	Maximum 12 inches	Galvanized Steel	Minimum 1/2 inch

2.9.4.1.1.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Width	Height	Material
Maximum 19 inches	Maximum 12 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
More than 19 inches	Maximum 12 inches	oil-impregnated bronze

2.9.4.1.1.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.4.1.1.6 Finish

Mill Galvanized

2.9.4.1.2 Duct Height Greater than 12 inches

2.9.4.1.2.1 Dampers

Provide dampers with multi-leaf opposed-type blades.

2.9.4.1.2.2 Frames

Maximum 48 inches in height; maximum 48 inches in width; minimum of 16 gauge galvanized steel,
minimum of 5 inches long.

2.9.4.1.2.3 Blades

Minimum of 16 gauge galvanized steel; 6 inch nominal width.

2.9.4.1.2.4 Blade Axles

To support the blades of round dampers, provide galvanized square steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

2.9.4.1.2.5 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic equivalent to nylon. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

2.9.4.1.2.6 Blade Actuator

Minimum 1/2 inch diameter galvanized steel.

2.9.4.1.2.7 Blade Actuator Linkage

Mill Galvanized steel bar and crank plate with stainless steel pivots.

2.9.4.1.2.8 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.4.1.2.9 Finish

Mill Galvanized

2.9.4.2 Round Dampers

2.9.4.2.1 Frames

Size	Galvanized Steel Thickness	Length
4 to 20 inches	Minimum 20 gauge	Minimum 6 inches
22 to 30 inches	Minimum 20 gauge	Minimum 6 inches
32 to 40 inches	Minimum 16 gauge	Minimum 6 inches

2.9.4.2.2 Blades

Size	Galvanized Steel Thickness
4 to 20 inches	Minimum 20 gauge
22 to 30 inches	Minimum 16 gauge
32 to 40 inches	Minimum 10 gauge

2.9.4.2.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

Size	Shaft Size and Shape
4 to 20 inches	Minimum 3/8 inch square
22 to 30 inches	Minimum 1/2 inch square
32 to 40 inches	Minimum 3/4 inch square

2.9.4.2.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, nylon, or a solid plastic equivalent to nylon. Axle bearings intended for low leakage at the damper frame must be neoprene, nitrile, or equivalent of 60 or greater durometer to reduce damper blade vibration. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Size	Material
4 to 20 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
22 to 30 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
32 to 40 inches	oil-impregnated bronze, or stainless steel sleeve bearing

2.9.4.2.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.4.2.6 Finish

Mill Galvanized

2.9.5 Automatic Balancing Dampers

Provide dampers as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.9.6 Automatic Smoke-Fire Dampers

Multiple blade type, 180 degrees F fusible fire damper link; smoke damper assembly to include ~~[pneumatically powered][~~electric~~]~~ damper operator. UL 555 as a 1.5 hour rated fire damper; further qualified under UL 555S as a leakage rated damper. Provide a leakage rating under UL 555S that is no

higher than Class ~~[~~II~~][or][III]~~ at an elevated temperature Category B (250 degrees F for 30 minutes). Ensure that pressure drop in the damper open position does not exceed 0.1 inch water gauge with average duct velocities of 2500 fpm.

2.9.7 Automatic Smoke Dampers

UL listed multiple blade type, supplied by smoke damper manufacturer, with pneumatic electric damper operator as part of assembly. Qualified under UL 555S with a leakage rating no higher than Class II or III at an elevated temperature Category B (250 degrees F for 30 minutes). Ensure that pressure drop in the damper open position does not exceed 0.1 inch water gauge with average duct velocities of 2500 fpm.

~~2.9.8 Air Supply And Exhaust Air Dampers~~

~~Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:~~

~~a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.~~

~~b. All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.~~

~~Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.~~

~~2.9.9 Air Deflectors (Volume Extractors) and Branch Connections~~

~~Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.~~

2.9.8 Plenums and Casings for Field-Fabricated Units

2.9.8.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 1 inch threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 16 gauge steel, galvanized after fabrication or of 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.9.8.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.9.8.3 Access Doors

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 36 by 18 inches and locate them 18 inches above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.9.8.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.9.8.5 Duct Liner

Unless otherwise specified, duct liner is not permitted.

2.9.9 Sound Attenuation Equipment

2.9.9.1 Systems with total pressure above 4 Inches Water Gauge

Provide sound attenuators on the discharge duct of each fan operating at a total pressure above 4 inch water gauge, and, when indicated, at the intake of each fan system. Provide sound attenuators elsewhere as indicated. Provide factory fabricated sound attenuators, tested by an independent laboratory for sound and performance characteristics. Provide a net sound reduction as indicated. Maximum permissible pressure drop is not to exceed 0.63 inch water gauge. Construct traps to be airtight when operating under an internal static pressure of 10 inch water gauge. Provide air-side surface capable of withstanding air velocity of 10,000 fpm. Certify that the equipment can obtain the sound reduction values specified after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Provide sound absorbing material conforming to ASTM C1071, Type I or II. Provide sound absorbing material that meets the fire hazard rating requirements for insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For connection to ductwork, provide a duct transition section. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system can be provided if complying with requirements specified for factory fabricated sound attenuators, in lieu of factory fabricated sound attenuators. Construct the double-walled duct and fittings from an outer metal pressure shell of zinc-coated steel sheet, 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Provide a sufficient length of run to obtain the noise reduction coefficient specified. Certify that the sound reduction value specified can be obtained within the length of duct run provided. Provide welded or spiral lock seams on the outer sheet metal of the double-walled duct to prevent water vapor penetration. Provide duct and fittings with an outer sheet that conforms to the metal thickness of high-pressure spiral and round ducts and fittings shown in SMACNA 1966. Provide acoustical insulation with a thermal conductivity "k" of not more than 0.27 Btu/inch/square foot/hour/degree F at 75 degrees F mean temperature. Provide an internal perforated zinc-coated metal liner that is not less than 24 gauge with perforations not larger than 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

2.9.9.2 System with total pressure of 4 Inch Water Gauge and Lower

Use sound attenuators only where indicated. Provide factory fabricated sound attenuators that are constructed of galvanized steel sheets. Provide attenuator with outer casing that is not less than 22 gauge. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 24 by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Provide air flow capacity as indicated or required. Provide pressure drop through the attenuator that does not exceed the value indicated, or that is not in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Acoustically test attenuators with metal duct inlet and outlet sections while under the rated air flow conditions. Include with the noise reduction data the effects of flanking paths and vibration transmission. Construct sound attenuators to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

~~2.9.9.3 Acoustical Duct Liner~~

~~Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of ASTM C1071, Type I and II. Provide uniform density, graduated density, or dual density liner composition, as standard with the manufacturer. Provide not less than 1 inch thick coated lining. Where acoustical duct liner is used, provide the thermal equivalent of the insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS for liner or combination of liner and insulation applied to the exterior of the ductwork. Increase duct sizes shown to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, provide acoustically equivalent lengths of fibrous glass duct, elastomeric duct liner or factory fabricated double-walled internally insulated duct with perforated liner.~~

2.9.10 Diffusers, Registers, and Grilles

Provide factory-fabricated units of ~~[~~steel~~][~~corrosion-resistant steel~~][or][~~aluminum~~]~~ that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.9.10.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.9.10.2 Perforated Plate Diffusers

Provide adjustable ~~[one-way,] [two-way,] [three-way,][or][~~four-way~~]~~ air pattern controls as indicated. Provide diffuser faceplates that do not sag or deflect when operating under design conditions.

~~2.9.10.3 Linear Diffusers~~

~~Make joints between diffuser sections that appear as hairline cracks.~~

~~Provide alignment slots for insertion of key strips or other concealed means to align exposed butt edges of diffusers.[Equip with plaster frames when mounted in plaster ceiling.] Do not use screws and bolts in exposed face of frames or flanges. Metal-fill and ground smooth frames and flanges exposed below ceiling. Furnish separate pivoted or hinged adjustable air-volume-damper and separate air-deflection blades.~~

~~2.9.10.4 Security Ceiling Diffusers~~

~~Provide diffusers that are steel with faceplate, fixed diffusion louvers, with flat surface margin, and an opposed blade damper. Provide faceplate that is 14 gage minimum with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.~~

2.9.10.3 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.9.10.4 Registers

Double-deflection supply registers.~~[Provide manufacturer-furnished volume dampers. Provide volume dampers of the group-operated, opposed-blade type and key adjustable by inserting key through face of register. Operating mechanism must not project through any part of the register face. Automatic volume control devices are acceptable.][~~ Provide exhaust and return registers as specified for supply registers, except provide exhaust and return registers that have a single set of nondirectional face bars or vanes having the same appearance as the supply registers.~~][Set face bars or vanes at [_____] degrees.]~~

~~2.9.10.5 Security Supply Air Registers Except in Cells~~

~~Provide supply air registers, except in prisoner cells and prisoner holding cells, that are steel with individually adjustable horizontal and vertical vanes, perforated faceplate, flat surface margin and opposed blade damper. Put vertical vanes in front; with 3/4 inch o.c. vane spacing. Provide a 14 gage (minimum) perforated faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.~~

~~2.9.10.6 Security Return and Other Air Registers Except in Cells~~

~~Provide return, exhaust, transfer and relief air registers, except in prisoner cells and prisoner holding cells, that are steel with perforated faceplate, flat surface margin, opposed blade damper, and duct mounting sleeve. Provide 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.~~

~~2.9.10.7 Security Supply Air Registers in Cells~~

~~Provide supply air registers in prisoner cells and prisoner holding cells~~

~~that are steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper, and back mounting flanges. Provide a 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.~~

~~2.9.10.8 Security Return and Other Type Air Registers in Cells~~

~~Provide steel return, exhaust, transfer and relief air registers in prisoner cells and prisoner holding cells with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper, and back mounting flanges. Provide 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum)wall sleeve.~~

2.9.11 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section ~~[~~ ~~07 60 00 FLASHING AND SHEET METAL~~ ~~]~~ ~~[~~08 91 00 METAL ~~[~~WALL~~]~~~~[AND]~~~~[DOOR]~~ LOUVERS~~]~~.

2.9.12 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel ~~[~~or aluminum~~]~~ sheets with galvanized~~[~~ or aluminum~~]~~ structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.9.13 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.9.14 Radon Exhaust Ductwork

Fabricate radon exhaust ductwork installed in or beneath slabs from Schedule 40 PVC pipe that conforms to ASTM D1785. Provide fittings that conform to ASTM D2466. Use solvent cement conforming to ASTM D2564 to make joints. Otherwise provide metal radon exhaust ductwork as specified herein.

2.10 AIR SYSTEMS EQUIPMENT

2.10.1 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use

V-belt drives designed for not less than ~~[~~150~~]~~ ~~[140] [120]~~ percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

2.10.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. ~~[~~Provide forward curved or backward-inclined airfoil design fan blades in wheel sizes up to 30 inches. Provide backward-inclined airfoil design fan blades for wheels over 30 inches in diameter~~]~~. ~~[Provide open-wheel radial type booster fans for exhaust dryer systems, and fans suitable for conveying lint and the temperatures encountered. Equip the fan shaft with a heat slinger to dissipate heat buildup along the shaft. Install an access (service) door to facilitate maintenance to these fans.]~~ Provide fan wheels over 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 36 inches or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. ~~Provide[[manually] [automatically] operated inlet vanes on suction inlets.~~ Provide ~~[manually] [~~automatically~~]~~ operated outlet dampers.] Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have ~~[~~open~~]~~ ~~[~~dripproof~~]~~ ~~[totally enclosed] [explosion-proof]~~ enclosures. ~~[~~Provide ~~[manual] [~~magnetic~~]~~ ~~[across-the-line] [reduced-voltage-start]~~ type motor starters with ~~[~~general-purpose~~]~~ ~~[weather-resistant] [watertight]~~ enclosure.~~]~~ ~~[~~Provide remote manual switch with pilot indicating light where indicated.~~]~~

2.10.1.2 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary

discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.~~{~~ Provide motors with ~~{~~open~~]~~~~[~~dripproof~~]~~~~[totally enclosed]~~ ~~[explosion-proof]~~ enclosure.~~]~~ ~~{~~Provide ~~[manual] [~~magnetic~~]~~ motor starters across-the-line with ~~{~~general-purpose~~]~~ ~~[weather-resistant] [explosion-proof]~~ enclosures.~~]~~~~[~~ Provide remote manual switch with pilot indicating light where indicated.~~]~~

~~2.10.1.3 Axial Flow Fans~~

~~Provide axial flow fans complete with drive components and belt guard, with steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Provide fan wheels that are dynamically balanced and keyed to the fan shaft, with radially projecting blades of airfoil cross-section. Enclose and isolate fan bearings and drive shafts from the air stream. Permanently lubricate fan bearings or provide them with accessible grease fittings. Provide precision self-aligning ball or roller type fan bearings that are sealed against dust and dirt. Provide fan bearings that have a L50 rated bearing life at not less than 200,000 hours of operation as defined by ABMA 9 and ABMA 11. Provide fan inlets with an aerodynamically shaped bell and an inlet cone. Install diffuser or straightening vanes at the fan discharge to minimize turbulence and provide smooth discharge air flow. Furnish fan unit with [inlet and outlet flanges,] [inlet screen,] [duct equalizer section,] and [manual] [automatic] operation adjustable inlet vanes. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [dripproof] [totally enclosed] [explosion-proof] enclosure. [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]~~

~~2.10.1.4 Panel Type Power Wall Ventilators~~

~~Provide propeller type fans, assembled on a reinforced metal panel with venturi opening spun into panel. Provide direct or V-belt driven fans with wheels less than 24 inches in diameter and provide V-belt driven fans with wheels 24 inches in diameter and larger. Provide fans with wall mounting collar. Provide lubricated bearings. Equip fans with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Provide [dripproof][totally enclosed fan cooled][explosion-proof] type motor enclosure. Install [gravity][motor operated] backdraft dampers where indicated.~~

~~2.10.1.5 Centrifugal Type Power Wall Ventilators~~

~~Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide removable and weatherproof motor housing. Provide unit housing that is designed for sealing to building surface and for discharge and condensate drippage away from building surface. Construct housing of heavy gauge aluminum. Equip unit with an [aluminum or plated steel wire discharge bird screen,] [disconnect switch,] [[anodized aluminum][stainless steel] wall grille,] [manufacturer's standard [gravity][motor-operated] damper,] an airtight~~

and liquid-tight metallic wall sleeve. Provide [totally enclosed fan-cooled] [dripproof] [explosion-proof] type motor enclosure. Use only lubricated bearings.

2.10.1.6 Centrifugal Type Power Roof Ventilators

Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with [birdscreen,] [disconnect switch,] [[gravity] [motorized] dampers,] [sound curb,] [roof curb,] and [extended base]. Provide [dripproof] [explosion-proof] type motor enclosure. Provide centrifugal type kitchen exhaust fans according to UL 705, fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings.

2.10.1.7 Propeller Type Power Roof Ventilators

Provide [direct][or][V-belt] driven fans. Provide hinged or removable weathertight fan housing, fitted with framed rectangular base constructed of aluminum or galvanized steel. Provide [totally enclosed fan cooled] [explosion-proof] type motors. Furnish motors with nonfusible, horsepower rated, manual disconnect mount on unit. Furnish fans with [gravity] [motor operated] dampers, [birdscreen][sound curb][roof curb]. Use only lubricated bearings.

2.10.1.8 Air-Curtain Fans

Provide fans that conform to AMCA 220 with AMCA seal. Furnish air curtains with a weatherproof housing constructed of high impact plastic or minimum 18 gauge rigid welded steel. Provide backward curved, non-overloading, centrifugal type fan wheels, accurately balanced statically and dynamically. Provide motors with totally enclosed fan cooled enclosures. Provide remote manual type motor starters with weather-resistant enclosure actuated when the doorway served is open. Provide air curtains that attain the air velocities specified within 2 seconds following activation. Provide bird screens at air intake and discharge openings. Provide air curtain unit or a multiple unit installation that is at least as wide as the opening to be protected. Provide the air discharge openings to permit outward adjustment of the discharge air. Place installation and adjust according to the manufacturer's written recommendation. Furnish directional controls on air curtains for service windows for easy clean or convenient removal. Design air curtains to prevent the adjustment of the air velocities specified. Make the interior surfaces of the air curtain units accessible for cleaning. Provide certified test data indicating that the fan can provide the air velocities required when fan is mounted as indicated. Provide air curtains designed as fly fans unless otherwise indicated. [Provide air curtains designed for use in service entranceways that develop an air curtain not less than 3 inches thick at the discharge nozzle. Provide air velocity that is not less than 1600 fpm across the entire entryway when measured 3 feet above the floor.] [Provide air curtains designed for use on customer entranceways that develop an air curtain not less than 8 inches thick at the discharge opening. Provide velocity that is not less than 600 fpm across the entire entryway when measured 3 feet above the floor. Equip recirculating type air curtains with readily removable filters, or design the filters for in-position

~~cleaning. Provide readily accessible and easily cleanable air capture compartment or design for in-position cleaning.] [Provide air curtains designed for use on service windows that develop an air curtain not less than 8 inches thick at the discharge opening. Provide air velocity that is not less than 600 fpm across the entire opening of the service window measured 3 feet below the air discharge opening.]~~

2.10.1.3 Ceiling Exhaust Fans

Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Provide U.L. listed fans. Provide PL-109-58 labeled ceiling exhaust fan product. Provide proof of PL-109-58 label for ceiling exhaust fan product.

2.10.2 Coils

Provide fin-and-tube type coils constructed of seamless ~~[~~copper~~]~~~~[red brass]~~ tubes and ~~[~~aluminum~~]~~~~[~~ or ~~]~~~~[~~copper~~]~~ fins mechanically bonded or soldered to the tubes.~~[~~ Provide copper tube wall thickness that is a minimum of ~~[0.016]~~~~[~~0.020~~]~~~~[0.024]~~ inches~~]~~.~~[~~ ~~Provide red brass tube wall thickness that is a minimum of [0.035] [0.049] inches].~~ ~~[~~Provide aluminum fins that are ~~[~~0.0055~~]~~~~[0.0075]~~ inch minimum thickness.~~]~~~~[~~ Provide copper fins that are 0.0045 inch minimum thickness.~~]~~ Provide casing and tube support sheets that are not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.~~[~~ Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.~~]~~

~~2.10.2.1 Direct-Expansion Coils~~

~~Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with UL 1995.~~

2.10.2.1 Water Coils

Install water coils with a pitch of not less than 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

~~2.10.2.2 Steam Heating Coils~~

~~Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded~~

~~steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 1/2 inch outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure testcoils in accordance with UL 1995.~~

~~2.10.2.3 Steam Preheat (Nonfreeze) Coils~~

~~Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 1 inch outside diameter for tube lengths 60 inches and over and 1/2 inch outside diameter for tube lengths under 60 inches. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 5/8 inch outside diameter for tube lengths 60 inches and over and 3/8 inch outside diameter for tube lengths under 60 inches with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes and hold securely in alignment. Limit maximum length of a single coil to 144 inches. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.~~

~~2.10.2.4 Electric Heating Coil~~

~~Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. Provide duct- or unit-mounted coil. Provide [nickel chromium resistor, single stage, strip] [nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.~~

2.10.2.2 Eliminators

Equip each cooling coil having an air velocity of over 400 fpm through the net face area with moisture eliminators, unless the coil manufacturer guarantees, over the signature of a responsible company official, that no moisture can be carried beyond the drip pans under actual conditions of operation. ~~Construct of minimum 24 gage [zinc-coated steel] [copper] [copper nickel] [or] [stainless steel], r~~Removable through the nearest access door in the casing or ductwork. Provide eliminators that have not less than two bends at 45 degrees and are spaced not more than 2-1/2 inches center-to-center on face. Provide each bend with an integrally formed hook as indicated in the SMACNA 1884.

~~2.10.2.3 Sprayed Coil Dehumidifiers~~

~~Provide assembly with reinforced, braced, and externally insulated galvanized steel casing, vertical in-line spray pump, bronze self-cleaning spray nozzles, galvanized steel pipe spray headers, adjustable float valve with replaceable neoprene seat, manufacturer's standard cooling coil, and welded black steel drain tank. Provide overflow drain, make-up, and bleed~~

~~connection.~~

2.10.2.3 Corrosion Protection for Coastal Installations

Provide as specified on the plans.~~[_____]~~

2.10.3 Air Filters

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.10.3.1 Extended Surface Pleated Panel Filters

Provide 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 500 fpm that does not exceed 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.10.3.2 Extended Surface Nonsupported Pocket Filters

Provide ~~[~~30~~][_____]~~ inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at ~~[~~500~~][_____]~~ fpm that does not exceed ~~[~~0.45~~][_____]~~ inches water gauge. Provide UL Class 1 filters. Provide fibrous glass media, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Provide pockets that do not sag or flap at anticipated air flows. Install each filter ~~[~~with an extended surface pleated panel filter as a prefilter~~]~~ in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.10.3.3 Cartridge Type Filters

Provide 12 inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at ~~[~~500~~][_____]~~ fpm that does not exceed ~~[~~0.56 ~~][_____]~~ inches, water gauge. Provide UL class 1 filters, and pleated microglass paper media with corrugated aluminum separators, sealed inside the filter cell to form a totally rigid filter assembly. Fluctuations in filter face velocity or turbulent airflow have no effect on filter integrity or performance. Install each filter ~~[~~with an extended surface pleated media panel filter as a prefilter~~]~~ in a factory preassembled side access housing, or a factory-made sectional frame bank, as indicated.

~~2.10.3.4 Sectional Cleanable Filters~~

~~Provide [1][2] inch thick cleanable filters. Provide viscous adhesive in 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one quart for each filter section. Provide one washing and charging tank for every 100 filter sections or fraction thereof; with each washing and charging unit consisting of a tank and [single][double] drain rack mounted on legs and drain rack with dividers and partitions to properly support the filters in the draining position.~~

2.10.3.5 Replaceable Media Filters

Provide the [dry-media][viscous adhesive] type replaceable media filters, of the size required to suit the application. Provide filtering media that is not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Enclose pad in a holding frame of not less than 16 gauge galvanized steel, equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [300][_____] fpm, with initial resistance of [0.13][_____] inches water gauge. Provide MERV that is not less than [_____] when tested according to ASHRAE 52.2.

2.10.3.6 Automatic Renewable Media Filters

Provide the following:

a. Automatic, renewable media filters consisting of a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass supplied in convenient roll form, and filter that does not require water supply, sewer connections, adhesive reservoir, or sprinkler equipment as part of the operation and maintenance requirements.

b. Basic frame that is fabricated of not less than 14 gauge galvanized steel, and sectional design filters with each section of each filter fully factory assembled, requiring no field assembly other than setting in place next to any adjacent sections and the installation of media in roll form.

c. Each filter complete with initial loading of filter media drive motor adequate to handle the number of sections involved, and [painted steel] [stainless steel] control box containing a warning light to indicate media runout, a runout switch, and a Hand-Off-Auto selector switch.

d. Media feed across the filter face in [full-face increments] [increments] automatically controlled as determined by [filter pressure differential] [time interval control] [time interval control with pressure override] [photo electric control] to provide substantially constant operating resistance to airflow and varying not more than plus or minus 10 percent. Roll or enclose media in such a way that collected particulates can not re-entrain.

e. Rolls of clean media, no less than 65 feet long, rerolled on disposable spools in the rewind section of the filter after the media has accumulated its design dirt load. Equip rewind section with a compression panel to tightly rewind used media for ease of handling. Provide media made of continuous, bonded fibrous glass material, UL Class 2, that does not compress more than 1/4 inch when subjected to air flow at 500 fpm. Factory charge media with an odorless and flame retardant adhesive which does not flow while in storage nor when subjected to temperatures up to 175 degrees F. Support media on both the leaving and entering air faces. Clean media must have initial resistance that does not exceed 0.18 inch water gauge at its rated velocity of 500 fpm. Set control so that the resistance to air flow is between 0.40 and 0.50 inch water gauge unless otherwise indicated.

f. Dust holding capacity, of 80 percent average arrestance under these operating conditions, when operating at a steady state with an upper operating resistance of 0.50 inch water gauge, that is at least 592

(55) grams of ASHRAE Standard Test Dust per square foot of media area, when tested according to the dynamic testing provisions of ASHRAE 52.2.

g. The horizontal type automatic renewable media filters, when used in conjunction with factory fabricated air handling units, that are dimensionally compatible with the connecting air handling units, and horizontal type filter housings with all exposed surfaces factory insulated internally with 1 inch, 1-1/2 pound density neoprene coated fibrous glass with thermal conductivity not greater than 0.27 Btu/hour/degree F/square foot/inch of thickness.

h. Access doors for horizontal filters with double wall construction as specified for plenums and casings for field-fabricated units in paragraph DUCT SYSTEMS.

2.10.3.7 Electrostatic Filters

Provide the following:

a. The combination dry agglomerator/extended surface, nonsupported pocket electrostatic filters or the combination dry agglomerator/automatic renewable, media (roll) type electrostatic filters, as indicated (except as modified). Supply each dry agglomerator electrostatic air filter with the correct quantity of fully housed power packs and equip with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, with lamps mounted in the cover to indicate these functions locally. Equip power pack enclosure with external mounting brackets, and low and high voltage terminals fully exposed with access cover removed for ease of installation. Furnish interlock safety switches for each access door and access panel that permits access to either side of the filter, so that the filter is de-energized in the event that a door or panel is opened.

b. Ozone generation within the filter that does not exceed five parts per one hundred million parts of air. Locate high voltage insulators in a serviceable location outside the moving air stream or on the clean air side of the unit. Fully expose ionizer wire supports and furnish ionizer wires precut to size and with formed loops at each end to facilitate ionizer wire replacement.

c. Agglomerator cell plates that allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up, with cells that are open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, provide a storage section that utilizes a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service supplied in 65 foot lengths in convenient roll form. Otherwise, provide section construction and roll media characteristics as specified for automatic renewable media filters. Also a dry agglomerator/renewable media combination with an initial air flow resistance, after installation of clean media, that does not exceed 0.25 inch water gauge at 500 fpm face velocity.

d. A MERV of the combination that is not less than 15 when tested according to ASHRAE 52.2 at an average operating resistance of 0.50 inch water gauge. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter

~~type, provide a storage section as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings as indicated.~~

~~e. A dry agglomerator/extended surface nonsupported pocket filter section combination with initial air flow resistance, after installation of clean filters, that does not exceed 0.65 inch water gauge at 500 fpm face velocity, with a MERV of the combination not less than 16 when tested according to ASHRAE 52.2. Furnish front access filters with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, supply side access housings which have dimensional compatibility.~~

2.10.3.4 High-Efficiency Particulate Air (HEPA) Filters

Provide HEPA filters that meet the requirements of IEST RP-CC-001 and are individually tested and certified to have an efficiency of not less than ~~[95] [~~99.97~~]~~ percent, and an initial resistance at 500~~[_____]~~ fpm that does not exceed 1~~[_____]~~ inches water gauge. Provide filters that are constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Provide interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer that are cemented to the perimeter of the ~~[upstream] [~~downstream~~]~~ face of the filter cell sides. Provide self-extinguishing rubber-base type adhesive or other materials conforming to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide filter cell sides that are ~~[3/4 inch thick exterior grade fire-retardant plywood] [cadmium plated steel] [~~galvanized steel~~]~~ assembled in a rigid manner. Provide overall cell side dimensions that are correct to 1/16 inch, and squareness that is maintained to within 1/8 inch. Provide holding frames that use spring loaded fasteners or other devices to seal the filter tightly within it and that prevent any bypass leakage around the filter during its installed life. Provide air capacity and the nominal depth of the filter as indicated. Install each filter in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Provide prefilters of the type, construction and efficiency indicated.

2.10.3.5 Holding Frames

Fabricate frames from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.10.3.6 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 3-7/8 inches in diameter, with white dials with black figures, and ~~[~~graduations~~]~~ ~~[graduated in 0.01 inch of water,]~~ with a minimum range of 1 inch of water beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure tips with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of

1/4 inch diameter ~~[~~aluminum~~]~~ ~~[vinyl]~~ tubing, and all hardware and accessories for gauge mounting.

2.11 AIR HANDLING UNITS

2.11.1 Field-Fabricated Air Handling Units

Provide built-up units as specified in paragraph DUCT SYSTEMS. Provide fans, coils spray-coil dehumidifiers, and air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.11.2 Factory-Fabricated Air Handling Units

Provide central station air handling~~[single-zone draw-through type][or][single-zone blow-through type][or][multizone blow-through type][blow-through double-deck type][blow-through triple deck type]~~ units as indicated. Units must include fans, coils, airtight insulated casing, ~~[~~ prefilters,~~]~~ ~~[~~secondary filter sections,~~][and][diffuser sections where indicated,]~~ ~~[air blender]~~ adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, ~~[~~mixing box~~]~~ ~~[combination sectional filter-mixing box,]~~ ~~[[pan][~~drysteam~~]~~[spray type] humidifier,~~]~~ vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity indicated. Provide air handling unit that is rated in accordance with AHRI 430 and AHRI certified for cooling.

2.11.2.1 Casings

Provide the following:

a. ~~[~~Casing sections ~~[[single] [~~ 2 inch double~~]~~ wall type~~]~~ ~~[as indicated]~~, constructed of a minimum 18 gauge galvanized steel, or 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304.~~]~~[Inner casing of double-wall units that are a minimum 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304.~~]~~ Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.

b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.

c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 18 gauge outer and 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 12 inches wide by 12 inches high. Access doors must be a minimum 24 inches wide, the full height of the unit casing or a minimum of 6 foot, whichever is less. ~~[Install a minimum 8 by 8 inches sealed glass window suitable for the intended application, in all access doors.]~~

d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 16 gauge ~~[galvanized steel] [~~corrosion resisting sheet steel conforming to ASTM A167, Type 304~~]~~, conforming

to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing.

e. Casing insulation that conforms to NFPA 90A. Insulate single-wall casing sections handling conditioned air with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.

f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors ~~[~~and casing sections~~]~~.

g. Fiber free ~~D~~duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.

h. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections ~~[_____][where indicated]~~.

2.11.2.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.11.2.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.11.2.4 Fans

Provide the following:

a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.

b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide bearings that are permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.

c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Design belt drives for not less than a 1.3 service factor based on motor nameplate rating.

d. ~~[~~Motor sheaves that are variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by AHRI Guideline D.~~]~~ Where fixed sheaves are required, the use of variable pitch sheaves is allowed during air balance, but replace them with an appropriate fixed sheave after air balance is completed. Select variable pitch sheaves to drive the fan at a speed that produces the specified capacity when set at the approximate midpoint of the sheave adjustment. Furnish motors for V-belt drives with adjustable bases, and with ~~[~~open~~][~~splashproof ~~][totally enclosed]~~ enclosures.

e. Motor starters of ~~[manual][~~magnetic~~][~~across-the-line ~~][reduced-voltage-start]~~ type with ~~[~~general-purpose~~][weather-resistant] [watertight]~~ enclosure. Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to AMCA 300, ASHRAE 68, or AHRI 260 I-P.

2.11.2.5 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

~~2.11.2.6 Diffuser Sections~~

~~Furnish diffuser sections between the discharge of all housed supply fans [and cooling coils of blow-through single zone units][and][filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Provide diffuser sections that are fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, designed to be airtight under positive static pressures up to [8][_____] inches water gauge and with an access door on each side for inspection purposes. Provide a diffuser section that contains a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish, and designed to accomplish uniform air flow across the down-stream [coil][filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream~~

component.

2.12 TERMINAL UNITS

2.12.1 Room Fan-Coil Units

Provide base units that include galvanized coil casing, coil assembly drain pan [valve and piping package,] [outside air damper,] [wall intake box,] air filter, fans, motor, fan drive, motor switch, an enclosure for cabinet models and casing for concealed models, leveling devices integral with the unit for vertical type units, and sound power levels as indicated. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models are acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Fasten each unit securely to the building structure. Provide units with capacity indicated. Provide room fan-coil units that are certified as complying with AHRI 440, and meet the requirements of UL 1995.

2.12.1.1 Enclosures

Fabricate enclosures from not lighter than 18 gauge steel, reinforced and braced. Provide enclosures with front panels that are removable and have 1/4 inch closed cell insulation or 1/2 inch thick dual density foil faced fibrous glass insulation. Make the exposed side of a high density, erosion-proof material suitable for use in air streams with velocities up to 4,500 fpm. Provide a discharge grille that is [adjustable] [fixed] and that is of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant according to UL 94 and the material complies with the heat deflection criteria specified in UL 1995. Provide galvanized or factory finished ferrous metal surfaces with corrosion resistant enamel, and access doors or removable panels for piping and control compartments, plus easy access for filter replacement. Provide duct discharge collar for concealed models.

2.12.1.2 Fans

Provide steel or aluminum, multiblade, centrifugal type fans. In lieu of metal, fans and scrolls could be of non-metallic materials of suitably reinforced compounds with smooth surfaces. Dynamically and statically balance the fans. Provide accessible assemblies for maintenance. Disassemble and re-assemble by means of mechanical fastening devices and not by epoxies or cements.

2.12.1.3 Coils

Fabricate coils from not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Provide coils with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 300 psi or under water at 250 psi air pressure. Provide coils suitable for 200 psi working

pressure. Make provisions for coil removal.

2.12.1.4 Drain Pans

Size and locate drain and drip pans to collect all water condensed on and dripping from any item within the unit enclosure or casing. Provide condensate drain pans designed for self-drainage to preclude the buildup of microbial slime and thermally insulated to prevent condensation and constructed of not lighter than 21 gauge type 304 stainless steel or noncorrosive ABS plastic. Provide insulation with a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and of a waterproof type or coated with a waterproofing material. Design drain pans so as to allow no standing water and pitch to drain. Provide minimum 3/4 inch NPT or 5/8 inch OD drain connection in drain pan. Provide plastic or metal auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages; if metal, provide auxiliary pans that comply with the requirements specified above. Extend insulation at control and piping connections 1 inch minimum over the auxiliary drain pan.

2.12.1.5 Manually Operated Outside Air Dampers

Provide manually operated outside air dampers according to the arrangement indicated, and parallel airfoil type dampers of galvanized construction. Provide blades that rotate on stainless steel or nylon sleeve bearings.

2.12.1.6 Filters

Provide disposable type filter that complies with ASHRAE 52.2. Provide filters in each unit that are removable without the use of tools.

2.12.1.7 Motors

Provide motors of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Provide motor switch with two or three speeds and off, manually operated, and mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent is allowed. Provide motors with permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Provide a motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity that does not exceed the following values:

Free Discharge Motors			
Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
200	70	110	90

Free Discharge Motors			
Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
300	100	110	110
400	170	150	150
600	180	210	220
800	240	240	230
1000	310	250	270
1200	440	400	440

High Static Motors	
Unit Capacity (cfm)	Maximum Power Consumption (Watts)
200	145
300	145
400	210
600	320
800	320
1000	530
1200	530

2.12.2 Coil Induction Units

Provide base unit that includes air plenums, air-discharge nozzles, air-discharge grilles, recirculation grilles, water coil assembly, valve and piping package, condensate drain pan, and adjustable air-balancing dampers, plus an enclosure for cabinet models and casing for concealed models. Make each unit capable of producing not less than the capacity indicated without exceeding the indicated static pressure. Provide a sound power level as indicated with power level data or values for these units based on tests conducted according to ASA S12.51. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. The values obtained for the standard cabinet models are acceptable for concealed models without separate tests, provided there is no variation between models as to coil configuration, air discharge nozzles, air balancing dampers, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL

~~COMPONENTS/SERVICES, subparagraph CONTROLS. Secure each unit to the building structure. Provide units with capacity indicated.~~

~~2.12.2.1 Enclosures~~

~~Fabricate enclosures from not lighter than 18 gauge steel, reinforced and braced. Provide a removable front panel of enclosure and insulate when required acoustically and to prevent condensation. Provide discharge grilles that are [adjustable][integrally stamped] and properly distribute air throughout the conditioned space. Plastic discharge and return grilles are not acceptable. Provide access doors for all piping and control compartments.~~

~~2.12.2.2 Air Plenums~~

~~Fabricate plenums from galvanized steel with interior acoustically baffled and lined with sound absorbing material to attenuate the sound power from the primary air supply to the room. Provide heat-resistant nozzles that are integral with or attached airtight to the plenum. Where coil induction units are supplied with vertical runouts, furnish a streamlined, vaned, mitered elbow transition piece for connection between the unit and ductwork. Provide an adjustable air-balancing damper in each unit.~~

~~2.12.2.3 Coils~~

~~Fabricate coils from not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins, mechanically bonded or soldered to the tubes. Furnish coil connections with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with terminal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 300 psi or under water at 250 psi air pressure and provide coils suitable for 200 psi working pressure.~~

~~2.12.2.4 Screens~~

~~Provide easily accessible lint screens or throwaway filters for each unit.~~

~~2.12.2.5 Drain Pan~~

~~Size and locate drain and drip pans to collect condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 21 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that has a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and that is a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans constructed of die-formed 22 gauge steel are allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 21 gauge steel material or of die-formed 21 gauge type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Provide drain connection when a condensate drain system is indicated. Make connection a minimum 3/4 inch NPT or 5/8 inch OD.~~

2.12.1 Variable Air Volume (VAV)~~ and Dual Duct Terminal~~ Units

a. Provide VAV and dual duct terminal units that are the type, size, and capacity shown, mounted in the ceiling or wall cavity, plus units that

are suitable for single or dual duct system applications. Provide actuators and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. For each VAV terminal unit, provide a temperature sensor in the unit discharge ductwork.

b. Provide unit enclosures that are constructed of galvanized steel not lighter than 22 gauge or aluminum sheet not lighter than 18 gauge. Provide single or multiple discharge outlets as required. Units with flow limiters are not acceptable. Provide unit air volume that is factory preset and readily field adjustable without special tools. ~~[~~ Provide reheat coils as indicated.~~]~~

c. Attach a flow chart to each unit. Base acoustic performance of the terminal units upon units tested according to AHRI 880 I-P with the calculations prepared in accordance with AHRI 885. Provide sound power level as indicated. Show discharge sound power for minimum and ~~[~~ 1-1/2~~][_____]~~ inches water gauge inlet static pressure. Provide acoustical lining according to NFPA 90A.

2.12.1.1 Constant Volume, Single Duct Terminal Units

Provide constant volume, single duct, terminal units that contain within the casing, a constant volume regulator. Provide volume regulators that control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 3/4 to 6 inch water gauge.

2.12.1.2 Variable Volume, Single Duct Terminal Units

Provide variable volume, single duct, terminal units with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Provide units that control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. Provide units with an internal resistance not exceeding 0.4 inch water gauge at maximum flow range. Provide external differential pressure taps separate from the control pressure taps for air flow measurement with a 0 to 1 inch water gauge range.

~~2.12.1.3 Variable Volume, Single Duct, Fan-Powered Terminal Units~~

~~Provide variable volume, single duct, fan-powered terminal units with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Provide units that control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 3/4 to 6 inch water gauge. Provide unit fan that is centrifugal, direct-driven, double-inlet type with forward curved blades. Provide either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type fan motor. Isolate fan/motor assembly from the casing to minimize vibration transmission. Provide factory furnished fan control that is wired into the unit control system. Provide a factory-mounted pressure switch to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.~~

~~2.12.1.4 Dual Duct Terminal Units~~

~~Provide dual duct terminal units with hot and cold inlet valve or dampers that are controlled in unison by single or dual actuators. Provide~~

actuator as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Provide unit that controls delivered air volumes within plus or minus 5 percent with inlet air variations from 1 to 8 inch water gauge in either duct. Include mixing baffles with the unit casing. Provide cabinet and closed duct leakage that does not exceed 2 percent of maximum rated air volume. Provide units with an internal resistance that does not exceed [_____] inch water gauge at maximum flow range.

2.12.1.5 Ceiling Induction Terminal Units

Provide ceiling induction unit with a calibrated primary air volume sensing device, primary air valve, induced air damper, and insulated induction tube. Arrange unit to induce air from the ceiling plenum to maintain a maximum total flow circulated to the conditioned space. Vary primary air upon demand of the room thermostat. Upon a demand for maximum cooling, provide a unit that delivers 100 percent primary air and, at minimum cooling, delivers [50] [25] percent primary air. Provide a terminal unit capable of closing to full shut off without additional actuators or linkage changes. Provide terminals that reset primary air volume within plus or minus 5 percent determined by the thermostat regardless of upstream changes in the static pressure. Provide a minimum inlet static pressure that does not exceed 1 inch water gauge, including a maximum of 0.3 inch water gauge downstream static pressure. Provide external differential pressure taps separate from control pressure taps for primary air flow measurement with 0 to 1 inch water gauge range. Make each unit normally [open] [closed] upon loss of pneumatic pressure. Factory pipe actuator and accuracy controls requiring only field installation of 20 psi pneumatic main air and room thermostat.

2.12.1.6 Series Fan Powered Variable Air Volume (VAV) Terminals

Provide units factory assembled, designed, tested, rated in accordance with AHRI 880 I-P, that are AHRI certified, listed in the AHRI DCAACP and that produce a supply air discharge mix by modulation of conditioned primary air and recirculating of return air. Provide units that include casing, centrifugal fan and motor, primary VAV damper or valve, electronic volume regulator, discharge air damper, primary air inlet cone with high and low pressure flow sensors, recirculating air filter frames, filter, and electrical disconnect. [Provide hot water heating coils integral to the terminal, or provide insulated hot water coil section attached to the discharge of the terminal.]

2.12.1.6.1 Casing

Provide removable full bottom access panels for servicing internal components without disturbing duct connections. Insulate inside of casing with manufacturer's standard insulation. Provide units that have recirculating air inlet equipped with filter frame, round primary damper or valve, and unit mounting brackets.

2.12.1.6.2 Fans and Motors

Provide centrifugal, forward curved, multiblade, fan wheels with direct-drive motors. Provide motors that are the high efficiency permanent-split capacitor type with thermal overload protection, permanently lubricated bearings, and have three speeds or are equipped with solid state speed controllers. Provide isolation between fan motor assembly and unit casing. Provide fan and motor that is removable through casing access panel.

~~2.12.1.6.3 Flow Sensor~~

~~Provide ring or cross type sensor with minimum of two pickup points which average the velocity across the inlet. Obtain flow measurement within plus or minus 5 percent of rated airflow with 1.5 diameters of straight duct upstream of unit and inlet static variation of 0.5 to 5.0 inches water gauge. Supply flow measuring taps and calibration flowchart with each unit for field balancing airflows.~~

~~2.12.1.6.4 Primary VAV Damper or Valve~~

~~Provide galvanized steel damper blade that closes against gasket inside unit. Connect damper to operating shaft with a positive mechanical connection. Provide nylon bearing for damper shaft. Cylindrical die cast aluminum valve inlet tapered to fit round flexible ducts with integral flow diffuser and beveled self-centering disc. Provide damper or valve leakage at shutoff that does not exceed 2 percent of capacity at 1 inch water gauge pressure.~~

~~2.12.1.6.5 Regulator~~

~~Provide electronic volume regulator. Electronic controls contained in NEMA ICS 6, Type 1 enclosure sealed from airflow. Provide unit with controls mounted on side or on air valve. System powered regulators are not permitted. Provide volume regulator that resets primary air volume as determined by thermostat, within upstream static pressure variation noted in paragraph titled "Flow Sensor." Provide volume regulators that are field adjustable, factory set and calibrated to indicated maximum and minimum primary airflows, direct acting and normally [open] [closed] upon loss of pneumatic pressure.~~

~~2.12.1.6.6 Electrical~~

~~Provide unit that incorporates single point electrical connection with electrical disconnect. Provide electrical components that are UL or ETL listed, installed in accordance with NFPA 70 and mounted in control box. Units UL or ETL listed as an assembly do not require airflow switch interlock with electric heating coil, when factory assembled.~~

~~2.12.1.6.7 Filters~~

~~Provide UL listed throwaway one inch thick fiberglass filters, standard dust-holding capacity.~~

~~2.12.1.7 Reheat Units~~

~~2.12.1.7.1 Hot Water Coils~~

~~Provide fin-and-tube type hot-water coils constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Provide headers that are constructed of cast iron, welded steel or copper. Provide casing and tube support sheets that are 16 gauge, galvanized steel, formed to provide structural strength. Provide tubes that are correctly circuited for proper water velocity without excessive pressure drop and are drainable where required or indicated. At the factory, test each coil at not less than 250 psi air pressure and provide coils suitable for 200 psi working pressure. Install drainable coils in the air handling units with a pitch of not less than 1/8 inch per foot of~~

tube length toward the drain end. Coils must conform to the provisions of AHRI 410.

2.12.1.7.2 Steam Coils

Provide steam coils constructed of cast semisteel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered to the tubes. Roll and bush, braze or weld tubes into headers. Provide coil casings and tube support sheets, with collars of ample width, that are not lighter than 16 gauge galvanized steel formed to provide structural strength. When required, furnish multiple tube supports to prevent tube sag. Float the fin tube and header section within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide coils that are factory pressure tested and capable of withstanding 250 psi hydrostatic test pressure or 250 psi air pressure, and are for [100] [200] psi steam working pressure. Provide steam-distribution tube type preheat coils with condensing tubes having not less than 5/8 inch outside diameters. Provide distribution tubes that have not less than 3/8 inch outside diameter, with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes held securely in alignment. Limit the maximum length of a single coil to 120 times the diameter of the outside tube. Other heating coils must be single tube type with an outside diameter not less than 1/2 inch. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Provide coils that conform to the provisions of AHRI 410.

2.12.1.7.3 Electric Resistance Heaters

Provide the duct-mounting type electric resistance heaters consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Provide electric duct heater that meets the requirement of Underwriters Laboratories and NFPA 70 and is provided with a built-in or surface-mounted high-limit thermostat. Interlock electric duct heaters electrically so that they cannot be energized unless the fan is running.

2.12.2 Unit Ventilators

Provide unit ventilators that include an enclosure, [galvanized casing,] [cold-rolled steel casing with corrosion resistant coating,] coil assembly, [resistance heating coil assembly,] [valve and piping package,] drain pan, air filters, fan assembly, fan drive, motor, motor controller, dampers, damper operators, and sound power level as indicated. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Secure each unit to the building structure. Provide the unit ventilators with capacity indicated. Provide the year-round classroom type unit ventilator with automatic controls arranged to properly heat, cool, and ventilate the room. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Make the sequence of control any one of the standard ANSI cycles specified in paragraph CONTROLS.

2.12.2.1 Enclosures

Fabricate enclosures from not lighter than 16 gauge galvanized steel,

reinforced and braced, or all welded framework with panels to provide equivalent strength. Provide casing that is acoustically and thermally insulated internally with not less than 1/2 inch thick dual density fibrous glass insulation. Make the exposed side a high density, erosion-proof material suitable for use in air streams with velocities up to 4500 fpm. Fasten the insulation with waterproof, fire-resistant adhesive. Design front panel for easy removal by one person. Provide discharge grilles that [have adjustable grilles or grilles with adjustable vanes and] properly distribute air throughout the conditioned space. Provide return grilles that are removable where front panel does not provide access to interior components. Plastic discharge or return grilles are not acceptable. Furnish removable panels or access doors for all piping and control compartments. Provide fan switch that is key operated or accessible through a locked access panel. Install gaskets at the back and bottom of the unit for effective air seal, as required.

2.12.2.2 Electric Resistance Heating Elements

Provide electric resistance heating elements that are of the sheathed, finned, tubular type, or of the open resistance type designed for direct exposure to the air stream. Provide heating element electrical characteristics as indicated. Where fan motor or control voltage is lower than required for the electric-resistance heating element, install a fused factory mounted and wired transformer.

2.12.2.3 Fans

Provide fans that meet the requirements as specified in paragraph AIR SYSTEMS EQUIPMENT. Provide galvanized steel or aluminum, multiblade, centrifugal type fans, dynamically and statically balanced. Equip fan housings with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Provide direct-connected fans.

2.12.2.4 Coils

Provide coils that are circuited for a maximum water velocity of 8 fps without excessive pressure drop and are otherwise as specified for hot water coils in paragraph TERMINAL UNITS.

2.12.2.5 Drain Pans

Size and locate drain and drip pans to collect all condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 18 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that is coated with a fire-resistant waterproofing material. In lieu of the above, drain pans constructed of die-formed 20 gauge steel is allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 18 gauge steel material, or of die-formed 18 gauge type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Furnish drain connection unless otherwise indicated. Make the minimum connection 3/4 inch NDT or 5/8 inch OD.

2.12.2.6 Filters

Disposable type rated in accordance with ASHRAE 52.2, installed upstream

of coil.

2.12.2.7 Dampers

Provide an outside air proportioning damper on each unit. In addition, provide a vane to prevent excessive outside air from entering unit and to prevent blow-through of outside air through the return air grille under high wind pressures. Where outside air and recirculated air proportioning dampers are provided on the unit, an additional vane is not required. Provide face and bypass dampers for each unit to ensure constant air volume at all positions of the dampers. Furnish each unit with a factory installed control cam assembly, pneumatic motor, or electric motor to operate the face and bypass dampers and outside air damper or outside air and recirculated air dampers in the sequence as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.12.2.8 Motors

Provide permanent split-capacitor type motors with built-in thermal overload protection and automatic reset. Mount motor on a resilient mounting, isolated from the casing and suitable for operation on electric service available. Provide a manually operated motor switch that provides for 2 or 3 speeds and off, mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of speed control, provide a solid state variable speed controller having minimum speed reduction of 50 percent.

2.12.2.9 Outside Air Intakes

Provide the manufacturer's standard design outside air intakes furnished with 1/2 inch mesh bird screen or louvers on 1/2 inch centers.

2.13 ENERGY RECOVERY DEVICES

2.13.1 Rotary Wheel

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream, with device performance according to ASHRAE 84 and that delivers an energy transfer effectiveness of not less than [70][85][_____] percent with cross-contamination not in excess of [0.1][1.0][_____] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions as indicated.

2.13.2 Run-Around-Coil

Provide assembly that is factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Computer

~~optimize components for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [_____] percent by volume of [ethylene][propylene] glycol solution, and frost control. Provide coils that conform to paragraph AIR HANDLING UNITS. Provide related pumps, and piping specialties that conform to requirements of [Section 23 63 00.00 10 COLD STORAGE REFRIGERATION SYSTEMS][Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS][23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE] [_____].~~

~~2.13.3 Heat Pipe~~

~~Provide a device that is a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat between exhaust and supply streams and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination. Provide heat exchanger tube core that is [1/2][5/8][1] inch nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Provide maximum fins per unit length and number of tube rows as indicated. Provide tubes that are fitted with internal capillary wick, filled with a refrigerant complying with ASHRAE 15 & 34, selected for system design temperature range, and hermetically sealed. Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide heat exchanger frame that is constructed of not less than 16 gauge galvanized steel and fitted with intermediate tube supports, and flange connections. Provide tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio.[Provide a drain pan constructed of welded Type 300 series stainless steel.] Provide heat recovery regulation by [system face and bypass dampers and related control system as indicated][interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil must be fitted with pleated flexible connectors.~~

~~2.13.4 Desiccant Wheel~~

~~Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.~~

2.13.1 Plate Heat Exchanger

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The

casing must be 20 gauge G90, galvanized steel, double wall construction with one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.14 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Field paint factory painting that has been damaged prior to acceptance by the Contracting Officer in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.15 SUPPLEMENTAL COMPONENTS/SERVICES

2.15.1 Chilled, Condenser, or Dual Service Water Piping

The requirements for chilled, condenser, or dual service water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.15.2 Refrigerant Piping

The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

2.15.3 Water or Steam Heating System Accessories

The requirements for water or steam heating accessories such as expansion tanks and steam traps are specified in Section ~~[23 52 00 HEATING BOILERS][~~ 23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM and~~]~~ 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS~~]~~.

2.15.4 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section ~~[22 00 00 PLUMBING, GENERAL PURPOSE][~~23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS~~]~~ except as modified herein.

2.15.5 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.15.6 Insulation

The requirements for shop and field applied insulation are specified in

Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.7 Controls

The requirements for controls are specified in [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS][and][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][and][Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

2.16 RADIANT PANELS

2.16.1 Hydronic Modular Panels

2.16.1.1 Panels

Modular radiant panels will fit into a standard 24 inch x 24 inch or 24 inch x 48 inch suspended T-Bar ceiling grid or flush mounted on a drywall ceiling. For flush mounted ceiling applications, the manufacturer will provide a one piece extruded aluminum frame. Panels must be supported from the T-bar assembly. Panels must be [14 gauge] or [16 gauge] extruded aluminum or sheet steel.

2.16.1.2 Heat Sink

The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.16.1.3 Water Tubes

Tubes must consist of ASTM B75/B75M [1/2 inch] [5/8 inch] O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. Heat pads will be used between the soldered fitting and the panel to protect the panel surface. The manufacturer will provide water pressure drop data as well as heating and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling). The panels will have the capacity to have multiple passes with connections either on the [same end] or [opposite ends], dependent on the number of passes.

2.16.1.4 Finish

All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.

2.16.1.5 Performance

Manufacturer will provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.16.1.6 Capacity

Modular radiant panel capacity will be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) to meet the required performance. Should any performance rating, chilled or hot water supply temperature, water pressure drop, etc. deviate from the schedule, the manufacturer will submit the updated

~~capacity. [The manufacturer will have factory testing facility available to perform performance test of units in accordance with said standard.]~~

~~2.16.1.7 Water Connections~~

~~Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.~~

~~2.16.1.8 Installation~~

~~Panels will be installed as recommended by the manufacturer.~~

~~2.16.1.9 Accessories~~

~~Stainless steel braded hoses, 12 inches or 18 inches long will be supplied with the panels.~~

~~The top of the heating and cooling panels must be covered with1-1/2 inches thick 1 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.~~

~~2.16.2 Hydronic Linear Panels~~

~~2.16.2.1 Panels~~

~~Linear radiant panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face. The linear radiant panel is to radiate or absorb heat from or to the zone below. Panels must be [14 gauge] or [16 gauge] extruded aluminum.~~

~~2.16.2.2 Heat Sink~~

~~The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.~~

~~2.16.2.3 Water Tubes~~

~~Tubes must consist of ASTM B75/B75M 1/2 inch or 5/8 inch O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. The manufacturer will provide water pressure drop data as well as heating and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).~~

~~2.16.2.4 Mounting~~

~~Units must be provided with mounting hardware as required for mounting in T-Bar applications or ceiling flush mounting. The manufacturer's standard hardware for mounting panels abutting each other must be submitted for approval.~~

~~2.16.2.5 Finish~~

~~All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.~~

~~2.16.2.6 Performance~~

~~Manufacturer must provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).~~

~~2.16.2.7 Capacity~~

~~Modular radiant panel capacity must be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) to meet the required performance. Should any performance rating, chilled or hot water supply temperature, water pressure drop, etc. deviate from the schedule, the manufacturer must submit the updated capacity. [The manufacturer must have factory testing facility available to perform performance test of units in accordance with said standard.]~~

~~2.16.2.8 Water Connections~~

~~Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.~~

~~2.16.2.9 Accessories~~

~~Stainless steel braded hoses, 12 inches or 18 inches long will be supplied with the panels.~~

~~The top of the heating and cooling panels must be covered with 1-1/2 inches thick 1 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.~~

~~2.16.3 Prefabricated Radiant-Heating Electric Panels~~

~~2.16.3.1 Description~~

~~Sheet metal enclosed panel with heating element suitable for [lay-in installation flush with T-bar ceiling grid] [surface mounting] [recessed mounting]. Comply with UL 2021~~

~~2.16.3.2 Panel~~

~~Minimum 0.027 inch thick, galvanized steel sheet back panel riveted to minimum 0.040 inch thick, galvanized steel sheet front panel with fused-on crystalline surface.~~

~~2.16.3.3 Heating Element~~

~~Powdered graphite sandwiched between sheets of electric insulation.~~

~~2.16.3.4 Electrical Connections~~

~~Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.~~

~~2.16.3.5 Exposed-Side Panel Finish~~

~~[Apply silk-screened finish to match appearance of Architect selected acoustical ceiling tiles.] [Baked-enamel finish in color as selected by Architect.]~~

~~2.16.3.6 Surface-Mounting Trim~~

~~Sheet metal with baked-enamel finish in color as selected by Architect.~~

~~2.16.3.7 Wall Thermostat~~

~~Bimetal, sensing elements; with contacts suitable for [low] [line]-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.~~

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of ~~[~~3~~][_____]~~ feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional ~~[~~3 ~~][_____]~~ feet.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all ~~[~~units~~]~~ ~~[units except room [fan-coil units][and][coil-induction units]]~~. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less

than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.4 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.5 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

Fabricate concealed ducts conveying moisture laden air from minimum 18 gauge, Type 300 series, stainless steel. Continuously weld, braze, or solder joints to be liquid tight. Pitch ducts to drain at points indicated. Make transitions to other metals liquid tight, companion angle bolted and gasketed.

~~3.2.5.1 Underground Ductwork~~

~~Provide PVC plastisol coated galvanized steel underground ductwork with coating on interior and exterior surfaces and watertight joints. Install ductwork as indicated, according to ACCA Manual 4 and manufacturer's instructions. Maximum burial depth is 6 feet.~~

3.2.5.1 Radon Exhaust Ductwork

Perforate subslab suction piping where indicated. Install PVC joints as

specified in ASTM D2855.

~~3.2.5.2 Light Duty Corrosive Exhaust Ductwork~~

~~For light duty corrosive exhaust ductwork, use PVC plastisol coated galvanized steel with PVC coating on interior [surfaces][and exterior surfaces][and epoxy wash primer coating on exterior surfaces].~~

~~3.2.6 FRP Ductwork~~

~~Provide fibrous glass reinforced plastic ducting and related structures that conform to SMACNA 1403. Provide flanged joints where indicated. Crevice-free butt lay-up joints are acceptable where flanged joints are not indicated. When ambient temperatures are lower than 50 degrees F, heat cure joints by exothermic reaction heat packs.~~

~~3.2.7 Kitchen Exhaust Ductwork~~

~~3.2.7.1 Ducts Conveying Smoke and Grease Laden Vapors~~

~~Provide ducts conveying smoke and grease laden vapors that conform to requirements of NFPA 96. Make seams, joints, penetrations, and duct-to-hood collar connections with a liquid tight continuous external weld. Provide duct material that is a [minimum 18 gauge, Type 304L or 316L, stainless steel] [minimum 16 gauge carbon steel]. [Include with duct construction an external perimeter angle sized in accordance with SMACNA 1966, except place welded joint reinforcement on maximum of 24 inch centers; continuously welded companion angle bolted flanged joints with flexible ceramic cloth gaskets where indicated; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Make angles, pipe couplings, frames, bolts, etc., the same material as that specified for the duct unless indicated otherwise.]~~

~~3.2.7.2 Exposed Ductwork~~

~~Provide exposed ductwork that is fabricated from minimum 18 gauge, Type 304L or 316L, stainless steel with continuously welded joints and seams. Pitch ducts to drain at hoods and low points indicated. Match surface finish to hoods.~~

~~3.2.7.3 Concealed Ducts Conveying Moisture Laden Air~~

~~Fabricate concealed ducts conveying moisture laden air from minimum [18 gauge, Type 300 series, stainless steel] [16 gauge, galvanized steel] [16 ounce, tempered copper sheet]. Continuously weld, braze, or solder joints to be liquid tight. Pitch ducts to drain at points indicated. Make transitions to other metals liquid tight, companion angle bolted and gasketed.~~

3.2.6 Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C916, Type I, NFPA 90A, UL 723, and ASTM E84. Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA 1966. Provide welded pins, cup-head pins,

or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA 1966 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

3.2.7 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.8 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums ~~[~~up to the point where the outdoor air reaches the conditioning unit~~][or][up to the point where the outdoor air mixes with the return air stream]~~.

3.2.9 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.2.10 Power Roof Ventilator Mounting

Provide foamed 1/2 inch thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

3.2.11 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum

of ~~[~~28~~]~~~~[~~14~~]~~~~[_____]~~ calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse ~~[_____]~~ protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

3.6.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.6.4 Closure Collars

Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

3.6.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

3.7.1 Temperatures less than 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

3.7.2 Temperatures between 120 and 400 degrees F

Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

3.7.3 Temperatures greater than 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

~~3.7.4 Finish Painting~~

~~The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.~~

~~3.7.5 Color Coding Scheme for Locating Hidden Utility Components~~

~~Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 3/8 inch diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks follow completion of the finished surface on which the disks are to be fastened. Provide color code board that is approximately 3 foot wide, 30 inches high, and 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1/16 inch transparent plastic cover. Make the color code symbols approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount the color code board [where indicated] [in the mechanical or equipment room]. Make the color code system as indicated below:~~

~~Color~~	~~System~~	~~Item~~	~~Location~~
~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~

3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

~~3.9 DUCTWORK LEAK TEST~~

~~Perform ductwork leak test for the entire air distribution and exhaust system, including fans, coils, [filters, etc.][filters, etc. designated as static pressure Class 3 inch water gauge through Class 10 inch water gauge.] Provide test procedure, apparatus, and report that conform to SMACNA 1972 CD. The maximum allowable leakage rate is [_____] cfm. Complete ductwork leak test with satisfactory results prior to applying insulation to ductwork exterior or concealing ductwork.~~

3.9 DUCTWORK LEAK TESTS

The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.10 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by

having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.11 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.12 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

3.13 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of ~~[room fan-coil units][coil-induction units,] [~~air terminal units,~~]~~ ~~[unit ventilators,]~~ thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

~~3.14 RADIANT PANELS~~

~~3.14.1 Installation~~

~~Install radiant panels level and plumb, maintaining sufficient clearance for normal services and maintenance.~~

~~3.14.2 Soldering~~

~~When soldering copper fittings at the panel, a heat pad will be used to protect the panel finish.~~

~~3.14.3 Connections~~

~~Install piping adjacent to radiant panels to allow for service and~~

~~maintenance.~~

3.14 OPERATION AND MAINTENANCE

3.14.1 Operation and Maintenance Manuals

Submit ~~[~~six~~]~~ ~~[_____]~~ manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.14.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 8~~[_____]~~ hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

SECTION 23 52 43.00 20

LOW PRESSURE WATER HEATING BOILERS (UNDER 800,000 BTU/HR OUTPUT)
05/15, CHG 2: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2017; Errata 2018) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME CSD-1	(2016) Control and Safety Devices for Automatically Fired Boilers

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-23 PART 1	(2013) National Board Inspection Code - Part 1 Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2020) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2021 18) National Fuel Gas Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UNDERWRITERS LABORATORIES (UL)

UL 795	(2016; Reprint Sep 2020) UL Standard for

Safety Commercial-Industrial Gas Heating Equipment

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.3 DESIGN REQUIREMENTS

Boiler must be suitable for installation in the space shown with ample room for opening doors and cleaning and removal and replacement of tubes. ~~Boiler must have an output of [_____] BTU/hr.~~ Boiler must be designed and tested in accordance with ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, NFPA 70 and ANSI Z21.13/CSA 4.9. Boiler must be installed in accordance with NBBI NB-23 PART 1. Paint boiler in accordance with manufacturer's recommendations. Boiler design working pressure must be ~~[~~minimum 80 psi~~30 psig] [_____~~. ~~Boiler operating pressure must be [12 psig] [_____]. Boiler operating temperature must be [180 degrees F] [_____]. Boiler return water temperature must be [160 degrees C] [_____]. Provide a thermostatically controlled three-way mixing valve on boiler suitable for operating conditions of the boiler.~~

1.3.1 Boiler Installation Requirements

1.3.1.1 Location

Install Boiler(s) and associated hot water pumps in a mechanical room inside the facility in accordance with NBBI NB-23 PART 1. Provide ample clearance around boilers to allow access for inspection, maintenance and repair. Passageways around all sides of boilers must have an unobstructed minimum width of 18~~36~~ inches or the clearances recommended by the boiler manufacturer whichever is greater.

1.3.1.2 Combustion Air

Provide supply of air for combustion and ventilation. In accordance with NFPA 54, NFPA 211 and manufacturer's installation manual, calculate the amount of combustion air necessary to operate the boiler. Install and locate properly sized combustion air dampers and louvers.

1.3.1.3 Sequence of Operation

Local, manual starting of boilers is required. Remote starting and stopping of the boiler by the HVAC control system is not permitted. This is to ensure that an operator witness the initial firing of the boiler at the beginning of each heating season to verify proper operation of the boiler and to promote proper maintenance.

1.3.2 Detail Drawings

1.3.2.1 Drawings

Show boiler hot water isolation valves, emergency disconnect switch, and complete boiler gas train on the contract drawings.

1.3.2.2 Fuel Train / Wiring Diagram

Submit fuel train and wiring diagram.

1.3.3 Water Analysis

Provide test reports of water analysis. UFC 3-240-13FN Industrial Water Treatment must be followed for all boiler installations.

1.4 SAFETY STANDARDS

Hot water boilers, burners and supplementary control devices, safety interlocks, or limit controls required under this specification, must meet requirements of the following standards as applicable:

~~a. Oil-Fired Units: UL 726, NFPA 31, NFPA 70, ASME CSD-1.~~

a~~b~~. Gas-Fired Units: ASME CSD-1, NFPA 54, NFPA 70, ANSI Z21.13/CSA 4.9 or UL 795.

~~c. Combination Gas- and Oil-Fired Units: ASME CSD-1, NFPA 54, NFPA 31, NFPA 70, UL 726, ANSI Z21.13/CSA 4.9, UL 795 or UL 296.~~

~~d~~b. All Units: ASME BPVC SEC IV, NFPA 70 and ASME CSD-1.

Controls not covered by the above must have a UL label, UL listing mark, or must be listed in the Factory Mutual Approval Guide.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

~~[~~ Submittals for this Section must be delivered to the project ~~Contracting Officer~~QC Manager, who will forward two complete sets of copies to the appropriate approving official for review and approval.

~~]~~ SD-02 Shop Drawings

Fuel Train

Wiring Diagram

SD-03 Product Data

Boilers

~~[~~ ~~Energy Star Label for Gas Fired Residential Boiler Product; S~~

~~][~~ ~~Energy Star Label for Oil-Fired Residential Boiler Product; S~~

~~]~~ Boiler Trim and Control Equipment

Burners and Control Equipment

~~Stack, Breeching, and Supports~~

SD-06 Test Reports

Operational Tests

Water Analysis

SD-07 Certificates

Boilers

Burners and Control Equipment

Boiler Trim and Control Equipment

Boiler manufacturer's certificate of boiler performance including evidence that the burners provided must be a make, model, and type certified and approved by the manufacturer of the boiler being provided.

SD-08 Manufacturer's Instructions

Boilers

~~Feedwater Treatment Feeder~~

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Heating Water Boilers

PART 2 PRODUCTS

2.1 BOILERS

Provide hot water heating boiler complete with firing equipment, combustion chamber, insulation with steel jacket, safety and operating controls, integral electrical wiring and other appurtenances, to make the boiler a complete, self-contained, fully-automatic unit, ready for service upon completion of utility connections.~~[Gas fired residential boilers less than 300,000 Btuh must have an Annual Fuel Utilization Efficiency (AFUE)of at least 90 percent, and be Energy Star labeled. Provide proof of Energy Star label for oil-fired residential boiler product.][Oil-fired residential boilers less than 300,000 Btuh must have an Annual Fuel Utilization Efficiency (AFUE) of at least 87 percent, and be Energy Star labeled. Provide proof of Energy Star label for gas fired residential boiler product.]{~~ Commercial boilers less than 300,000 Btuh must have an Annual Fuel Utilization Efficiency (AFUE) of at least 80 percent.~~}]{~~ Gas fired boilers greater than 300,000 Btuh input must have a thermal efficiency of at least 80 percent when fired at the maximum and minimum capacities which are provided and allowed by the controls.~~}][Oil-fired boilers greater than 300,000 Btuh output must have a thermal efficiency of at least 82 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.]~~

2.1.1 General Requirements

Design, construction, installation, testing, and operation of boiler and appurtenances shall comply with NBBI NB-23 PART 1, ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, ANSI Z21.13/CSA 4.9, and the manufacturer's instructions.

2.1.1.1 P1509 Boilers

The BOILER shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard. The BOILER shall operate at a minimum of 95% AFUE Efficiency as registered with AHRI. The BOILER shall be certified for indoor installation.

The BOILER shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber. The burner shall be a premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide smooth operation at all modulating firing rates. The BOILER shall be supplied with a negative pressure regulation gas valve and be equipped with a pulse width modulation blower system to precisely control the fuel/air mixture to the burner. The BOILER shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

The BOILER shall utilize a 24 VAC control circuit and components. The control system shall have a factory installed display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The BOILER shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 30 psi (standard); outlet water temperature sensor with a dual thermistor to verify accuracy; system supply water temperature sensor; outdoor air sensor, flue temperature sensor with dual thermistor to verify accuracy; low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.

The BOILER shall feature the "SMART SYSTEM™" control which is standard and factory installed with 128 x 128 resolution display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities, USB drive for simple uploading of parameters and a PC port connection for connection to a local computer for programming and trending. A secondary operating control that is field mounted outside or inside the appliance is not acceptable. The BOILER shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The BOILER shall have a built-in "Cascade" with leader redundancy to sequence and rotate while maintaining modulation of up to eight boilers of different Btu inputs without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The BOILER shall be capable of remote communication via optional CON-X-US™ Remote Connectivity with the capability of historical trending and sending text message or email alerts to notify the caretaker of a

boiler alarm and remote programming of onboard boiler control. The control must have optional capability to communicate via Modbus protocol with a minimum of 46 readable points. The BOILER shall have an optional gateway device which will allow integration with BacNet protocols.

The "SMART SYSTEM™" control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump (pump shall be supplied by manufacturer) to keep a fixed Delta T across the boiler regardless of the modulation rate. The BOILER shall have the capability to receive a 0-10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues such as erratic temperature cycling.

The BOILER shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 46 connection points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Low Water Cut Off, Louver Proving Switch, Tank Thermostat, Domestic Hot Water Building Recirculation Pump Contacts, Domestic Hot Water Building Recirculation Temperature Sensor Contacts, Remote Enable/Disable, System Supply Temperature Sensor, Outdoor Temperature Sensor, Tank Temperature Sensor, Modbus Building Management System Signal and Cascade Control Circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on all models. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump and the Boiler pump.

The boiler shall be installed and vented with a direct Vent system with horizontal sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved material constructed of PVC, CPVC, Polypropylene or Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet.

2.2 BURNERS AND CONTROL EQUIPMENT

~~[2.2.1 Atmospheric-Type Gas Burner~~

~~Atmospheric-type gas burner (under 400,000 BTU/hr input). ASME CSD-1 and ANSI Z21.13/CSA 4.9. Automatic recycling burner. ON-OFF type combustion control system.[Interrupted] [Intermittent] pilot type ignition system, and pilot must be electrode-ignited natural gas type. Design burner and combustion control equipment for firing natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [1000 BTU per cubic foot] and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1 and ANSI Z21.13/CSA 4.9, including complete gas shut-off and pilot gas. Gas pressure available: [[_____] inches of water gage (WC)] psig.~~

~~]~~[2.2.1 Gas-Fired Power Burner

Gas-fired power burner ~~(over 400,000 BTU/hr input)~~. Interrupted pilot

type ignition system, and pilot must be the electrode-ignited natural gas type. Design burner and combustion control equipment for firing natural gas having a specific gravity of {0.6} [_____] and a heating value of approximately {1000 BTU per cubic foot} [_____] and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 54, ANSI Z21.13/CSA 4.9 and UL 795. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. The combustion control system must be the [on/off] [high-low-off] {positioning or} {metering} type. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated. Gas pressure available: [[_____] inches of water gage] [[_____] psig].

][2.2.2 Oil-Fired Power Burner

Oil-fired power burner (under 400,000 BTU/hr input). Direct electric-spark-ignited type ignition system. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31 and UL 726. The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type.

][2.2.3 Oil-Fired Power Burner

Oil-fired power burner (over 400,000 BTU/hr input). Pressure-atomizing type burner. Direct electric-spark-ignited type ignition system. Design burner and combustion control equipment for firing commercial grade number 2 fuel oil and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31 and UL 726. The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated.

][2.2.4 Gas and Light Oil-Fired Power Burner

Gas and light oil-fired power burner (over 400,000 BTU/hr Input). The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type. Pressure-atomizing type oil burner. Interrupted-pilot type ignition system, and pilot be electrode-ignited natural gas type, except that the oil burner be direct electric-spark-ignited. Design burner and combustion control equipment for firing commercial grade number 2 fuel oil and natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [1000 BTU per cubic foot] [_____] and be an integral part of boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31, UL 726, NFPA 54, ANSI Z21.13/CSA 4.9 and UL 795. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated. Gas pressure available: [[_____] inches of water gage] [[_____] psig].

]2.3 BOILER TRIM AND CONTROL EQUIPMENT

Provide in accordance with ASME CSD-1 and ASME BPVC SEC IV and additional requirements specified below.

2.3.1 Emergency Disconnect Switch

Provide and locate on wall outside boiler room entrance or just inside door, when boiler room door is on building exterior as required by ASME CSD-1 to allow rapid and complete shutdown of the boiler in the event of an emergency. Emergency switch must be a [__15 or 20___]-amp. fuse-type safety switch. Switch must be red and furnished with a label indicating function of switch.

2.3.2 Relief Valves

Provide relieving capacity for the full output of boiler installed. Safety relief-valve piping must conform to ASTM A53/A53M, schedule 40 steel pipe and be piped full-size [to a floor drain] [to 6 inches above floor].

2.3.3 Pressure and Altitude Gage or Combination Pressure/Altitude Gage

Provide one located on supply water piping and one on return water piping.

2.3.4 Thermometer

Provide thermometer with a scale equivalent to 1.5 times outlet water temperature. Provide one located on supply water piping and one on return water piping.

2.3.5 Drain Tapping

Provide drain valve and piping [to a floor drain] [to 6 inches above floor].

2.3.6 Make-up Water Station

2.3.6.1 Pressure Reducing Station

Provide a water pressure-reducing valve and relief valve, or a combination of the two in the makeup water line to the boiler to maintain a water pressure of [12 psig] [_____] in the hot water system. Provide a 3/4 inch globe valve by-pass around this valve.

2.3.6.2 Backflow Preventers

Section 22 00 00 PLUMBING, GENERAL PURPOSE. Locate upstream of by-pass.

2.3.7 Feedwater Treatment Feeder

Provide floor mounted, Type II - Shot-Type Feeder (manual, intermittent feed), as indicated for use with pressures up to 200 psig maximum.

2.3.7 Combustion Regulator

Provide adjustable temperature, thermostatic immersion type that must limit boiler water temperature to a maximum of 250 degrees F. Control must actuate burner through an electric relay system to maintain boiler

water temperature within normal prescribed limits at loads within rated capacity of boiler.

2.3.8 Air Vent Valve

Provide with screwed connection, stainless steel disk, and stainless steel seats to vent entrapped air.

2.3.9 High Temperature Limit Switch

Provide adjustable immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat must function to cause a safety shutdown by closing fuel valves~~[~~,~~]~~ ~~[~~and~~]~~ shutting down burner equipment ~~[, activating a red indicating light, and sounding an alarm]~~ in the event that boiler water temperature rises to the high temperature limit setting. A safety shutdown due to high temperature must require manual reset before operation can resume and prevent recycling of burner equipment. Pre-set high temperature limit devices that cannot be easily tested are not allowed.

2.3.10 Low Water Level Cutoff Switch

Low water level cutoff must cause a safety shutdown by closing fuel valves~~[~~, ~~]~~ ~~[~~and~~]~~ shutting down burner equipment ~~[, activating a red indicating light, and sounding an alarm]~~ in the event that water level drops below the lowest safe permissible water level established by the boiler manufacturer and ASME BPVC SEC IV. A safety shutdown due to low water must require manual reset before operation can resume and prevent recycling of burner equipment.

2.3.11 Boiler Safety Control Circuits

Provide boiler safety control circuits, including control circuits for burner ~~[~~and draft fan~~]~~, must be single-phase, two-wire one-side grounded, and not over 120 volts. Provide safety control switching in ungrounded conductors. Provide overcurrent protection. In addition to circuit grounds, ground metal parts which do not carry current to a grounding conductor.

~~2.3.12 Indicating Lights~~

~~Each safety interlock requiring a manual reset must have an individually labeled red indicating light. Non-recycling control interlocks must have the reset located on the control itself. Red indicating lights on the control panel may be omitted if the burner combustion control system has a Keyboard Display Module installed that will identify the lockout information required in Item c. below. Indicating lights must have colors as follows:~~

~~a. Amber: Ignition on~~

~~b. Green: Main fuel safety shut-off valves open~~

~~c. Red (One for Each): Safety lockout, flame failure, low water level, and high temperature~~

~~[d. Blue: Draft~~

~~]2.3.13 Alarm Bell~~

~~Provide alarm bell, electrically operated, with a manual disconnect switch. Disconnect switch must be type and wired so that switching off alarm following a safety shutdown will not prevent alarm from sounding again upon recurrence of a subsequent safety shutdown condition.~~

2.3.12 Post-Combustion Purge

Provide controls and wiring necessary to ensure operation of draft fan for a period of not less than 15 seconds or of sufficient duration to provide four complete air changes in the boiler combustion chamber (whichever is greater) following shutdown of burner upon satisfaction of heat demand and in accordance with ASME CSD-1 . Upon completion of post-combustion purge period, draft fan must automatically shutdown until next restart.

2.3.13 Draft

Comply with boiler manufacturer's recommendations.

~~2.3.14 Stack, Breeching, and Supports~~

~~[Provide boiler stack constructed of sheet steel having a thickness of not less than 0.0972 inches with welded joints. Insulate stack located inside the building with 1 1/2 inches of mineral wool conforming to applicable requirements of ASTM C592, Class II - for use up to 1200 degrees F. Insulation must receive a finish coat of finishing cement not less than 3/4 inch thick, trowelled to a smooth finish. Provide stack supports, umbrella collar and cap, and flue transition piece. Stack diameter and height must be in accordance with manufacturer's recommendations and conform to NFPA 211.]~~

~~[NFPA 211, [Type B - gas] [Type L - oil and gas/oil], prefabricated multi-wall type, flashed to the roof, and complete with rain cap. Stack diameter and height must be in accordance with manufacturer's recommendations and conform to NFPA 211.]~~

~~2.3.15 Hot Water Coils~~

~~Provide coils capable of heating [_____] GPM of water with [_____] degree F rise conforming to ASME BPVC SEC IV.~~

~~2.3.16 Stack Thermometer~~

~~Provide flue gas dial type thermometer with scale calibrated from 150 to 750 degrees F and mounted in flue gas outlet.~~

2.4 ELECTRIC MOTORS

Electric motors must meet requirements of NEMA MG 1. Motors less than 1 hp must meet NEMA High Efficiency requirements. Motors 1 hp and larger must meet NEMA Premium Efficiency requirements. Motors which are an integral part of the packaged boiler system must be the highest efficiency available by the manufacturer of the packaged boiler. Motors must be variable speed.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Install equipment in accordance with manufacturer's installation instructions and NBBI NB-23 PART 1. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets. Feedwater treatment feeders must be mounted so that the top of the feeder is no higher than 48 inches above the finished floor.

3.2 EQUIPMENT FOUNDATIONS

Locate equipment foundations as indicated, designed, and made of sufficient size and weight to preclude shifting of equipment under operating conditions or under abnormal conditions that could be imposed upon the equipment. Foundations must meet requirements of the equipment manufacturer. Concrete and grout must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 BOILER CLEANING

Before being placed in service, boiler must be boiled out for a period of 24 hours at a pressure not exceeding 12 psig. Solution to be used in the boiler for the boiling out process must consist of two pounds of trisodium phosphate per 100 gallons of water. Upon completion of boiling out, flush out boiler with potable water, drain, and charge with chemically treated water. Protect boiler and appurtenances against internal corrosion until testing is completed and boiler is accepted. Professional services are required for cleaning/treatment process.

3.4 FIELD QUALITY CONTROL

Perform and furnish everything required for inspections and tests as specified herein to demonstrate that boiler and auxiliary equipment, as installed, are in compliance with contract requirements. Start-up and operate the system. During this time, clean strainers until no further accumulation of foreign material occurs. Exercise care to minimize loss of water when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence. Test instrumentation must be calibrated and have full scale readings from 1.5 to 2 times test values.

3.4.1 Operational Tests

Furnish the services of an engineer or technician approved by the boiler manufacturer of installation, startup, operational and safety testing. This person must remain on the job until each boiler has been successfully operated. Furnish and perform everything required for inspections and tests of the boiler and auxiliary equipment. Test instrumentation must be calibrated and have full-scale reading from 1.5 to 2 times test values. Demonstrate proper operability of combustion control, flame safeguard control and safety interlocks. Provide a detailed description of all boiler startup and operational tests in the Commissioning Plan.

3.4.1.1 Preliminary Operational Test

Operate the boilers continuously for a period of at least 8 hours to

demonstrate proper operability of the combustion control, flame safeguard control, and safety interlocks.

3.4.1.2 Acceptance Operational Test and Inspection

Prior to requesting an acceptance test, conduct a satisfactory operational test for at least 8 hours, and provide a certified statement that the equipment is installed per all requirements of this guide. Contracting Officer and QC Manager, upon receipt of the notice from the Contractor, will request a boiler inspection by a Naval Facilities Engineering and Expeditionary Warfare Center (EXWC) NAVFAC boiler inspector. Fifteen days advance notice is required for scheduling inspector to conduct acceptance operational test and inspection.

-- End of Section --

SECTION 23 64 10

WATER CHILLERS, VAPOR COMPRESSION TYPE
11/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 550/590 I-P	(2015; ERTA 2016) Performance Rating Of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2016) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators

NEMA MG 11 (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82 Protection of Stratospheric Ozone

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are ~~[~~for Contractor Quality Control approval.~~][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-03 Product Data

~~Water Chiller; G[, [_____]]~~

~~Posted Instructions~~

Verification of Dimensions

~~Factory Tests~~

System Performance Tests

Demonstrations

Refrigerant

~~[~~ Water Chiller - Field Acceptance Test Plan

~~]~~ SD-06 Test Reports

Field Acceptance Testing

~~[~~ Water Chiller - Field Acceptance Test Report

~~]~~ ~~Factory Tests~~

System Performance Tests

SD-07 Certificates

Refrigeration System~~; G[, [_____]]~~

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

~~[~~ Water Chiller - Installation Instructions~~; G[, [_____]]~~

~~]~~ SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals~~; G[, [_____]]~~

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 CERTIFICATIONS

1.3.1 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the ~~Contracting Officer~~QC Manager at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

1.5 DELIVERY, STORAGE, AND HANDLING

Stored items must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation will be the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.6 PROJECT REQUIREMENTS

1.6.1 Verification of Dimensions

The Contractor must become familiar with all details of the work, verify all dimensions in the field, and advise the ~~Contracting Officer~~QC Manager of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment will be standard Commercial cataloged products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. These products must have a two year record of satisfactory field service prior to bid opening. The two year record of service must include applications of equipment and materials under similar circumstances and of similar size. Products having less than a two year record of satisfactory field service will be acceptable if a certified record of satisfactory field service for not less than 6000 hours can be shown. The 6000 hour service record must not include any manufacturer's prototype or factory testing. Satisfactory field service must have been completed by a product that has been, and presently is being sold or offered for sale on the commercial market through the following copyrighted means: advertisements, manufacturer's

catalogs, or brochures.

2.2 MANUFACTURER'S STANDARD NAMEPLATES

~~[Major equipment including chillers, compressors, compressor drivers, condensers, water coolers, receivers, refrigerant leak detectors, heat exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life. Plates must be fixed in prominent locations with nonferrous screws or bolts.~~

~~][~~Nameplates are required on major components if the manufacturer needs to provide specific engineering and manufacturing information pertaining to the particular component. Should replacement of this component be required, nameplate information will insure correct operation of the unit after replacement of this component. Plates shall be durable and legible throughout equipment life and made of non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable.

~~]~~2.3 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. ~~[Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure.]~~ Motor enclosure type may be either TEAO or TEFC.

e. ~~[Where two-speed motors are indicated, variable-speed controllers may be provided to accomplish the same function.][Use adjustable frequency drives for all variable-speed motor applications.]~~ Provide variable

frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

f. Provide inverter duty premium efficiency motors for use with variable frequency drives.

2.4 SELF-CONTAINED WATER CHILLERS, VAPOR COMPRESSION TYPE

Unless necessary for delivery purposes, units must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately must be sealed and charged with a nitrogen holding charge. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, must have lifting eyes or lugs. Chiller must be provided with a single point wiring connection for incoming power supply. Chiller's condenser and water cooler must be provided with ~~[~~standard~~] [marine]~~ water boxes with ~~[grooved mechanical] [~~flanged~~] [welded]~~ connections.

2.4.1 Scroll, Reciprocating, or Rotary Screw Type

Chiller must be certified for performance per AHRI 550/590 I-P. If specified performance is outside of the Application Rating Conditions of AHRI 550/590 I-P, Table 2 then the chiller's performance must be rated in accordance with AHRI 550/590 I-P. Chiller must conform to ANSI/ASHRAE 15 & 34. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

e. Scroll~~, reciprocating, or rotary screw~~ compressor

f. Compressor driver, ~~[~~electric motor~~] [gas-engine]~~

g. Compressor driver connection

h. Water cooler (evaporator)

i. ~~[~~Air~~][Water]~~-cooled condenser coil

~~[j. Heat recovery condenser~~

~~][k. Receiver~~
~~]~~
~~[l. Tools~~

~~]2.4.2 Centrifugal or Rotary Screw Type~~

~~Chiller must be certified for performance per AHRI 550/590 I-P. If specified performance is outside of the Application Rating Conditions of AHRI 550/590 I-P, Table 2 then the chiller's performance must be rated in~~

accordance with AHRI 550/590 I-P. Chiller must conform to ANSI/ASHRAE 15 & 34. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

e. Centrifugal or rotary screw compressor

f. Compressor driver, [electric motor] [gas-engine] [steam turbine]

g. Compressor driver connection

h. Water cooler (evaporator)

i. [Air][Water]-cooled condenser coil

[j. Heat recovery condenser coil

][k. Receiver

] l. Purge system for chillers which operate below atmospheric pressure

[m. Tools

]2.5 SPLIT-SYSTEM WATER CHILLER, VAPOR COMPRESSION TYPE

Total chiller system must be certified for performance per AHRI 550/590 I-P. If chiller is not in scope of AHRI 550/590 I-P then chiller must be rated in accordance with AHRI 550/590 I-P. Individual chiller components must be constructed and rated in accordance with the applicable AHRI standards. Chiller system must conform to ANSI/ASHRAE 15 & 34. The chiller must be ASHRAE 90.1 - IP compliant and meet 10 CFR Part 433, 434 and 435 efficiency performance standards for federal construction. The manufacturer must provide certification of compliance. Chiller must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site in strict accordance with manufacturer's recommendations. Unit components delivered separately must be sealed and charged with a nitrogen holding charge. Unit assembly must be completed in strict accordance with manufacturer's recommendations. Chiller must operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, must have lifting eyes or lugs. Chiller must include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller's water cooler must be provided with [standard] [marine] water boxes with [grooved mechanical] [flanged] [welded] connections. Chillers must operate at partial load conditions without increased vibration over normal vibration at full load, and must be capable of continuous operation down to minimum capacity. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

[e. Receiver
]
[f. Tools

]2.5.1 Compressor-Chiller Unit

As a minimum, the compressor-chiller unit must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor

b. Compressor driver, electric motor

c. Compressor driver connection

d. Water cooler (evaporator)

2.5.2 Condensing Unit

As a minimum, the condensing unit must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor

b. Compressor driver, electric motor

c. Compressor driver connection

d. Air or water cooled condenser

2.5.3 Remote Water Cooler (Evaporator)

2.5.3.1 Shell and Tube Type

Cooler must be constructed and rated in accordance with AHRI 480. Cooler must be of the shell-and-coil or shell-and-tube type design. Cooler's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Cooler's water side must be designed and factory pressure tested for not less than [150] [250] [300] psi. Cooler shell must be constructed of seamless or welded steel. [Coil bundles must be totally removable and arranged to drain completely.] Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Cooler must be skid-mounted. Refrigerant circuit must be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. For the water side of water cooler, performance must be based on a fluid velocity not less than 3 fps and not more than 12 fps and a fouling factor per AHRI 550/590 I-P.[Evaporator must be provided with electric freeze protection type.]

~~2.5.3.2 Brazed Plate Type~~

~~Cooler must be rated in accordance with AHRI 480. Cooler must be of the brazed plate design. Cooler's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Cooler's water side must be designed and factory pressure tested for not less than [150] [250] [300] psi. Cooler shell must be constructed of stainless steel plates brazed together with copper. Refrigerant circuit must be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. For the water side of water cooler, performance must be based on a fluid velocity not less than 3 fps and not more than 12 fps and a fouling factor per AHRI 550/590 I-P. [Evaporator must be provided with electric freeze protection type.]~~

~~2.5.4 Remote Air-Cooled Condenser~~

~~Condenser must be a factory-fabricated and assembled unit, consisting of coils, fans, and condenser fan motors. Condenser must be rated in accordance with ANSI/AHRI 460. [Unless the condenser coil is completely protected through inherent design, louvered panel coil guards must be provided by the manufacturer to prevent physical damage to the coil.] Manufacturer must certify that the condenser and associated equipment are designed for the submitted condensing temperature. For design conditions, if matched combination catalog ratings matching remote condensers to compressors are not available, the Contractor must furnish a crossplotting of the gross heat rejection of the condenser against the gross heat rejection of the compressor, for the design conditions to show the compatibility of the equipment furnished.~~

~~2.5.4.1 Condenser Casing~~

~~Condenser casing must be aluminum not less than [0.040] [0.080] inch or hot-dip galvanized steel not lighter than 18 gauge 0.0516 inch. [Condensers having horizontal air discharge must be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing].~~

~~2.5.4.2 Coil~~

~~[Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless [copper] [or] [aluminum] tubes with compatible [copper] [or] [aluminum] fins. Fins must be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils must be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.][The condenser coil must be of the microchannel heat exchanger technology (MCHX) type consisting of a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds in a two-pass arrangement. Provide coils constructed of aluminum alloys for fins, tubes, and manifolds. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.]~~

~~[Coil must be entirely coated in accordance with the requirements of paragraph COIL CORROSION PROTECTION.~~

]2.5.4.3 Fans

Provide centrifugal or propeller type fans as best suited for the application. Fans must be direct [or] [V-belt] driven. [Belt drives must be completely enclosed within the unit casing or equipped with a guard.] [When belt drive is provided, an adjustable sheave to furnish not less than 20 percent fan-speed adjustment must be provided. Sheave sets must be matched and selected to provide the capacity indicated at the approximate midpoint of the adjustment.] Fans must be statically and dynamically balanced.

2.5.4.4 Condenser Sizing

Size condensers for full capacity at 30 degrees F temperature difference between entering outside air and condensing refrigerant. Subcooling must not be considered in determining compressor and condenser capacities. For design conditions, submit a cross-plot of net refrigeration effect of compressor to establish net refrigeration effect and compatibility of equipment furnished.

2.5.4.5 Low Ambient Control

Provide factory mounted head pressure control for operation during low ambient conditions. Head pressure must be controlled by [fan cycling,] [fan speed control,] [condenser refrigerant flooding]. Low ambient control must permit compressor operation below[40 degrees F][0 degrees F][[_____] degrees F].

2.5.4.6 High Ambient Unloading

Provide unloading capability to allow operation in high ambient conditions [[_____] degrees F] above design conditions.

2.5.5 Remote Water-Cooled Condenser

Condenser must be a factory-fabricated and assembled unit constructed and rated in accordance with AHRI 450. Condenser may be of either the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Condenser's water side must be designed and factory pressure tested for not less than [150] [250] [300] psi. Condensers must be complete with pressure relief valve or rupture disk, water drain connections, refrigerant charging valve, refrigerant valves, liquid-level indicating devices, and stand or saddle. Low pressure refrigerant condenser must be provided with a purge valve located at the highest point in the condenser to purge non-condensibles trapped in the condenser. Condenser shell must be constructed of seamless or welded steel. [Coil bundles must be totally removable and arranged to drain completely.] Tubes may be either seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable, except for the coaxial tubes. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Condenser performance must be based on water velocities not less than 3 fps nor more than 12 fps and a fouling factor per AHRI 550/590 I-P. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 20 percent in excess of the fully charged system for remote water cooled condensers. As a minimum, the condenser must include the following components as

~~defined in paragraph CHILLER COMPONENTS.~~

~~a. Liquid-level indicating devices.~~

~~b. Companion flanges, bolts, and gaskets for flanged water connections.~~

2.5 CHILLER COMPONENTS

2.5.1 Refrigerant and Oil

Refrigerants must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. Provide SDS sheets for all refrigerants.

2.5.2 Structural Base

Chiller and individual chiller components must be provided with a factory-mounted structural steel base (welded or bolted) or support legs. Chiller and individual chiller components must be isolated from the building structure by means of ~~[molded neoprene isolation pads.] [~~ vibration isolators with published load ratings. Vibration isolators must have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.~~]~~

2.5.3 Chiller Refrigerant Circuit

Chiller refrigerant circuit must be completely piped and factory leak tested in accordance with ANSI/ASHRAE 15 & 34. ~~[~~For multicompressor units, not less than 2 independent refrigerant circuits must be provided. ~~]~~Circuit must include as a minimum a ~~[~~combination filter and drier,~~]~~ combination sight glass and moisture indicator, an electronic or thermostatic expansion valve with external equalizer or float valve, charging ports, compressor service valves for field-serviceable compressors, and superheat adjustment.

2.5.4 Controls Package

Provide chillers with a complete ~~[~~factory-mounted~~] [remote-mounted where indicated]~~, microprocessor based operating and safety control system. Controls package must contain as a minimum a digital display, an on-auto-off switch, ~~[~~motor starters,~~]~~ ~~[variable frequency motor controller,] [~~disconnect switches,~~]~~ power wiring, and control wiring. Controls package must provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS ~~[BAS] [UMCS]~~ interfaces as defined below.

2.5.4.1 Operating Controls

Chiller must be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. Adjustable timer or automated controls to prevent a compressor from short cycling

c. Automatic lead/lag controls (adjustable) for multi-compressor units

d. Load limiting

e. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls must automatically re-cycle the chiller on power interruption.

f. Startup and head pressure controls to allow system operation at all ambient temperatures down to ~~[~~ 15 ~~]~~ degrees F.

~~[~~ g. Fan sequencing for air-cooled condenser

~~]~~2.5.4.2 Monitoring Capabilities

During normal operations, the control system must be capable of monitoring and displaying the following operating parameters. Access and operation of display must not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures

b. ~~[~~Entering and leaving chilled water pressure~~]~~ and ~~[~~Chilled water flow~~]~~

~~c. [Entering and leaving condenser water pressure][Condenser water flow]~~

~~d~~c. Self diagnostic

~~e~~d. Operation status

~~f~~e. Operating hours

~~g~~f. Number of starts

~~h~~g. Compressor status (on or off)

~~i~~h. Compressor load (percent)

~~j~~i. Refrigerant discharge and suction pressures

~~k~~j. Magnetic bearing levitation status (if applicable)

~~l~~k. Magnetic bearing temperatures (if applicable)

~~m~~l. Oil pressure

~~[n. Condenser water entering and leaving temperatures~~

~~][o. Number of purge cycles over the last 7 days~~

~~]~~2.5.4.3 Configurable Setpoints

The control system must be capable of being configured directly at the unit's interface panel. ~~[~~ No parameters may be capable of being changed without first entering a security access code. ~~]~~ The programmable setpoints must include the following as a minimum:

a. Leaving Chilled Water Temperature

~~[b. Leaving Condenser Water Temperature~~

]][cb. Time Clock/Calendar Date

]2.5.4.4 Safety Controls with Manual Reset

Chiller must be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Low chilled water temperature protection

b. High condenser refrigerant discharge pressure protection

c. Low evaporator pressure protection

d. Chilled water flow detection

e. High motor winding temperature protection

f. Low oil flow protection if applicable

g. Magnetic bearing controller (MBC), Internal fault (if applicable)

h. MBC, High bearing temperature (if applicable)

i. MBC, Communication fault (if applicable)

j. MBC, Power supply fault (if applicable)

[k. Motor current overload and phase loss protection

]2.5.4.5 Safety Controls with Automatic Reset

Chiller must be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

a. Over/under voltage protection

b. Chilled water flow interlock

c. MBC, Vibration (if applicable)

d. MBC, No levitation (if applicable)

[e. Phase reversal protection

]2.5.4.6 Remote Alarm

During the initiation of a safety shutdown, a chiller's control system must be capable of activating a remote alarm bell. In coordination with the chiller, the Contractor must provide an alarm circuit (including transformer if applicable) and a minimum 4 inch diameter alarm bell. Alarm circuit must activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell must not sound for a chiller that uses low-pressure cutout as an operating control.

2.5.4.7 Utility Monitoring and Control System Interface

Provide a Utility Monitoring and Control System (UMCS) interface meeting the requirements of Section 23 09 00.00 22 INSTRUMENTATION AND CONTROL FOR HVAC and the requirements of [Section 23 09 23.01 LONWORKS DIRECT DIGITAL

CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.0213 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]. The interface must provide all system operating conditions, capacity controls, and safety shutdown conditions as network points. In addition, the following points must be overridable via the network interface:

a. Unit Start/Stop

[b. Leaving Chilled Water Temperature Setpoint

][c. Leaving Condenser Water Temperature Setpoint

]2.5.5 Compressor(s)

2.5.5.1 Scroll Compressor(s)

Compressors must be of the hermetically sealed design. Compressors must be mounted on vibration isolators to minimize vibration and noise. Rotating parts must be statically and dynamically balanced at the factory to minimize vibration. Lubrication system must be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater must be provided.[Provide continuous compressor unloading to [10 percent][15 percent] of full-load capacity by way of variable speed compressor motor controller or variable unloading of the scroll.]

2.5.5.2 Rotary Screw Compressor(s)

Compressors must operate stably for indefinite time periods to at least 25 percent capacity reduction without gas bypass external to the compressor. Provision must be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors must include:

a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Allow access to internal compressor components for repairs, inspection, and replacement of parts.

b. Rotors must be solid steel, possessing sufficient rigidity for proper operation.

c. A maximum rotor operating speed no greater than 3600 RPM. Provide cast iron rotor housing.

d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors with minimal clearance at rotor tops and rotor ends.

e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

f. Bearing housing must be conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11.

g. A differential oil pressure or flow cutout to allow the compressor to

operate only when the required oil pressure or flow is provided to the bearings.

h. [A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide minimum automatic capacity modulation from 100 percent to 15 percent.] [Use a Variable Frequency Drive (VFD) to modulate capacity modulation from 100 percent to 15 percent.]

i. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.

j. Crankcase oil heaters must be provided.

2.5.5.3 Centrifugal Compressor(s)

Centrifugal compressors may be either single or multistage, having dynamically balanced impellers, either direct or gear driven by the compressor driver. Impellers must be over-speed tested at 1.2 times the impeller-shaft speed. Impeller shaft must be steel with sufficient rigidity for proper operation at any required operating speed. Compressors must be capable of variable speed operation and may have either oil-free bearing drives or oil-lubricated bearing drives. Centrifugal compressors must include:

a. Shaft main bearings that are either oil lubricated, oil free ceramic or magnetic levitated. The oil lubricated bearings must be the rolling element type in accordance with ABMA 9 or ABMA 11, journal type with bronze or babbitt liners, or of the aluminum-alloy one-piece insert type. Oil lubricated or oil free ceramic bearings must be rated for an L(10) life of not less than 200,000 hours. Magnetic levitated main shaft bearings must be in accordance with ISO 14839-1, ISO 14839-2, ISO 14839-3, ISO 14839-4, and provided with radial and axial magnetic levitated bearings (combination permanent and electro magnets) to levitate the shaft thereby eliminating metal to metal contact and thus eliminating the need for oil. The active magnetic bearings must be equipped with an automatic vibration reduction and balancing system. Each bearing position must be sensed by position sensors and provide real time positioning of the rotor shaft, controlled by on-board digital electronics. In the event of a power failure, the magnetic bearings will remain in operation throughout the compressor coast-down using a reserve power supply. Provide mechanical bearings designed for emergency touchdowns, as a backup to the magnetic bearings.

b. Casing of cast iron, aluminum, or steel plate with split sections gasketed and bolted or clamped together.

c. Lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

d. Provisions to ensure proper lubrication of bearings and shaft seals prior to starting and upon stopping with or without electric power supply (if applicable). On units providing forced-feed lubrication prior to starting, a differential oil pressure cutout interlocked with the compressor starting equipment must allow the compressor to operate only when the required oil pressure is provided to the bearings (if applicable).

~~e. Oil sump heaters controlled as recommended by the manufacturer.~~

~~f. Temperature-or pressure-actuated prerotation vane, variable geometry diffuser or suction damper to provide automatic capacity modulation from 100 percent capacity to 25 percent capacity. If operation to 25 percent capacity cannot be achieved without providing gas bypass external to the compressor, then the Contractor must indicate in the equipment submittal the load percent at which external hot gas bypass is required to prevent surge and to provide the specified capacity reduction and its impact on performance.~~

2.5.6 Compressor Driver, Electric Motor

Components such as motors, ~~[~~starters~~], [variable speed drives]~~, and wiring must be in accordance with paragraph ELECTRICAL WORK. ~~[~~Motor starter ~~][Variable frequency drive]~~ must be ~~[~~unit mounted~~] [remote mounted]~~ as indicated with ~~[~~starter~~][variable frequency drive]~~ type, wiring, and accessories coordinated with the chiller manufacturer.

~~2.5.7 Compressor Driver, Gas-Engine~~

~~Gas-engine compressor driver must operate on natural gas and be in accordance with NFPA 37 and NFPA 54. Engine must be designed for stationary applications and include all ancillaries necessary for operation. Engine must be a manufacturer's standard production model and be specifically designed for chiller operation. Engine must include as a minimum a [heavy duty industrial] [standard automotive] grade block, starting system, lubrication system, coolant system, engine heat exchanger, [engine cooling radiator,] fuel supply system, electronic ignition, and controls package. Engine must be either [naturally aspirated,] [supercharged,] or [turbocharged] and include appropriate air filters. Engine must be 2- or 4-stroke-cycle and compression-ignition type. Engine must be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. Engine must have a minimum of 2 cylinders. Opposed-piston type engines must have not less than 4 cylinders. Engine block must have a coolant drain port.~~

~~2.5.7.1 Starting System~~

~~Engine starting system must be either the [electric] [pneumatic] type and be of sufficient capacity, at the maximum temperature specified, to crank the engine without damage or overheating. [Electric starting system must operate on a [24] [_____]-volt DC system utilizing a negative circuit ground. A starting battery system must be provided and must include the battery, corrosion resistant battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. Battery must be in accordance with SAE J537. Battery charger must conform to UL 1236 and be the current-limiting type with overcurrent protection.] [Pneumatic starting system must be as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE, for a working pressure of 150 psi.]~~

~~2.5.7.2 Lubrication System~~

~~Engine must be provided with a pressurized oil lubrication system. System must include a lubrication oil pump that is engine driven. One full-flow filter must be provided for each pump. Filters must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. System pressure must be regulated as recommended by the engine manufacturer. A pressure relief valve must be~~

provided on the crankcase. Crankcase breathers must be piped to the outside. System must be readily accessible for servicing such as draining, refilling, and overhauling.

2.5.7.3 Coolant System

Engine must include an automatic engine jacket water cooling system. Water must be circulated through the system with an engine-driven circulating pump. [System coolant must use a combination water and ethylene-glycol sufficient for freeze protection at the minimum temperature specified.]

[2.5.7.4 Engine Heat Exchanger

Engine heat exchanger must be of the shell-and-tube type construction and be in accordance with ASME BPVC SEC VIII D1. Shell material must be carbon steel. Tubes must be seamless copper or copper-nickel. Tubes must be individually replaceable. Unit's waterside working pressure must be rated for not less than 150 psig and factory tested at 150 percent of design working pressure. Water connections larger than 3 inches must be ASME Class 1500 flanged. Unit must be provided with gasketed removable covers, drains, and vents.

][2.5.7.5 Engine Cooling Radiator

Heat exchanger may be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces must be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers must be the pressure type incorporating a pressure valve, vacuum valve and a cap. Caps must be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system must be capable of withstanding a minimum pressure of 7 psi and must be protected with a strong grille or screen guard. Each heat exchanger must have at least 2 tapped holes; one must be equipped with a drain cock, the rest must be plugged.

]2.5.7.6 Fuel Supply System

Engine fuel supply system must be factory mounted. System must include as a minimum a solenoid shut-off valve, a gas pressure regulator, and carburetors (including a throttle body assembly) or fuel injectors.

2.5.7.7 Controls Package

The controls for the gas-engine must be incorporated into the overall controls package for the water chiller. The engine controls must be capable of monitoring, displaying, and controlling, as applicable, the following conditions. The control system must be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data must include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system must also be capable of receiving at a minimum the following operating conditions:

a. Coolant-fluid inlet and outlet temperatures

b. Lubricating-oil inlet and outlet temperatures and pressures

c. Engine run-time hours

d. Engine current status mode (on/off)

e. Engine speed

f. Percent engine load

g. Engine jacket temperature

2.5.7.8 Exhaust Piping

Exhaust piping must be ASTM A53/A53M Schedule 40 seamless black iron, exhaust piping installation must be per the engine manufacturer's recommendations, except as modified herein. Horizontal sections of exhaust piping must be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction must be long radius. Exhaust piping and mufflers must be insulated in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Vertical exhaust piping must be provided with a hinged, gravity-operated, self-closing, rain cover.

2.5.7.9 Exhaust Muffler

Engine must be provided with a chamber type exhaust muffler. The muffler must be of welded steel and designed for [outside] [inside] [vertical] [horizontal] mounting. Eyebolts, lugs, flanges, or other items must be provided as necessary for support in the location and position indicated. Pressure drop through the muffler must not exceed the recommendations of the engine manufacturer. Outside mufflers must be zinc coated or painted with high temperature [_____ degrees F] resisting paint. The muffler and exhaust piping together must reduce the noise level to less than [_____] dBa at a distance of 75 feet from the end of the exhaust piping with the chiller operating at 100 percent of rated output capacity. The muffler must have a drain valve, nipple, and cap at the low-point of the muffler.

2.5.7.10 Exhaust System Connections

Flexible connectors must be provided at the exhaust piping connection to the engine. An expansion joint must be provided in the exhaust piping at the muffler connection. Flexible connectors and expansion joints must have flanged connections. Flexible sections must be made of convoluted seamless tube without joints or packing. Expansion joints must be the bellows type. Expansion and flexible elements must be stainless steel suitable for engine exhaust gas at 1200 degrees F. Flexible connectors and expansion joints must be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.5.8 Compressor Driver, Steam Turbine

Steam turbine must be suitable for direct connection to the compressor. Turbine must have a capacity 10 percent greater than the compressor brake horsepower requirement at full-load condition. Steam strainer must be either internally mounted or installed in connecting piping. Turbine must include sentinel warning valve, forced-feed lubrication, oil cooler, oil reservoir, oil relief valve, oil piping, oil-pressure gauge, tachometer, and gland-seal piping if a condensing turbine is used. If a non-condensing turbine is used, provision must be made for drain piping.

~~The turbine must be suitable for automatic control. An overspeed trip governor must be provided to shut off the steam supply at 115 percent of design speed. Provision must be made to stop the turbine upon operation of the compressor safety devices and upon power failure by the use of a solenoid trip on the emergency overspeed governor. Turbine must be governed by a pneumatically controlled hydraulic governor during automatic operation and with a manual control effective during failure of the air supply. Pneumatic valve must be actuated by a temperature controller with its sensing element in contact with the chilled water. Turbine must be designed to operate at the steam pressure and exhaust conditions indicated. If the turbine is a condensing type, a surface-type steam condenser complete with single-stage air ejector, inter- and after-condenser, electric-driven dual condensate pumps, atmospheric relief valve, and expansion joint must be furnished.~~

2.5.7 Compressor Driver Connections

~~[~~ Each compressor must be driven by a V-belt drive or direct connected through a flexible coupling, except that flexible coupling is not required on hermetic units. V-belt drives must be designed for not less than 150 percent of the driving motor capacity. Flexible couplings must be of the type that does not require lubrication.~~]~~ ~~[Each machine driven through speed-increasing gears must be so designed as to assure self-alignment, interchangeable parts, proper lubrication system, and minimum unbalanced forces. Bearings must be of the sleeve or roller type. Gear cases must be oil tight. Shaft extensions must be provided with seals to retain oil and exclude all dust.~~

~~]~~2.5.8 Water Cooler (Evaporator)

Cooler must be of the shell-and-coil or shell-and-tube type design. Cooler shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Performance must be based on a water velocity not less than 3 fps nor more than 12 fps and a fouling factor per AHRI 550/590 I-P.

Brazed plate heat exchanger must be constructed of 304 or 316 stainless steel, designed to a refrigerant-side working pressure of 430 psig and a waterside working pressure of 150 psig. Evaporator must be factory tested at 1.1 times maximum allowable refrigerant side working pressure and 1.5 times maximum allowable water side working pressure. ~~[~~Provide cooler heaters to protect the evaporator to an ambient of minus 20 degrees F. ~~]~~ Provide cooler with factory-installed flow switches. All water connections must use either flanged or grooved-pipe connections. Factory insulate all cold surfaces.

2.5.9 Air-Cooled Condenser Coil

~~[~~Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless ~~[~~copper~]~~ ~~[~~or~]~~ ~~[~~aluminum~]~~ tubes with compatible ~~[~~copper~]~~ ~~[~~or~]~~ ~~[~~aluminum~]~~ fins. Fins must be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils must be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil must be factory leak and pressure tested after

assembly in accordance with ANSI/ASHRAE 15 & 34.]]The condenser coil must be of the microchannel heat exchanger technology (MCHX) type consisting of a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds in a two-pass arrangement. Provide coils constructed of aluminum alloys for fins, tubes, and manifolds. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.]

[Coil must be entirely coated in accordance with the requirements of paragraph COIL CORROSION PROTECTION.

]2.5.10 Water-Cooled Condenser Coil

Condenser must be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Condenser's water side must be designed and factory pressure tested for not less than [150] [250] [300] psi. Condensers must be complete with refrigerant relief valve/rupture disc assembly, water drain connections, and refrigerant charging valve. Low pressure refrigerant condenser must be provided with a purging device to purge non-condensibles trapped in the condenser while keeping refrigerant emissions below requirements of ASHRAE Std 147. Purge units must be certified per AHRI 580. Condenser shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable, except for the coaxial tubes. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Performance must be based on water velocities not less than 3 fps nor more than 12 fps and a fouling factor per AHRI 550/590 I-P. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 5 percent in excess of the fully charged system for single packaged systems.

2.5.11 Heat Recovery Condenser Coil

Condenser must be of the shell-and-coil or shell-and-tube type design and must not be a part of the standard condenser. Condenser must be provided and installed by the chiller manufacturer. Condenser's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Condenser's water side must be designed and factory pressure tested for not less than [150] [250] [300] psi. Condenser must have performance characteristics as indicated on the drawings. Condenser shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable, except for the coaxial tubes. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Performance must be based on water velocities not less than 3 fps nor more than 12 fps and a fouling factor per AHRI 550/590 I-P.

2.5.12 Receivers

Receiver must bear a stamp certifying compliance with ASME BPVC SEC VIII D1 and must meet the requirements of ANSI/ASHRAE 15 & 34. Inner surfaces must be thoroughly cleaned by sandblasting or other approved means. Each receiver must have a storage capacity not less than 20 percent in excess

~~of that required for the fully-charged system. Each receiver must be equipped with inlet, outlet drop pipe, drain plug, purging valve, relief valves of capacity and setting required by ANSI/ASHRAE 15 & 34, and two bull's eye liquid-level sight glasses. Sight glasses must be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 3 inches horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull's eye sight glass, external gauge glass with metal glass guard and automatic closing stop valves may be provided.~~

~~2.5.13 Chiller Purge System~~

~~Chillers which operate at pressures below atmospheric pressure must be provided with a purge system. Purge system must automatically remove air, water vapor, and non-condensible gases from the chiller's refrigerant while keeping refrigerant emissions below requirements of ASHRAE Std 147. Purge units must be certified per AHRI 580. Purge system must condense, separate, and return all refrigerant back to the chiller. An oil separator must be provided with the purge system if required by the manufacturer. Purge system must not discharge to occupied areas, or create a potential hazard to personnel. Purge system must include a purge pressure gauge, number of starts counter, and an elapsed time meter. Purge system must include lights or an alarm which indicate excessive purge or an abnormal air leakage into chiller.~~

~~[~~2.5.10 Tools

One complete set of special tools, as recommended by the manufacturer for field maintenance of the system, must be provided. Tools must be mounted on a tool board in the equipment room or contained in a toolbox as directed by the ~~Contracting Officer~~QC Manager.

~~]~~2.6 ACCESSORIES

~~2.6.1 Refrigerant Leak Detector~~

~~Detector must be the continuously-operating, halogen-specific type. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include [a single sampling point] [[_____] sampling points] installed where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant(s) in use. The detector's relay must be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation. [Detector must be compatible with the facility's Building Control Network (BCN). The BCN must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]~~

2.6.1 Refrigerant Relief Valve/Rupture Disc Assembly

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ANSI/ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.6.2 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 0.5 inches in height.

2.6.2.1 Installation Identification

Each new refrigerating system must be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.2.2 Controls and Piping Identification

Refrigerant systems containing more than 110 lb of refrigerant must be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow ~~[, the ventilation system,]~~ and the refrigerant compressor(s).

b. Pressure limiting device(s).

~~[2.6.3 Automatic Tube Brush Cleaning System~~

~~2.6.3.1 Brush and Basket Sets~~

~~One brush and basket set (one brush and two baskets) must be furnished for each condenser tube. Brushes must be made of nylon bristles, with titanium wire. Baskets must be polypropylene.~~

~~2.6.3.2 Flow-Diverter Valve~~

~~Each system must be equipped with one flow-diverter valve specifically designed for the automatic tube brush cleaning system and have parallel flow connections. The flow-diverter valve must be designed for a working pressure of [150][250][300] psig. End connections must be flanged. Each valve must be provided with an electrically operated air solenoid valve and position indicator.~~

~~2.6.3.3 Control Panel~~

~~The control panel must provide signals to the diverter valve at a preset~~

~~time interval to reverse water flow to drive the tube brushes down the tubes and then signal the valve to reverse the water flow to drive the brushes back down the tubes to their original position. The controller must have the following features as a minimum:~~

~~a. Timer to initiate the on-load cleaning cycle.~~

~~b. Manual override of preset cleaning cycle.~~

~~c. Power-on indicator.~~

~~d. Diverter-position indicator.~~

~~e. Cleaning-cycle-time adjustment~~

~~f. Flow-switch bypass.~~

~~]~~2.6.3 Gaskets

Gaskets must conform to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.6.4 Bolts and Nuts

Bolts and nuts, except as required for piping applications, must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.7 FABRICATION

2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand ~~[125] [~~6,000~~500]~~ hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.7.2 Factory Applied Insulation

Chiller must be provided with factory installed insulation on surfaces subject to sweating including the water cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be field applied, however it must be installed to provide easy removal and replacement of heads without damage to the insulation. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in

attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

~~[~~2.7.3 Coil Corrosion Protection

~~[~~ Provide coil with a uniformly applied ~~[~~epoxy electrodeposition~~] [phenolic] [vinyl]~~ type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum ~~[1,000]~~[6~~3~~,000 ~~]~~ hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

~~]]2.8 FACTORY TESTS~~

~~2.8.1 Chiller Performance Test~~

~~The Contractor and proposed chiller manufacturer shall be responsible for performing the chiller factory test to validate the specified full load capacity, full load EER, and [IPLV] [NPLV] in accordance with AHRI 550/590 I-P except as indicated. The Contractor and chiller manufacturer must provide to the Government a certified chiller factory test report in accordance with AHRI 550/590 I-P to confirm that the chiller performs as specified. Tests must be conducted in an AHRI certified test facility in conformance with AHRI 550/590 I-P procedures and tolerances, except as indicated. At a minimum, chiller capacity must be validated to meet the scheduled requirements indicated on the drawings. Tolerance or deviation must be in strict accordance with AHRI 550/590 I-P. Stable operation at minimum load of [10] [_____] percent of total capacity must be demonstrated during the factory test.~~

~~2.8.1.1 Temperature Adjustments~~

~~Temperature adjustments must adhere to AHRI 550/590 I-P to adjust from the design fouling factor to the clean tube condition. Test temperature adjustments must be verified prior to testing by the manufacturer. There must be no exceptions to conducting the test with clean tubes with the temperature adjustments per AHRI 550/590 I-P. The manufacturer must clean the tubes prior to testing to obtain a test fouling factor of 0.0000.~~

~~2.8.1.2 Test Instrumentation~~

~~The factory test instrumentation must be per AHRI 550/590 I-P and the calibration must be traceable to the National Institute of Standards and Technology.~~

~~2.8.1.3 Equipment Adjustments~~

~~If the equipment fails to perform within allowable tolerances, the manufacturer must be allowed to make necessary revisions to his equipment~~

and retest as required. [The manufacturer shall assume all expenses incurred by the Government to witness the retest.]

[2.8.2 Chiller Sound Test

Chillers must be sound tested at the factory prior to shipment to confirm the sound pressure level specified herein. Tests and data must be conducted and measured in strict accordance with AHRI 575 at the full load system operating conditions. The chiller sound pressure level, in decibels (dB), with a reference pressure of 20 micropascals, must not exceed [85] [90] [_____] dB, A weighted. Ratings must be in accordance with AHRI 575. No reduction of entering condenser water temperature or raising of leaving chilled water temperature will be allowed. A minimum of 75 percent of the sound data points must be taken along the length of the machine, and established as the minimum percentage of total possible points used to determine sound levels. In the event that the chiller does not meet the dBA sound pressure level, the manufacturer shall, at his expense, provide sufficient attenuation to the machine to meet the specified value. This attenuation must be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller. The attenuation material, adhesives, coatings, and other accessories must have surface burning characteristics as determined by ASTM E84.

]2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Chilled and Condenser Water Piping and Accessories

Chilled and condenser water piping and accessories must be provided and installed in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.8.2 Refrigerant Piping

Refrigerant piping for split-system water chillers must be provided and installed in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.8.3 Cooling Tower

Cooling towers must be provided and installed in accordance with Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.

2.8.2 Temperature Controls

Chiller control packages must be fully coordinated with and integrated [into the temperature control system indicated in Section 23 30 00 HVAC AIR DISTRIBUTION and [Section 23 09 00.00 22 INSTRUMENTATION AND CONTROL FOR HVAC] and [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.0213 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]] [into the existing air-conditioning system].

PART 3 EXECUTION

3.1 INSTALLATION

Installation of water chiller systems including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with the manufacturer's written installation

instructions, including the following:

[(1) Water chiller - installation instructions

]3.1.1 Installation Instructions

Provide manufacturer's standard catalog data, at least [5] [_____] weeks prior to the purchase or installation of a particular component, highlighted to show features such as materials, dimensions, options, performance and efficiency. Data must include manufacturer's recommended installation instructions and procedures. Data must be adequate to demonstrate compliance with contract requirements.

3.1.2 Vibration Isolation

If vibration isolation is specified for a unit, vibration isolator literature must be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

~~3.1.3 Posted Instructions~~

~~Provide posted instructions, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.~~

3.1.3 Verification of Dimensions

Provide a letter including the date the site was visited, conformation of existing conditions, and any discrepancies found.

3.1.4 System Performance Test Schedules

Provide a schedule, at least [2] [_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test.

3.1.5 Certificates

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, proof of such compliance must be provided. The label or listing of the specified agency must be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above must be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

3.1.6 Operation and Maintenance Manuals

Provide [Six] [_____] complete copies of an operation manual in bound 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. [Six] [_____] complete copies of maintenance manual in bound 8 1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

~~3.1.7 Connections to Existing Systems~~

~~Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.~~

3.1.7 Refrigeration System

3.1.7.1 Equipment

Refrigeration equipment and the installation thereof must conform to ANSI/ASHRAE 15 & 34. Necessary supports must be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, water coolers, and similar items. Compressors must be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations must be provided. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. ~~Isolators must limit vibration to [_____] percent at lowest equipment rpm.~~ Lines connected to pumps mounted on pedestal blocks must be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts must be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.7.2 Field Refrigerant Charging

a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system must be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor must provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system must be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points must be installed and tightened.

b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant must be pumped into the system receiver or other suitable container. The refrigerant must not be discharged into the atmosphere.

c. Contractor's Responsibility: The Contractor must, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.7.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase must be furnished. One charge must be used during the performance testing period, and upon the satisfactory completion of the tests, the oil must be drained and replaced with the second charge.

~~3.1.8 Mechanical Room Ventilation~~

~~Mechanical ventilation systems must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.~~

3.1.8 Field Applied Insulation

Field installed insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.9 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

~~3.2 FACTORY TEST SCHEDULING AND REPORTS~~

~~Provide schedules which identify the date, time, and location for each test. Schedules must be submitted for the Chiller Performance Tests [and the Chiller Sound Test].[The Chiller Performance Test schedule must also allow the witnessing of the test by a Government Representative.]~~

~~[Six] [_____] copies of the certified test report must be forwarded to the Government for approval prior to project acceptance. Calibration curves and information sheets for all instrumentation must be included. Provide copies in bound 8 1/2 by 11 inch booklets. Reports must certify the compliance with performance requirements and follow the format of the required testing standard for the Chiller Performance Tests [and the Chiller Sound Tests]. Test report must include certified calibration report of all test instrumentation. Calibration report must include certification that all test instrumentation has been calibrated within 6 months prior to the test date, identification of all instrumentation, and certification that all instrumentation complies with requirements of the test standard. Test report must be submitted [1] [_____] week after completion of the factory test.~~

3.2 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative must be provided for ~~[~~2 ~~_____]~~ days. The representative shall advise on the following:

a. Hermetic machines:

(1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 micrometers.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

b. Open Machines:

(1) Erection, alignment, testing, and dehydrating.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction. Perform and document that proper Indoor Air Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. At least one week before the official equipment warranty start date, all condenser

coils on air-cooled water chillers and split-system water chillers must be cleaned in accordance with the chiller manufacturer's instructions. This work covers two coil cleanings. The condenser coils must be cleaned with an approved coil cleaner by a service technician, factory trained by the chiller manufacturer. The condenser coil cleaner must not have any detrimental affect on the materials or protective coatings on the condenser coils. Testing, adjusting, and balancing must be as specified in Section 23 05 93.00 22 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.4 FIELD ACCEPTANCE TESTING

3.4.1 Test Plans

a. Manufacturer's Test Plans: Within [120][_____] calendar days after contract award, submit the following plans:

[(1) Water chiller - Field Acceptance Test Plan

] Field acceptance test plans must be developed by the chiller manufacturer detailing recommended field test procedures for that particular type and size of equipment. Field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

The Contracting OfficerQC Manager will review and approve the field acceptance test plan for each of the listed equipment prior to commencement of field testing of the equipment. The approved field acceptance tests of the chiller and subsequent test reporting.

b. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of tower system controls which interlock and interface with controls for the equipment provided under [Section 23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS] [Section 23 09 00.00 22 INSTRUMENTATION AND CONTROL FOR HVAC][Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.0213 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

c. Prerequisite testing: Chillers for which performance testing is dependent upon the completion of the work covered by Section 23 05 93.00 22 TESTING, ADJUSTING, AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.

d. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures must be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

Controller must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance variables: Each test plan must list performance variables that are required to be measured or tested as part of the field test.

Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Chiller manufacturer must furnish with each test procedure a description of acceptable results that have been verified.

Chiller manufacturer must identify the acceptable limits or tolerance within which each tested performance variable must acceptably operate.

f. Job specific: Each test plan must be job specific and must address the particular cooling towers and particular conditions which exist in this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized components: Each test plan must include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.4.2 Testing

a. Each water chiller system must be field acceptance tested in compliance with its approved field acceptance test plan and the resulting following field acceptance test report submitted for approval:

~~[~~ (1) Water chiller - Field Acceptance Test Report

~~]~~ b. Manufacturer's recommended testing: Conduct the manufacturer's recommended field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing.

c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.

d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the ~~Contracting Officer~~QC Manager in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment must be reviewed, approved, and signed by the Contractor's test director. The

manufacturer's field test representative must review, approve, and sign the report of the manufacturer's recommended test. Signatures must be accompanied by the person's name typed.

f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

3.5 SYSTEM PERFORMANCE TESTS

~~[~~Six~~] [_____]~~ copies of the report must be provided in bound 8 1/2 by 11 inch booklets.

3.5.1 General Requirements

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment must be conducted by the manufacturer's approved start-up representative experienced in system start-up and testing, at such times as directed. Tests must cover a period of not less than ~~[~~48~~] [_____]~~ hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments must be made as necessary and tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points must be installed and tightened. Any refrigerant lost during the system startup must be replaced. If tests do not demonstrate satisfactory system performance, deficiencies must be corrected and the system must be retested. Tests must be conducted in the presence of the ~~Contracting Officer~~QC Manager. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test must be provided by the Contractor. Field tests must be coordinated with Section 23 05 93.00 22 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.5.2 Test Report

The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report must also include the following information and must be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:

(1) The refrigerant used in the system.
(2) Condensing temperature and pressure.
(3) Suction temperature and pressure.
(4) Running current, voltage and proper phase sequence for each phase of all motors.
(5) The actual on-site setting of all operating and safety controls.
(6) Chilled water pressure, flow and temperature in and out of the chiller.
(7) The position of the ~~[~~capacity-reduction gear~~] [gas supply control valve] [fuel oil supply valve]~~ at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

3.6 DEMONSTRATIONS

Contractor must conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total ~~[~~ 4 ~~]~~ hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The training course must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

Provide a schedule, at least ~~[~~2~~]~~ ~~[~~ ~~]~~ weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

-- End of Section --

SECTION 23 64 26

CHILLED~~, CHILLED-HOT, AND CONDENSER~~ WATER PIPING SYSTEMS
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(20~~15~~20) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2018) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2016) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.9	(2017) Building Services Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing

Qualifications

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2008; R 2014 20) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D2308	(2007; R 2013) Standard Specification for Thermoplastic Polyethylene Jacket for Electrical Wire and Cable
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1007	(2018) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2019) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(1988; R 2019) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 515	(2017) Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017; Errata 1 2017) Butterfly Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems

1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are ~~[~~for Contractor Quality Control approval.~~][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD. Submit the following in accordance with Section 01 33 00.05 20 SUBMITTAL PROCEDURES:

SD-03 Product Data

~~Grooved Mechanical Connections For Steel; G[, [_____]]~~

~~Grooved Mechanical Connections For Copper; G[, [_____]]~~

Calibrated Balancing Valves; G[, [_____]]

Automatic Flow Control Valves; G[, [_____]]

Pump Discharge Valve

Water Temperature Mixing Valve; G[, [_____]]

Water Temperature Regulating Valves; G[, [_____]]

Water Pressure Reducing Valve

Pressure Relief Valve

Combination Pressure and Temperature Relief Valves

Expansion Joints; G[, [_____]]

Pumps; G[, [_____]]

Combination Strainer and Pump Suction Diffuser

Expansion Tanks

Air Separator Tanks

Water Treatment Systems; G[, [_____]]

Proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph WATER ANALYSIS", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

SD-06 Test Reports

Piping Welds NDE Report

Pressure Tests Reports; G[, [_____]]

Report shall be provided in bound 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

Condenser Water Quality Test Reports; G[, [_____]]

Test reports, each month for a period of one year after project completion, in bound 8-1/2 by 11 inch booklets. In the reports, identify the chemical composition of the condenser water. Also include the comparison of the manufacturer's recommended operating conditions for the cooling tower and condenser in relation to the condition of the condenser water. Document in the report any required corrective action taken.

One-Year Inspection Report For Cooling Water; G[, [_____]]

At the completion of one year of service, in bound 8-1/2 by 11

~~inch booklets. In the report, identify the condition of each cooling tower and condenser. Include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions. Identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.~~

SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

~~Piping for Steam and Condensate~~

~~Piping for High-Pressure Compressed-Air Systems~~

~~Fittings~~

~~Unions~~

~~Flanges~~

~~Gaskets~~

~~Bolting~~

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course~~; G[, [_____]]~~

SD-10 Operation and Maintenance Data

Requirements for data packages are specified Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Water Treatment Systems~~; G[, [_____]]~~

An operation manual in bound 8-1/2 by 11 inch booklets listing

step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown. Include testing procedures used in determining water quality.

A maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide.

Calibrated Balancing Valves, Data Package 3~~; G[, [_____]]~~

~~Automatic Flow Control Valves, Data Package 3; G[, [_____]]~~

~~Pump Discharge Valve, Data Package 2; G[, [_____]]~~

Water Temperature Mixing Valve, Data Package 3~~; G[, [_____]]~~

Water Temperature Regulating Valves, Data Package 3~~; G[, [_____]]~~

Water Pressure Reducing Valve, Data Package 3~~; G[, [_____]]~~

Pressure Relief Valve, Data Package 2~~; G[, [_____]]~~

Combination Pressure and Temperature Relief Valves, Data Package 2~~; G[, [_____]]~~

Expansion Joints, Data Package 2~~; G[, [_____]]~~

Pumps, Data Package 3~~; G[, [_____]]~~

Combination Strainer and Pump Suction Diffuser, Data Package 2~~; G[, [_____]]~~

Expansion Tanks, Data Package 2~~; G[, [_____]]~~

Air Separator Tanks, Data Package 2~~; G[, [_____]]~~

1.4 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative

requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the ~~Contracting Officer~~QC Manager of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.7.3 Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior

to bid opening.

The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

Piping and fittings 1 inch and smaller shall have threaded connections. Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded, ~~[grooved,]~~ or welded connections. Piping and fittings 3 inches and larger shall have ~~[grooved,]~~ welded, or flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges shall conform to ASME B16.1, Class 125. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded

fittings shall be identified with the appropriate grade and marking symbol.

~~2.2.2.4 Grooved Mechanical Connections For Steel~~

~~Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.~~

~~Each grooved mechanical joint shall be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation shall be in compliance with joint manufacturer's written instructions.~~

~~Use fitting and coupling houses of malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12; or steel conforming ASTM A106/A106M, Grade B or ASTM A53/A53M. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and conforming to ASTM D2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved mechanical connections shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A183. Pipe connections and fittings shall be the product of the same manufacturer. Provide joint installation be in compliance with joint manufacturer's written instructions.~~

2.2.2.4 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

~~2.3 POLYPROPYLENE PIPING (CHILLED WATER APPLICATIONS ONLY)~~

~~2.3.1 Pipe~~

~~Polypropylene pipe shall be Schedule 40, copolymer, and shall meet ASTM F2389 and NSF/ANSI 14.~~

~~2.3.2 Fittings~~

~~Fittings shall meet ASTM F2389 and NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement shall bear the NSF seal "NSF-PW."~~

~~Polypropylene fittings shall conform to dimensional requirements of Schedule 40. Polypropylene piping that will be exposed to UV light shall be provided with a Factory applied UV resistant coating.~~

~~2.4 PIPING FOR STEAM AND CONDENSATE~~

~~Steam and condensate piping for 150-, 350-, 2,000-, and 6,000-pound per square inch (psi) service shall be black carbon steel (BCS). Steam and condensate piping includes fittings, unions, flanges, gaskets, and bolting.~~

~~2.4.1 Type BCS-150 (150-psi Service)~~

~~Pipe or tube (1/8 inch through 10 inches): Schedule 40 for steam, Schedule 80 for condensate, seamless black carbon steel, conforming to ASTM A106/A106M, Grade B and ASME B36.10M~~

~~Fittings (1/8 inch through 2 inches): 300-psi working steam pressure (wsp) banded malleable iron, screwed end, conforming to ASTM A197/A197M and ASME B16.3~~

~~Fittings (1/8 inch through 2 inches): 2,000-or 3,000-psi water, oil, or gas (wog) forged carbon steel, socket weld or screwed end, conforming to ASTM A105/A105M and ASME B16.11~~

~~Fittings (2-1/2 through 10 inches): Wall thickness to match pipe, long radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9~~

~~Unions (1/8 inch through 2 inches): 250-psi wsp, malleable iron, screwed end, ground joint, with brass or bronze seat insert, conforming to ASME B16.39~~

~~Unions (1/8 inch through 2 inches): 2,000 or 3,000-psi wog, forged carbon steel; socket weld through 2-inch, screwed end through 1-inch, conforming to ASTM A105/A105M and ASME B16.11, with ground joint and stainless-steel seat insert~~

~~Flanges (2-1/2 through 10 inches): 150-pound, forged carbon steel, welding neck, with raised face or flat face and concentric finish, conforming to ASTM A105/A105M and ASME B16.5~~

~~Flange Gaskets: Compressed non-asbestos sheet conforming to ASTM F104, Type 1, P1161A, coated on both sides with graphite or similar lubricant, containing not less than 75-percent non-asbestos fiber materials~~

~~Bolting: Bolting and flange bolting shall be hexhead and shall conform to ASTM A325. Heavy hex-nuts shall conform to ASME B18.2.2. Square-head bolts and nuts are not acceptable.~~

~~2.4.2 Type BCS-350 (350-psiService)~~

~~Pipe or tube (1/8 inch through 10 inches): Schedule 40 for steam, Schedule 80 for condensate; seamless black carbon steel, conforming to ASTM A106/A106M, Grade B and ASME B36.10M~~

~~Fittings (1/8 inch through 2 inches): 2,000-or 3,000-psi wog to match pipe wall, forged carbon steel, socket weld or screwed end, conforming to ASTM A105/A105M and ASME B16.11~~

~~Fittings (1/8 inch through 10 inches): Schedule 40, long-radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9~~

Unions (1/8 inch through 2 inches): 2,000-or 3,000-psi wog to match pipe wall, forged carbon steel, socket weld through 2-inch, screwed end through 1-inch, conforming to ASTM A105/A105M and ASME B16.11, with ground joint and stainless-steel seat insert

Flanges (2-1/2 through 10 inches): 300-pound, forged carbon steel, weld neck, with raised face and concentric serrated finish, conforming to ASTM A181/A181M, Class 70, and ASME B16.5

Gaskets: Spiral-wound, non-asbestos-fiber-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Heavy hex-head, carbon-steel bolts or bolt studs and semifinished heavy hexnuts, conforming to ASTM A325.

Square-head bolts are not acceptable.

2.5 PIPING FOR HIGH-PRESSURE COMPRESSED-AIR SYSTEMS

High-pressure compressed-air condensate piping includes fittings, unions, flanges, gaskets, and bolting.

2.5.1 Type BCS-2,000 (2,000-psi Service)

Pipe or tube (1/8 inch through 3 inches): Schedule 40, seamless black carbon steel, conforming to ASTM A106/A106M, Grade B, or ASTM A53/A53M, Grade B, Type S, and ASME B36.10M

Fittings (1/8 inch through 1-1/2 inches): 2,000-psi wog, forged carbon steel, socket weld, conforming to ASTM A105/A105M and ASME B16.11

Fittings (2 through 3 inches): Schedule 40, long radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9

Flanges (1 inch through 3 inches): 900-pound, forged carbon steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A105/A105M or ASTM A181/A181M, Class 60, and ASME B16.5

Gaskets: Spiral wound, non-asbestos-fiber-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Alloy-steel bolt studs conforming to ASTM A193/A193M, Grade B7, and semifinished heavy hex-nuts, conforming to ASTM A194/A194M, Grade 2H

2.5.2 Type BCS-6,000 (6,000-psi Service)

Pipe or tube (1/2 inch through 3 inches): XXS, seamless, black carbon steel, conforming to ASTM A106/A106M, Grade B, or ASTM A53/A53M, Grade B, Type S and ASME B36.10M

Fittings (1/2 inch through 1-1/2 inches): 6,000-psi wog, forged carbon steel, socket weld, conforming to ASTM A105/A105M and ASME B16.11

Fittings (2 through 3 inches): XXS, long-radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, ASME B16.9, and ASME B36.10M

~~Flanges (2 through 3 inches): 2,500-pound, forged carbon steel, welding neck with raised face and concentric serrated finish, conforming to ASTM A105/A105M and ASME B16.5~~

~~Gaskets: Spiral-wound, non-asbestos-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1~~

~~Bolting: Alloy steel bolt studs conforming to ASTM A193/A193M, Grade B7, and semifinished heavy hex-nuts, conforming to ASTM A194/A194M, Grade 2H~~

2.3 COPPER TUBING

Provide copper tubing and fittings with a ANSI/ASME Class 125 service rating, which for 150 degrees F., the pressure rating is 175 psig.

2.3.1 Tube

Use copper tube conforming to ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.3.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

Copper tubing of sizes larger than 4 inches shall have brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

~~2.3.3 Grooved Mechanical Connections For Copper~~

~~Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.~~

~~Each grooved mechanical joint shall be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation shall be in compliance with joint manufacturer's written instructions.~~

~~Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A536. Provide gaskets for use in grooved joints shall constructed of molded synthetic polymer of pressure responsive design and shall conform to ASTM D2000 for circulating medium up to 230 degrees F. Provide grooved joints in conformance with AWWA C606.~~

2.3.3 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.4 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be furnished by the same manufacturer as the grooved pipe joint and fitting system.

2.4.1 Gate Valve

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.4.2 Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80, Class 125. Globe and angle valves 3 inches and larger shall conform to MSS SP-85, Class 125.

2.4.3 Check Valve

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80. Check valves 3 inches and larger shall conform to MSS SP-71, Class 125.

2.4.4 Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves smaller than 8 inches shall have throttling handles with a minimum of ~~[two][~~seven~~]~~ locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators.

2.4.5 Plug Valve

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by

rotation of the handwheel to lift and turn the plug. ~~[~~Valve shall a weatherproof operators with mechanical position indicators.~~]~~ Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.4.6 Ball Valve

Full port design. Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators. Ball valves may be provided in lieu of gate valves.

2.4.7 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.4.8 Calibrated Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the gallons per minute flow for each differential pressure reading. ~~[In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.]~~

~~2.4.9 Automatic Flow Control Valves~~

~~Valve shall automatically maintain the constant flow indicated on the design drawings. Valve shall modulate by sensing the pressure differential across the valve body. Valve shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Provide valve that controls the flow within 5 percent of the tag rating. Valve materials shall be the same as specified for the ball or plug valves.~~

~~Provide valve that are [electric][or][pneumatic] type as indicated. Valve shall be capable of positive shutoff against the system pump head, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. Provide the meter complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.~~

~~2.4.10 Pump Discharge Valve~~

~~Valve shall shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Provide an integral pointer on the valve which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure.~~

2.4.9 Water Temperature Mixing Valve

Valve, ASSE 1017 for water service.

2.4.10 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.4.11 Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body.

2.4.12 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.4.13 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

~~2.4.14 Float Valve~~

~~[Angle pattern][and][or] [Globe pattern]. Valve bodies 3 inches nominal pipe size and smaller shall be bronze. Valve bodies larger than 3 inches shall be cast iron or bronze. Steel parts shall be corrosion resistant. Where float rods are extended for tank applications, extension shall be properly supported and guided to avoid bending of float rod or stressing of valve pilot linkage.~~

2.4.14 Drain Valves

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter. ~~[~~Freeze-proof type valves shall be provided in installations exposed to freezing temperatures.~~]~~

2.4.15 Air Venting Valves

~~[Manually-operated general service type air venting valves, brass or bronze valves that are furnished with threaded plugs or caps.]~~ ~~[~~Automatic type air venting shall be the ball-float type with brass/bronze or brass

bodies, 300 series corrosion-resistant steel float, linkage and removable seat.~~]~~ Air venting valves on water coils shall have not less than 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 1/2 inch threaded end connections.

2.4.16 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.5 PIPING ACCESSORIES

2.5.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 22 gauge ~~[~~brass sheet,~~] [monel,] [corrosion-resistant steel,]~~ with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.2 Cyclonic Separator

Metal- bodied, with removal capability of removing solids 45 microns/325 mesh in size and heavier than 1.20 specific gravity, maximum pressure drop of 5 psid, with cleanout connection.

2.5.3 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening vanes, a suction pipe support, and a blowdown outlet and plug. Strainer shall be in accordance with ASTM F1199, except as modified and supplemented by this specification. Unit body shall have arrows clearly cast on the sides indicating the direction of flow.

Strainer screen shall be made of minimum 22 gauge ~~[~~brass sheet,~~] [monel,] [corrosion-resistant steel,]~~ with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

2.5.4 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single

braid. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.5.5 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.5.6 Temperature Gauges

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor or in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor or in locations indicated.

2.5.6.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.5.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment.

2.5.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.5.6.4 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.5.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to MSS SP-58 and MSS SP-69.~~[~~ If ferrous materials are utilized provide hot-dipped galvanized hangers, inserts and supports.~~]~~

2.5.8 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.5.9 Expansion Joints

2.5.9.1 Slip-Tube Type

Slip-tube expansion joints, ASTM F1007, Class I or II. Joints shall be provided with internally-externally alignment guides, injected semi-plastic packing, and service outlets. End connections shall be flanged or beveled for welding as indicated. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer.

2.5.9.2 Flexible Ball Type

Flexible ball expansion joints shall be capable of 360 degrees rotation plus 15 degrees angular flex movement. Joints shall be constructed of carbon steel with the exterior spherical surface of carbon steel balls plated with a minimum 5 mils of hard chrome in accordance with EJMA Stds. Joint end connections shall be threaded for piping 2 inches or smaller. Joint end connections larger than 2 inches shall be grooved, flanged, or beveled for welding. Provide joint with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.5.9.3 Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.6 PUMPS

~~Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.2. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be [open] [splash-proof] [totally enclosed], and have sufficient horsepower for the service required. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller~~

~~in a NEMA 250, Type 1 enclosure with "START-STOP" switch in~~See section 23 21 23 Hydronic Pumps.~~ the cover.~~

~~2.6.1 Construction~~

~~Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.~~

~~Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.~~

~~[Pump and motor shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings. Pump shall be provided with steel shaft coupling guard. Base-mounted pump, coupling guard, and motor shall each be bolted to a fabricated steel base which shall have bolt holes for securing base to supporting surface.] [Close-coupled pump shall be provided with integrally cast or fabricated steel feet with bolt holes for securing feet to supporting surface. Close- coupled pumps shall be provided with drip pockets and tapped openings.] Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.~~

~~2.6.2 Mechanical Shaft Seals~~

~~Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone particle separator in line.~~

~~2.6.3 Stuffing-Box Type Seals~~

~~Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.~~

2.7 EXPANSION TANKS

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall be the bladder-type thus having ~~have~~ a replaceable polypropylene or butyl lined or ~~diaphragm~~vinyl lined tank which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all

components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.8 AIR SEPARATOR TANKS

[External air separation tank shall have an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Tank shall be steel combination air and sediment separator wtih internal coalescing medium to remove entrained air and suspended solids. Tank shall be, constructed for, and tested to, pressure-temperature rating of 125 psi at 150 degrees F. Tank shall have tangential inlets and outlets connections, threaded for 2 inches and smaller and flanged for sizes 2-1/2 inches and larger. Air released from a tank shall be [to the atmosphere] [vented as indicated]. Tank shall be provided with a blow-down connection with a gate valve and piped to the nearest floor drain.

]Design to separate air from water and to direct released air to automatic air vent. Unit shall be of one piece cast-iron construction with internal baffles and two air chambers at top of unit; one air chamber shall have outlet to expansion tank and other air chamber shall be provided with automatic air release device. Tank shall be steel, constructed for, and tested to a ANSI Class 125 pressure-temperature rating.

]2.9 ELECTRICAL HEAT TRACING

Heat trace systems for pipes, valves, and fittings shall be in accordance with IEEE 515 and be UL listed. System shall include all necessary components, including heaters and controls to prevent freezing.

Provide self-regulating heaters consisting of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. Heater shall be able to be crossed over itself without overheating. Heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket in accordance with ASTM D2308.

Provide heater with self-regulating factor of at least 90 percent, in order to provide energy conservation and to prevent overheating.

Heater shall operate on line voltages of 120 volts single phase without the use of transformers.

Size Heat Tracing according to the following table

Pipe Size (Inch, Diameter)	Minus 10 degrees F	Minus 20 degrees F
3 inches or less	5 watts per foot (wpf)	5 wpf
4 inch	5 wpf	8 wpf
6 inch	8 wpf	8 wpf
8 inch	10 wpf	10 wpf

System shall be controlled by an ambient sensing thermostat set at 40

degrees F either directly or through an appropriate contactor.

2.10 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing equivalent chromium (CPR) is prohibited.

~~2.10.1 Water Analysis~~

~~Conditions of make-up water to be supplied to the condenser and chilled water systems were reported in accordance with ASTM D596 and are as follows:~~

~~Date of Sample~~	~~[_____]~~
~~Temperature~~	~~[_____] degrees F~~
~~Silica (Sino 2)~~	~~[_____] pp (mg/1)~~
~~Insoluble~~	~~[_____] pp (mg/1)~~
~~Iron and Aluminum Oxides~~	~~[_____] pp (mg/1)~~
~~Calcium (Ca)~~	~~[_____] pp (mg/1)~~
~~Magnesium (Mg)~~	~~[_____] pp (mg/1)~~
~~Sodium and Potassium (Nan and AK)~~	~~[_____] pp (mg/1)~~
~~Carbonate (HO 3)~~	~~[_____] pp (mg/1)~~
~~Sulfate (SO 4)~~	~~[_____] pp (mg/1)~~
~~Chloride (JCL)~~	~~[_____] pp (mg/1)~~
~~Nitrate (NO 3~~	~~[_____] pp (mg/1)~~
~~Turbidity~~	~~[_____] unit~~
~~pH~~	~~[_____]~~
~~Residual Chlorine~~	~~[_____] pp (mg/1)~~
~~Total Alkalinity~~	~~[_____] PM (me/1~~
~~Non-Carbonate Hardness~~	~~[_____] PM (me/1~~
~~Total Hardness~~	~~[_____] PM (me/1~~
~~Dissolved Solids~~	~~[_____] pp (mg/1)~~
~~Fluorine~~	~~[_____] pp (mg/1)~~

~~Conductivity~~	~~[_____] McMahon/cm~~

2.10.1 Chilled ~~and Condenser~~ Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

~~2.10.2 Glycol Solution~~

~~A [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol shall be provided in the chilled water. The glycol shall be tested in accordance with ASTM D1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.~~

2.10.2 Water Treatment Services

The services of a company regularly engaged in the treatment of ~~[condenser] [condenser and~~ chilled~~]~~ water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the ~~[condenser] [condenser and~~ chilled~~]~~ water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.10.3 Chilled Water System

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

~~2.10.4 Condenser Water~~

~~The water treatment system shall be capable of [automatically] [continuously] feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. [Automatic chemical feed systems shall automatically feed chemicals into the condenser water based on varying system conditions.] [Continuous chemical feed systems shall continuously feed chemicals into the condenser water at a constant rate. The system shall be initially set manually based on the water analysis of the make-up water.]~~

~~2.10.4.1 Chemical Feed Pump~~

~~One pump shall be provided for each chemical feed tank. The chemical feed pumps shall be positive displacement diaphragm type. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. The~~

discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge.

2.10.4.2 Tanks

Two chemical tanks shall be provided. The tanks shall be constructed of [high density polyethylene] [stainless steel] with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

2.10.4.3 Injection Assembly

An injection assembly shall be provided at each chemical injection point along the condenser water piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the condenser water piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the condenser water line.

2.10.4.4 Water Meter

Water meters shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the make-up water line, as indicated.

2.10.4.5 Timers

Timers shall be of the automatic reset, adjustable type, and electrically operated. The timers shall be suitable for a 120 volt current. The timers shall be located within the water treatment control panel.

2.10.4.6 Water Treatment Control Panel

The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of [stainless steel] [steel] with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light
(2) MAN-OFF-AUTO selector switch
(3) Indicating lamp for bleed-off valve
(4) Indicating lamp for each chemical feed pump
(5) Set point reading for each timer

2.10.4.7 Chemical Piping

The piping and fittings shall be constructed of [schedule 80 PVC] [stainless steel] suitable for the water treatment chemicals.

2.10.4.8 Sequence of Operation

[The chemicals shall be added based upon sensing the make-up water flow rate and activating appropriate timers. A separate timer shall be provided for each chemical. The blow down shall be controlled based upon the make-up water flow rate and a separate timer.] [The system shall contain an adjustable valve for continuous blow down. The flow rate from the appropriate chemical tanks shall be manually set at the metering pump

~~for continuous chemical feed.] The injection of the chemical required for biological control shall be controlled by a timer which can be manually set for proper chemical feed. Timer set points, blow down rates, and chemical pump flow rates shall be determined and set by the water treatment company.~~

~~2.10.4.9 Test Kits~~

~~One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.~~

~~2.10.4.10 Bleed Line~~

~~A bleed line with a flow valve of the needle-valve type sized for the flow requirement or fixed orifice shall be provided in the pump return to the tower. The bleed line shall be extended to the nearest drain for continuous discharge.~~

2.11 ELECTRICAL WORK

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

~~[~~Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors.~~]~~ ~~[~~Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.~~]~~

2.12 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

2.12.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with ASTM B117, and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

2.12.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

2.13 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.14 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of ~~[anodized aluminum][~~stainless steel~~][_____]~~. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.15 RELATED COMPONENTS/SERVICES

2.15.1 Drain and Make-Up Water Piping

Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

~~2.15.2 Cathodic Protection~~

~~Requirements for cathodic protection systems is specified in [Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 26 42 13.00 20 CATHODIC PROTECTION BY GALVANIC ANODES][and] [Section 26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)][Section 26 42 19.00 20 CATHODIC PROTECTION BY IMPRESSED CURRENT].~~

2.15.2 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.3 Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.15.4 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00PAINTS AND COATINGS.

~~[~~2.15.4.1 Color Coding

Requirements for color coding for piping identification are specified in Section 09 90 00 PAINTS AND COATINGS.

~~][2.15.4.2 Color Coding For Hidden Piping~~

~~A color coding scheme for locating hidden piping shall be in accordance with [Section 22 00 00 PLUMBING, GENERAL PURPOSE] [Section 22 00 70 PLUMBING, HEALTHCARE FACILITIES].~~

~~]~~PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the ~~Contracting Officer~~QC Manager in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding

procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and verify the work meets the acceptance criteria specified in ASME B31.9. NDE on piping welds covered by ASME B31.9 is visual inspection only. Submit a piping welds NDE report meeting the requirements specified in ASME B31.9.

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.3 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.4.2 Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.9. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

~~3.1.4.4 Grooved Mechanical Connections~~

~~Prepare grooves in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.~~

3.1.4.4 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.5 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps,

control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.5 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.6 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.9 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

3.1.10 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.10.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.10.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.10.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.10.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.10.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. ~~[~~Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.~~]~~

3.1.10.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

3.1.10.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.10.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

~~3.1.10.11 Seismic Requirements~~

~~Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.~~

3.1.10.11 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the ~~Contracting Officer~~QC Manager. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.11 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.12 Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall

comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, ~~[Schedule 30][Schedule 20][~~ Standard weight~~]~~. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

~~3.1.13.1 Refrigerated Space~~

~~Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar.~~

~~In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors.~~

~~Integral cast-in collar type sleeve shall be flashed [as indicated.] [with not less than 4 inches of cold side vapor barrier overlap of sleeve surface.] Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than [4][_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer.~~

~~Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.~~

3.1.13.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.13.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a .17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve

shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.13.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.13.4 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.14 Access Panels

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in~~[~~ Section 08 31 00 ACCESS DOORS AND PANELS~~][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS]~~.

~~3.2 INSTALLATION FOR POLYPROPYLENE PIPING (CHILLED WATER APPLICATIONS ONLY)~~

~~3.2.1 Locations~~

~~Plastic pipe to include polypropylene shall not be installed in air~~

~~plenums. Plastic pipe to include polypropylene shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.~~

~~3.2.2 Pipe Joints~~

~~Joints for polypropylene pipe and fittings shall be made by heat fusion welding socket-type or butt-fusion type fittings and shall comply with ASTM F2389. Joint surfaces shall be clean and free from moisture, and shall be undisturbed until cool.~~

~~3.2.3 Overheating Precautions~~

~~Adequate provisions shall be taken to ensure that the pipe does not exceed operating temperatures recommended by the manufacturer. This includes a safeguard provision from preventing a pump from running with zero flow, if such operation could overheat the pipe beyond pipe manufacturer's recommendations. If heat tracing is permitted elsewhere in the specifications, ensure that the heat tracing is installed per piping manufacturer's recommendations to prevent overheating of the pipe.~~

~~3.2.4 Testing and Flushing~~

~~Pressure test shall be conducted for 15 minutes at 1.5 times the operating pressure or 150 psi, whichever is greater, with no observable loss in pressure. Water, rather than air, must be used for pressure testing plastic pipe. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 fps through all portions of the piping system. Flushing shall be continued until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials. Upon completion of flushing, drain all water from system at low points, and remove/clean/replace strainers.~~

3.2 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.4.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.4.2 Pressure Tests

Each piping system , except for polypropylene piping, shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

~~3.4.3 Condenser Water Quality Test Reports~~

~~The condenser water system shall be analyzed by the water treatment company a minimum of once a month for a period of one year after system acceptance. Submit for approval the specified condenser water quality test reports. The analysis and resulting reports shall include the following information recorded in accordance with ASTM D596.~~

~~Date of Sample~~	~~[_____]~~
~~Temperature~~	~~[_____] degrees F~~
~~Silica (Sino 2)~~	~~[_____] pp (mg/1)~~
~~Insoluble~~	~~[_____] pp (mg/1)~~
~~Iron and Aluminum Oxides~~	~~[_____] pp (mg/1)~~
~~Calcium (Ca)~~	~~[_____] pp (mg/1)~~
~~Magnesium (Mg)~~	~~[_____] pp (mg/1)~~
~~Sodium and Potassium (Nan and AK)~~	~~[_____] pp (mg/1)~~
~~Carbonate (HO 3)~~	~~[_____] pp (mg/1)~~
~~Sulfate (SO 4)~~	~~[_____] pp (mg/1)~~
~~Chloride (JCL)~~	~~[_____] pp (mg/1)~~

Nitrate (NO 3	[_____] pp (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Non-Carbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microhm/cm

3.4.3 Related Field Inspections and Testing

3.4.3.1 Piping Welds

Examination of Piping Welds is specified in the paragraph EXAMINATION OF PIPING WELDS (above).

3.4.3.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93.00 22 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93.00 22 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the [chilled water,] [chilled-hot water,][and][condenser water piping system[s]]. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be [one man-day.][[_____][_____] continuous man-days]. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

~~[3.6 ONE-YEAR INSPECTION REPORT FOR COOLING WATER~~

~~At the conclusion of the one year period, each connecting [cooling tower] [and] [liquid chiller condenser] inspect for problems due to corrosion, scale, and biological growth. If the equipment is found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.~~

~~]~~ -- End of Section --

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SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT
05/18

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with the additions and modifications specified herein.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 340/360 I-P	(2015) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2016) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2010) Ventilation for Acceptable Indoor Air Quality

ASHRAE 90.1 - IP	(~~2013~~2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2018) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541	(2006; Rev F) Chemical Conversion Coatings on Aluminum and Aluminum Alloys

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for ~~[~~Contractor Quality Control approval.~~] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-03 Product Data

Spare Parts

Posted Instructions

Coil Corrosion Protection

System Performance Tests

Training~~; G[, [_____]]~~

Inventory

~~Environmental Data~~

~~Supplied Products~~

Manufacturer's Standard Catalog Data

~~Computer Room Humidifier~~

~~Humidifier~~

SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up~~; G[, [_____]]~~

System Performance Tests~~; G[, [_____]]~~

SD-07 Certificates

Service Organizations

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals~~; G[, [_____]]~~

SD-11 Closeout Submittals

Ozone Depleting Substances; S~~[, [_____]]~~

1.4 QUALITY ASSURANCE

Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or

required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

h. Equipment schedules

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an inventory of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, cap piping and similar openings capped to keep out dirt and other foreign matter.

1.6 ENVIRONMENTAL REQUIREMENTS

For proper Indoor Environmental Quality, maintain pressure within the building as indicated. Ventilation must meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2. ~~Thermal comfort must meet or exceed [ASHRAE 55] [AFGM 2016-01]~~.

1.7 WARRANTY

Provide equipment with the ~~[~~Manufacturer's Standard Warranty.~~] [[1 year] [2 year] [5 year] [10 year] [____ year] manufacturer's warranty.]~~

PART 2 PRODUCTS

~~2.1 ENERGY EFFICIENCY REQUIREMENTS~~

~~42 USC 8259b requires the procurement of energy efficient products in product categories covered by the Energy Star program or the Federal Energy Management Program for designated products. A list of covered product categories is available from the Federal Energy Management Web site at http://energy.gov/eere/femp/covered-product-categories. A list of qualified light commercial products is available at http://www.energystar.gov/productfinder/product/certified-light-commercial-hvac/result~~

~~Submit Material, Equipment, and Fixtures List of all supplied products within a covered product category, including manufacturer's catalog numbers, specification and drawing reference number, warranty information, fabrication site, and energy performance data. For product categories covered by the Energy Star program, submit documentation that the product is Energy Star-qualified. For product categories covered by the Federal Energy Management Program, submit documentation that the product meets or exceeds FEMP-designated efficiency requirements.~~

~~2.1.1 Room Air Conditioners~~

~~Selected room air conditioners are required to meet performance requirements specified by Energy Star. Information on the requirements can be found at ENERGY STAR Version 4.0 Room Air Conditioners Program Requirements.~~

~~2.1.2 Air-Source Heat Pumps~~

~~Selected air-source heat pumps are required to meet applicable performance requirements specified by Energy Star. Information on the requirements can be found for residential models (single-phase units of 65,000 BTU/h or less)at http://www.energystar.gov/products/specs/system/files/Central_ASHP_and_CAC_Program_Req v4_1.pdf and for light commercial models (three-phase units of less than 240,000 BTU/h) at http://www.energystar.gov/products/specs/system/files/lchvac_prog_req_v2_2_0.pdf.~~

2.1 MATERIALS

Provide Manufacturer's standard catalog data, at least ~~[~~5 weeks~~] [_____]~~ prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data includes manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with ASHRAE 90.1 - IP.

2.1.1 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 2 years prior to ~~[bid opening] [~~request for proposal~~]~~. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

2.1.2 Product Sustainability Criteria

2.1.2.1 Energy Efficient Equipment

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN BUILD paragraph ENERGY EFFICIENT EQUIPMENT.

2.1.2.2 Electrical Equipment / Motors

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 1. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors must be continuous duty with the enclosure specified. Motor starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors must be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.1.2.3 Ozone Depleting Substances

Unitary air conditioning equipment must not use CFC-based refrigerants. Refrigerant may be an approved alternative refrigerant in accordance with EPA's Significant New Alternative Policy (SNAP) listing. Provide documentation in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN BUILD paragraph OZONE DEPLETING SUBSTANCES.

~~2.1.2.4 Local/Regional Materials~~

~~Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][_____] mileradius from the project site, if available from a minimum of three sources.~~

~~2.1.2.5 Environmental Data~~

~~Submit Table 1 of ASTM E2129 for the following products: [_____].~~

2.1.3 Nameplates

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life and made of ~~[anodized aluminum] [~~stainless steel ~~] [_____]~~. Fix plates in prominent locations with nonferrous screws or bolts.

2.1.4 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts

which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

2.2 EQUIPMENT

2.2.1 Packaged Terminal [Air Conditioners] [Heat Pumps]

2.2.1.1 Packaged Terminal Unit

Provide a [vertical] [through-the-wall], [grade/floor mounted][wall mounted],[wall hung] heavy-duty commercial grade, factory assembled and precharged [air conditioner] [heat pump] unit in accordance with [AHRI 390] [ANSI/AHRI/CSA 310/380] and UL 1995. Provide units listed in AHRI DCAACP.[Provide Units removable from inside the building for servicing without removing the outside cabinet.] Provide unit with a noise rating in accordance with AHRI 350 that does not exceed [85][_____] dB while the entire unit is operating at any fan or compressor speed.[Heat pump units must contain a reversing valve to change unit to heating cycle.] Provide an outdoor coil temperature sensor to guard against coil freeze-up by either switching to supplemental heat only, or by cycling the compressor to defrost the coil. Provide [Air Conditioners][Heat pumps] with [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].] [Provide units suitable for use with minimal ductwork having a total external static resistance up to 0.1 inch of water.]

2.2.1.2 Compressor

Provide a hermetically sealed [reciprocating] [rotary] [variable speed] [digital scroll] [scroll] type Compressor. Provide compressor with permanent split capacitor motor, overload protection, and vibration isolators. Protect compressor against high discharge pressure, loss of charge, low voltage, and short cycling.

2.2.1.3 Air to Refrigerant Coils

Provide evaporator and condenser coils with [nonferrous] [copper or aluminum] tubes of 3/8 inch minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. [Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Provide casing of galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure they are suitable for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a [factory operating charge of refrigerant and oil][or][holding charge].[Unit shipped with a holding charge must be field charged with refrigerant and oil.] Provide a condensate removal system.

2.2.1.4 Fans

Provide direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in

overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.2.1.5 Air Filters

Provide standard filter on all packaged terminal units;[1 inch] [2 inch] [_____] inch MERV [7] [8] [13] [_____], throwaway filter capable of filtering the entire air supply.

2.2.1.6 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

[2.2.1.6.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service. Electric resistance heating elements with high temperature-limit safety device, factory-mounted, and wired to chassis.

][2.2.1.6.2 Gas-Fired Heating Section

Provide completely assembled, wired and piped gas fired heating systems within the unit suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [pilot ignition]. fire test all units prior to shipment. Valve must include a pressure regulator. Safety controls must include a flame sensor and air pressure switch. Provide heater section with a forced combustion blower to insure flame stability under varying wind conditions. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.

][2.2.1.6.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.2.1.6.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.2.1.7 Cabinet Construction

Provide cabinet free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal must be a minimum of 18 gauge steel with a protective coating. Provide removable face panels and allow full access to unit appurtenances. Access to controls must be without removal of the face panel. Discharge conditioned air through adjustable louvers. Thermally and acoustically insulate the cabinet with materials which

conform to NFPA 90A. Furnish units with a [field-wired] [prewired] subbase that has leveling screws [with] [without] provisions for remote unit control. Subbase must be of 18 gauge galvanized steel construction with a protective coating to match that of the room cabinet. Paint and finishes must comply with the requirements specified in paragraph EQUIPMENT AND COMPONENTS FACTORY COATING.

2.2.1.8 Louver

Provide storm proof type Louver, constructed of [anodized,] [stamped] [or] [extruded] aluminum.

2.2.1.9 Ventilation Damper Assembly

Operated by automatic actuator. Dampers must close on unit shutdown or loss of power and open on heating or cooling start-up. Dampers must have a maximum leakage rate of 3 CFM/ft2 at 1 inch w.g. static pressure.

2.2.1.10 Wall Sleeve

Provide water and airtight [completely insulated] [non-insulated] assembly, with weather-resistant protective coating.

2.2.1.11 Duct Package

Duct extension must consist of 18 gauge minimum galvanized steel plenum extender with all necessary internal dampers and baffles to divert [25] [_____] percent of the supply air as indicated. Duct extension must be painted with a protective coating that matches room cabinet.

2.2.1.12 Unit Controls

Controls must include an on-off switch, high and low selector switch for [the cooling mode] [both the heating and cooling mode], multiple speed fan [cooling] [cooling and heating] mode, room air fan switch, outside air damper control, and an adjustable cooling [only] [and heating] thermostat. Function and temperature controls must be [integral to unit] [remotely mounted as indicated or as accepted by the Contracting Officer].

Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

~~2.2.2 Room [Air Conditioner] [Heat Pump]~~

~~Provide a [window] [through-the-wall] mounted, appliance grade, factory-assembled [air conditioner] [heat pump] unit in accordance with AHAM RAC-1 and UL 484. Units must include a self-contained, precharged, slide-in and removable chassis-mounted, air-cooled refrigeration system. Provide units removable from inside the building for servicing without removing the outside cabinet. Mount compressors on vibration isolators. Minimum cooling capacity must be not less than that indicated. Provide units listed in the AHAM RAC-1.[Provide light tight units serving dark rooms.] Cooling section must be equipped with a filter-drier on the suction line. Fan and condenser motors must have [open] [drip proof] [totally enclosed] [explosion proof] enclosures.[Room Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]] [Room Heat Pumps must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]~~

~~2.2.2.1 Primary/Supplemental Heat~~

~~Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.~~

~~[2.2.2.1.1 Electric Heating~~

~~Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 40 watts per square inch. provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service. Electric resistance heating elements with high temperature-limit safety device, factory-mounted, and wired to chassis.~~

~~][2.2.2.1.2 Gas-Fired Heating Section~~

~~Provide completely assembled, wired and piped gas fired heating systems within the unit suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [pilot ignition]. fire test all units prior to shipment. Valve must include a pressure regulator. Safety controls must include a flame sensor and air pressure switch. Provide heater section with a forced combustion blower to insure flame stability under varying wind conditions. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.~~

~~][2.2.2.1.3 Hot Water Coils~~

~~Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.~~

~~][2.2.2.1.4 Steam Coils~~

~~Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.~~

~~]2.2.2.2 Filters~~

~~[Provide replaceable media filters of the [dry-media] [washable] type, of the size required to suit the application. Average efficiency must be not less than [25][_____] percent when tested in accordance with ASHRAE 52.2.] [Provide air filters of the [throw-away] [or] [permanent washable] type removable without the use of tools and arranged to filter both room and ventilating air. Filters must have a minimum efficiency reporting value (MERV) of [6][8][_____] when tested in accordance with ASHRAE 52.2.]~~

~~2.2.2.3 Fans~~

~~Provide direct driven, statically and dynamically, [centrifugal][or][propeller] type fans. Design outdoor fan so that condensate evaporates without drip, splash, or spray on building exterior. Remove condensate by means of a drain or by evaporation and diffusion.~~

~~2.2.2.4 Casing~~

~~Provide exterior casings for the specified room HVAC Units constructed of factory phosphatized and painted galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Fit casing with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Incorporate provisions to permit replacement of major unit components. Seal penetrations of cabinet surfaces, including the floor. Unit base must be watertight. Fit unit with a drain pan which extends under all areas where water may accumulate. Fabricate drain pan from Type 30X stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071.~~

~~Construct outside cabinets, including metal grilles to protect condenser coils, of zinc-coated steel or aluminum. Steel and zinc-coated surfaces must receive at least one coat of primer and manufacturer's standard factory-applied finish Insulate cabinets to prevent condensation and run off of moisture. Provide mounting hardware made of corrosion-resistant material or protected by a corrosion-resistant finish. Provide with metal or plastic mounting flanges on each side, top, and bottom of unit. For through-the-wall installations provide aluminum or shop painted zinc-coated steel flanged telescopic wall sleeves. Design wall sleeves to restrict driving rain. For window mounted units provide shop-painted metal mounting brackets, braces, and sill plates.~~

~~2.2.2.5 Energy Efficiency~~

~~Minimum energy efficiency ratio (EER) must be in accordance with the paragraph EQUIPMENT EFFICIENCY. [Room air conditioners must include the~~

~~Energy Star label affixed to the equipment.]~~

~~2.2.2.6 Units for Operation on 115 Volts~~

~~Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords must have a 15- or 20-amp, 3-pole, 125-volt ground type plug to match receptacle.~~

~~2.2.2.7 Units for Operation on 208 or 230 Volts~~

~~Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords must have a 15-, 20-, or 30-amp, 3-pole, 250-volt ground type plug to match receptacle.~~

~~2.2.2.8 Controls~~

~~Provide units internally prewired by manufacturer with a 24 volt control circuit powered by an internal transformer. Terminal blocks must be provided for power wiring and external control wiring. Unit must be internally protected by [fuses] [or] [a circuit breaker] in accordance with UL 1995. [Unit must be provided with microprocessor controls to provide all 24V control functions.]~~
~~Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~Mount controls in cabinet. Manual controls must permit operation of either the fan or the fan and refrigerating equipment. Fan control must provide two fan speed settings. Automatic controls must include a thermostat for controlling air temperature. Thermostat must have an adjustable range, including 72 to 80 degrees F and must automatically turn the refrigeration system on or off to maintain the preselected temperature within plus or minus 4 degrees F.~~

~~2.2.3 Self-Contained Air Conditioners [Heat Pumps]~~

~~2.2.3.1 Small-Capacity Self-Contained air conditioners [Heat Pumps] (Not exceeding 65,000 Btu/h)~~

~~2.2.3.1.1 General~~

~~Unit must be an air-cooled, factory assembled, weatherproof packaged unit as indicated. Unit must be the [air conditioning][heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [~~

~~ANSI/AHRI 210/240][ANSI/AHRI 340/360]. Unit must be provided with equipment as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be direct drive forward curved centrifugal scroll type. Condenser fans must be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit must be provided with a full factory operating charge of refrigerant. Unit must have an Energy Star label.[Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Unit must be provided with hot gas reheat.]~~

~~2.2.3.1.2 Air-to-Refrigerant Coils~~

~~Air-to-refrigerant coils must have [seamless copper][or] [aluminum] tubes of 5/16 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel] [or] [aluminum]. Contact of dissimilar metals must be avoided. Coils must be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil must be factory pressure and leak tested. Separate expansion devices must be provided for each compressor circuit.~~

~~[Condenser] [Evaporator] [Condenser and Evaporator] coil must be coated with a uniformly applied [epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [500][1,000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.~~

~~2.2.3.1.3 Fan Section~~

~~Fan must be the [centrifugal] [propeller] type in accordance with paragraph FANS. Do not locate fan and fan motor in the discharge airstream of the unit. Motors must have [open] [splash proof] [totally enclosed] enclosure and be suitable for the indicated service. The unit design must prevent water from entering into the fan section.~~

~~2.2.3.1.4 Compressor~~

~~Provide direct drive, [hermetic reciprocating,] [variable speed] [digital scroll] [scroll] type Compressor. Compressor must have internal over current and over temperature protection, internal pressure relief, rotor lock suction and discharge refrigerant connections, centrifugal oil pump, vibration isolation, and discharge refrigerant connections.~~

~~2.2.3.1.5 Refrigeration Circuit~~

~~Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant lines must have service pressure tap ports and refrigerant line filter.~~

~~2.2.3.1.6 Unit Controls~~

~~Provide units internally prewired by manufacturer with a 24 volt control circuit powered by an internal transformer. Terminal blocks must be provided for power wiring and external control wiring. Unit must be~~

internally protected by [fuses] [or] [a circuit breaker] in accordance with UL 1995.

a. [Unit must be provided with microprocessor controls to provide all 24V control functions.]Unit must be controlled by a [two stage heating/cooling thermostat] [one stage heating/cooling thermostat] with [manual] [automatic] changeover.[Unit must be controlled by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

b. Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

b. Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

b. Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.2.3.1.7 Roof Curb

Provide a roof curb that mates with the unit to provide support and be completely weather tight. Provide curb with sealing strips to ensure an airtight seal between supply and return openings of the curb and unit. Design curb to allow ductwork to be directly connected to the curb.[The roof curb must be provided by the Manufacturer of the equipment.][The Roof Curb must be a minimum of [_____] inches tall.][Provide an acoustical roof curb to meet noise requirements.]

2.2.3.1.8 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

[2.2.3.1.8.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.

][2.2.3.1.8.2 Gas-Fired Heating Section

Provide factory assembled heating section as an integral part of the

packaged unit. Design must be UL certified for outdoor application. Unit must have threaded gas connection. Provide heating section with [a pilot][an electronic] ignition system to light burner each time thermostat calls for heat. A flame sensor must prove flame and keep main burner on. The main valve must close should a loss of flame occur. When the thermostat is satisfied, extinguish the main burner. Provide a forced combustion blower to supply combustion air to the heating section. Construct the heat exchanger and burners of stainless steel.

][2.2.3.1.8.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.2.3.1.8.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.2.3.1.9 Single Source Power Entry

Provide single source power entry to allow single source power connection to unit and heater combination. Single source power entry kit includes specific matching heater(s), high voltage terminal blocks, fuse blocks and fuses, cut-to-length interconnecting wiring, and [plug with matching receptacle][junction box (if required)] to provide power sources with fuse protection as required for both the unit and accessory heater. [The equipment disconnect must be provided by the Manufacturer of the equipment.]

[2.2.3.1.10 Fully Modulating Economizer

Provide a fully modulating economizer with 0-100 percent fresh air damper, damper drive motor, and fixed dry bulb enthalpy control [solid state enthalpy control] [differential enthalpy control]. Control economizer operations by the pre-set position of the enthalpy control. Include a barometric relief damper with the down flow economizer to provide a pressure operated damper that is gravity closing and prohibits entrance of outside air on equipment "off" cycle.

Use water economizer in lieu of air economizers where possible. Use waterside economizers in lieu of airside economizers when applicable and life cycle cost effective. Where air economizers are used, provide separate dampers for ventilation air and minimum outdoor air requirements. Air economizers must not be used in ASHRAE climate zones 1, 2, 3a, and 4a. Air economizers must be designed with controls and alarms to indicate economizer malfunction.

]2.2.3.1.11 Manual Outside Air Damper

Provide manual outside air damper with rain hood and screen suitable for up to [25][_____] percent outside air. Dampers must have a maximum leakage rate of 3 CFM/ft2 at 1 inch w.g. static pressure

~~2.2.3.1.12 Low Ambient Control~~

~~Provide low ambient control to allow cycling of compressor for cooling operation at low ambient temperatures down to [0][_____] degrees F.~~

~~2.2.3.1.13 Filters~~

~~Provide a [1][2][_____] inch MERV [7][8][13][_____], throwaway filter.~~

~~2.2.3.2 Large-Capacity Self-Contained air conditioners [Heat Pumps] (Greater than 65,000 Btu/h)~~

~~2.2.3.2.1 General~~

~~Provide an air-cooled, factory assembled, weatherproof packaged unit for [dedicated downflow][or][horizontal] airflow. Exterior panels must be zinc coated galvanized steel phosphatized and painted.[All access doors and panels must be hinged with neoprene gaskets.] Unit must be listed, labeled, and classified in accordance with UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360]. Provide unit with equipment as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be direct drive forward curved centrifugal scroll type. Condenser fans must be manufacturer's standard for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type. UProvide unit with a full factory operating charge of refrigerant. Unit must be 100 percent run tested at the factory. No penetrations are allowed within the perimeter of the curb in the down flow unit's base pan other than the raised 1-1/8 inch high supply/return openings to provide added water integrity precaution from condensate drain back up.~~

~~Provide a belt driven, forward curved centrifugal indoor fan with adjustable motor sheaves. Thermally protect all motors. Provide unit with a removable, reversible, double-sloped condensate drain pan.[Air conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]~~

~~2.2.3.2.2 Casing~~

~~Construct exterior casings for the specified unitary equipment of factory phosphatized and painted galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Fit casing with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. All access doors and panels must have neoprene gaskets.[Casing must have double-wall, hinged access doors for filters, heating, return/exhaust air, and supply fan section.] Incorporate provisions to permit replacement of major unit components. Seal penetrations of cabinet surfaces, including the floor. Unit base must be watertight. Fit unit with a drain pan which extends under all areas where water may accumulate. Fabricate drain pan from Type 30X stainless steel, galvanized steel with protective coating, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two~~

conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071.

2.2.3.2.3 Air-to-Refrigerant Coils

Provide air-to-refrigerant coils with [seamless copper][or][aluminum] tubes of 5/16 inch minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Factory pressure and leak test each coil.

a. Provide separate expansion devices for each compressor circuit. Condensate drain pans must be removable and double-sloped.

b. Dual compressor units must have intermingled evaporator coils.

c. Condensate drain pans must be removable and double-sloped.[

d. Provide condenser coils with hail protection guards.]

e. Coat [condenser] [evaporator] [condenser and evaporator] coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] [epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [500][1000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.2.3.2.4 Compressor

Provide direct drive, [hermetic reciprocating,] [or] [scroll] type compressor. Compressor must have internal over current and over temperature protection, internal pressure relief, high pressure cutout, rotor lock suction and discharge refrigerant connections, centrifugal oil pump, vibration isolation, and discharge refrigerant connections. Compressors must have crankcase heaters. Motor must be suction gas-cooled. Cooling partial load capacity must be provided by [a dual stage compressor] [two or more compressors controlled to stage up and down based on load] [a variable speed compressor].

2.2.3.2.5 Refrigeration Circuit

Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant lines with service pressure tap ports and refrigerant line filter.

2.2.3.2.6 Unit Controls

Provide units internally prewired by manufacturer with a 24 volt electromechanical control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by [fuses] [or] [a circuit breaker] in accordance with UL 1995. Units with three-phase power must be equipped with phase monitoring protection to protect against problems caused by phase loss,

phase imbalance and phase reversal.

a. [Provide unit with microprocessor controls to provide all 24V control functions.]Control unit by a [two stage heating /cooling thermostat] [one stage heating/cooling thermostat] with [manual] [automatic] changeover. [Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

b. Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

b. Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

b. Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.2.3.2.7 Supply Air Fan

Units having AHRI cooling capacity equal or greater than 110,000 Btu/h must have supply fans controlled by [two-speed motors] [variable speed motors].

[Provide direct drive, forward curved, centrifugal scroll type supply air fan.][Provide supply air plenum fan with backward-curved fan wheel.]

2.2.3.2.8 Roof Curb

Provide a roof curb that mates with the unit to provide support and be completely weather tight. Provide curb with sealing strips to ensure an airtight seal between supply and return openings of the curb and unit. Design curb to allow ductwork to be directly connected to the curb.[The roof curb must be provided by the Manufacturer of the equipment.][The roof curb must be a minimum of [_____] inches tall.][Provide an acoustical roof curb to meet noise requirements.]

2.2.3.2.9 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

[2.2.3.2.9.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 40 watts per square inch. Provide coil with automatic reset high limit

~~control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.~~

~~][2.2.3.2.9.2 Gas-Fired Heating Section~~

~~Construct gas-fired heat exchanger and burner of stainless steel suitable for [natural gas] [liquid propane gas] fuel supply. Provide burner with [direct spark] [pilot] ignition. Heating section must have modulation with a turn down ratio of at least [4] [3] to 1. Provide heating section completely assembled and integral to unit. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction and completely accessible for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.~~

~~][2.2.3.2.9.3 Hot Water Coils~~

~~Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.~~

~~][2.2.3.2.9.4 Steam Coils~~

~~Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.~~

~~]2.2.3.2.10 Single Source Power Entry~~

~~Provide single source power entry to allow single source power connection to unit and heater combination. Single source power entry kit includes specific matching heater(s), high voltage terminal blocks, fuse blocks and fuses, cut-to-length interconnecting wiring, and [plug with matching receptacle][junction box (if required)] to provide power sources with fuse protection as required for both the unit and accessory heater. [The equipment disconnect must be provided by the Manufacturer of the equipment.]~~

~~[2.2.3.2.11 Fully Modulating Economizer~~

~~Provide fully modulating economizer to include 0-100 percent fresh air damper, damper drive motor, and [fixed dry bulb enthalpy control] [solid state enthalpy control] [differential enthalpy control]. Control economizer operations by the pre-set position of the enthalpy control. Include a barometric relief damper with the down flow economizer to provide a pressure operated damper that is gravity closing and prohibits entrance of outside air on equipment "off" cycle. [Economizer dampers must be ultra low-leak type with leakage rate of one percent based on testing data completed in accordance with AMCA 500-D.]~~

~~]2.2.3.2.12 Manual Outside Air Damper~~

~~Provide manual outside air damper with rain hood and screen suitable for~~

up to [25][_____] percent outside air. [Test Louvers in accordance with AMCA 500-L.]

2.2.3.2.13 Low Ambient Control

Provide low ambient control to allow cycling of compressor for cooling operation at low ambient temperatures down to [0][_____] degrees F.

2.2.3.2.14 Filters

Provide 2 inch thick high efficiency throwaway type filters that are MERV [8] [13]. Filters must have an average dust spot efficiency of [25-35][_____] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Filters must be UL Class 1.

2.2.4 Computer Room Air Conditioner

2.2.4.1 General

Provide an [air-cooled][water-cooled], self-contained type air conditioning unit. Unit must be [a packaged unit with an internal water-cooled condenser][a split-system with a remote [condenser][condensing unit]]. Design and construct unit for automatic control of space conditions. Unit must be in accordance with ASHRAE 127 and UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][AHRI 340/360 I-P]. Design and conruct the system for maximum reliability and ease of maintenance. Provide necessary redundancy, access to refrigeration circuits, means of troubleshooting, and malfunction alarms. Provide unit with necessary fans, air filters,[coil frost protection,][liquid receiver,] internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be double-width, double inlet, forward curved centrifugal scroll type. Condenser or outdoor fans must be manufacturer's standard for unit specified and may be [either] [propeller][or][centrifugal scroll] type. Fan and condenser motors must have [open][dripproof][totally enclosed][explosion proof] enclosures.[Remote unit must be as specified in paragraph REMOTE CONDENSER OR CONDENSING UNIT.][Computer Room Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]

2.2.4.2 Air-to-Refrigerant Coils

Provide [evaporator][evaporator and condenser] coils with [nonferrous][copper] [or] [aluminum] tubes of 3/8 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph CORROSION PROTECTION.] Casing must be [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory for suitability at the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil] [or] [a holding charge].[Field charge unit shipped with a holding charge with refrigerant and oil.] Provide separate expansion devices for each compressor circuit.

~~2.2.4.3 Water-to-Refrigerant Coils~~

~~Provide coils of the [tube-in-tube] [shell-and-coil] [shell-and-tube] [or] [concentric tube] type as an integral part of the self-contained unit. Water-wetted metals must be [copper][or][90/10][or][70/30][copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Unit must be rated for not less than 400 psi refrigerant side and 125 psi water side pressure service at operating temperatures. Supply unit with water as indicated. Water supply, return and control system wetted parts must be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit must be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Piping arrangement must include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow. Base performance on an allowable water velocity not less than 3 fps nor more than 10 fps with a fouling factor of [0.001][0.0005]. Provide a separate condenser for each compressor circuit. Set control for refrigerant condensing temperature of [_____] degrees F. Fit units which use a once-thru water-source with a strainer protected solenoid shut-off valve. The valve must be a fully automatic, self-contained temperature regulating valve with integral thermometer. Mercury cannot be used in thermometers.~~

~~2.2.4.4 Compressor~~

~~Provide Compressor that is direct drive, [semi-hermetic] [or] [hermetic reciprocating,] [or] [scroll] type capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide compressors of 7.5 tons and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start each compressor in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, [lubrication pump,] thermal overloads, and [high] [high and low] pressure safety cutoffs and protection against short cycling.~~

~~2.2.4.5 Refrigeration Circuit~~

~~Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves and connections, and pumpdown valves for each circuit. Provide reversible-flow type filter-drier in each liquid line. Refrigerant flow control devices must be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. Provide a refrigerant suction line [thermostatic][thermostatic and water flow switch] control to prevent freeze-up in event of loss of water flow during heating cycle.~~

~~2.2.4.6 Unit Controls~~

~~Control a unit's basic functions and space ambient conditions [including [humidification][or][dehumidification]] at one factory installed and tested station. Controller modules must provide automatic centralized control of computer room critical equipment, simplifying emergency~~

switching and unit testing. When the module recognizes an alarm condition, it automatically switches to a stand-by device. User must be able to program a switching delay to allow time to correct emergency conditions. Provide modules with capability to balance the runtime of all connected air units. Provide clear, simplified instructions for programming and configuration controllers, minimizing the chances of operator error. Provide a [paper strip chart][electronic] temperature and humidity recorder, integral or external to the unit, readable to specified control accuracy, complete with supplies required for 1 year of operation. Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.2.4.6.1 Externally Accessible Controls

Provide the following externally accessible controls:

a. Start and stop total system functions.

b. Audible alarm silence.

c. Main power disconnect.

2.2.4.6.2 Status Indicators

Provide the following externally visisble status indicators:

a. Power On.

b. System On.

c. Malfunction.

d. Provision for remote alarm status indication.

2.2.4.6.3 Alarmed Conditions

Provide the following system status conditions both audibly and visually alarmed:

a. Loss of air flow.

b. Dirty filters.

c. Compressor overload or lock-out (compressor high head pressure and low suction pressure).

d. [High][High and low] room temperature.

e. High humidity alarm at [_____] percent relative humidity.

2.2.4.6.4 Space Temperature

Control the space temperature within plus or minus 1.5 degrees F of the set point over a range of 60 to 90 degrees F with a set point of [_____]. Space relative humidity must be controlled within plus or minus 5 percent of the set point over a range of 20 to 80 percent with a set point of [_____] percent.

2.2.4.6.5 Safety Controls

Safety controls must include the following:

a. Fused, unfused or line-break circuit breaker disconnects, as indicated or required.

b. Automatic pump-out or pump-down liquid flooding controls.

c. High refrigerant pressure cutout. System must remain off for 1 hour or until pressure returns to acceptable range.

d. Low refrigerant pressure cutout where automatic pump-down is not provided. System must remain off for 1 hour or until pressure returns to acceptable range.

e. Accessible hermetic and open compressor low oil pressure cutout.

f. Elapsed time meter for each compressor where load equalization is not incorporated.

g. Lead and lag compressor selector switch, when compatible with system.

2.2.4.7 Cabinet Construction

Totally enclose the cabinet. Provide pulsation free enclosure surfaces, with hinged and removable doors and panels for vertical side or front access to unit components. Routine maintenance access to compressor and system control components must be possible without unit shut-down. Thermally and acoustically insulate enclosure surfaces. Interior baffle and compartment surfaces must be galvanized steel. Collect all condensate in drain pans of steel with external insulation as required. Provide surface mounting steel pads and vibration isolating pads. Prepare, prime and finish enclosure surfaces. Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING. Fit cabinets with integral or separable, adjustable and lockable jacks to support the units from the structural slab at the raised-floor elevation.

2.2.4.8 Filters

Provide filters of the [sectional] [or] [panel] [cleanable] type and capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. [1] [2]

inch MERV [7][8][13], provide throwaway filter on all units below 6 Tons.

Provide filter rack that can be converted to 2.0 inch capability. Provide factory supplied 2.0 inch, MERV [8][13], throwaway filters on all units above 6 Tons. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.

2.2.4.9 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 120 degrees F at 104 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [20][55][_____]degrees F. Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. [Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.]

[2.2.4.9.1 Sound Rating

Provide units with a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 270.

]2.2.4.9.2 Air-Cooled Condenser

Provide Unit in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit; complete with casing, [propeller] [or] [centrifugal] type fans, heat rejection coils, connecting piping and wiring, and all necessary accessories.

2.2.4.9.3 Enclosure

Provide [open][drip proof][totally enclosed][explosion proof] enclosures for fan and condenser motors.

2.2.4.10 Computer Room Humidifier

Provide humidifiers that meet the requirements of ANSI/AHRI 640

2.2.4.10.1 Steam Spray Type Humidifier

Provide steam spray humidifiers that inject steam directly into the [surrounding air][or][air stream]. [Single grid humidifiers must consist of a single copper distribution grid with pipe connection on one end and cap on the other end. Field install automatic steam control valves and condenser traps.][House enclosed grid in a copper enclosure with a built-in condensate drain connection.] [Wick wrap exposed grid.][Equip package type steam spray humidifiers to trap out and to evaporate condensate and to supply dry steam to a single distribution grid. Grid must be steam jacketed and condensate drained. Unit must trap excess condensate to return system. Provide package type steam spray humidifiers with modulating electric, electronic, or pneumatic steam control valve.] Steam spray humidifiers must be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

~~2.2.4.10.2 Steam-Diffuser Type Humidifier~~

~~Provide diffuser units that separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. Materials must be [noncorrosive materials][Type 30X stainless steel].~~

~~2.2.4.10.3 Electrode Canister Type Humidifier~~

~~Provide humidifier of the self-contained steam generating electrode type utilizing a [plastic] [disposable] canister with full probes connected to electric power via electrode screw connectors. Construct the electrodes from expanded low carbon steel, zinc plated and dynamically formed for precise current control. The humidifier assembly must include integral fill cup, fill and drain valves and associated piping. Design the canister to collect the mineral deposits in the water and provide clean particle free steam to the air stream. Water chemistry requirements must be provided with humidifier submittal data.~~

~~2.2.4.10.4 Ultrasonic Type Humidifier~~

~~Provide humidifier of the self-contained ultrasonic type operating on the principle of ultrasonic nebulization of water. Make the casing of high-quality stainless steel. The ultrasonic humidifier must not produce any unacceptable noise radiation or frequency interference with communications or other electronic equipment. Water chemistry requirements must be provided with humidifier submittal data.~~

~~2.2.4.11 Fans~~

~~Provide direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fans. Design outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.~~

2.2.1 ~~[Mini-]~~Split-System Air Conditioners and ~~[~~Heat Pumps~~]~~

2.2.1.1 Small-Capacity Split-System Air-Conditioners (Not Exceeding 65,000 Btu/hr)

Provide an air-cooled, split system which employs a remote condensing unit, a separate ~~[~~floor mounted~~,]~~ ~~[~~wall mounted~~,]~~ or ~~[~~ceiling mounted~~]~~ indoor unit, and interconnecting refrigerant piping. Provide the ~~[~~air conditioning or ~~][~~heat pump~~]~~ type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with ~~[~~ANSI/AHRI 210/240 or~~][~~AHRI 340/360 I-P~~]~~. Provide indoor unit with necessary fans, air filters, and galvanized steel cabinet construction. The remote unit must be as specified in paragraph CONDENSING UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified and may be ~~[~~either~~]~~ ~~[~~propeller~~]~~ ~~[~~or~~]~~ ~~[~~centrifugal scroll~~]~~ type. Fan and condenser motors must have ~~[open][drip-proof][~~totally enclosed~~][explosion-proof]~~ enclosures. Design unit to operate at outdoor ambient temperatures up to ~~[~~115~~]~~ ~~[_____]~~ degrees F.

2.2.1.1.1 Energy Efficiency

~~Provide unit with an Energy Star label. [~~Air Conditioners must have minimum efficiences meeting ASHRAE 90.1. ~~[a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]~~

2.2.1.1.2 Air-to-Refrigerant Coil

Provide condensing coils with ~~[~~copper~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~ tubes of 3/8 inch minimum diameter with ~~[~~copper~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~ fins that are mechanically bonded or soldered to the tubes. Casing must be ~~[~~galvanized steel~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging.

Coat ~~[~~outdoor condenser~~] [evaporator] [condenser and evaporator]~~ coil with a uniformly applied ~~[~~epoxy electrodeposition~~][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl]~~ type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum ~~[500][1,000][~~6,000~~____]~~ hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

~~2.2.1.1.3 Compressor~~

~~Provide direct drive [hermetic reciprocating] [variable speed] [digital scroll] [scroll] type compressor.Provide compressor with internal over temperature and pressure protector; sump heater; oil pump; high pressure and low pressure controls; and liquid line dryer.~~

2.2.1.1.3 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide refrigerant charging valves. Provide filter-drier in liquid line.to prevent freeze-up in event of loss of water flow during heating cycle.

2.2.1.1.4 Unit Controls

Provide unit internally prewired with a ~~[~~24~~][120][_____]~~ volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by fuses or a circuit breaker in accordance with UL 1995. Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal. ~~[~~ Provide unit with microprocessor controls to provide all 24V control functions.~~] [Control unit by a [two stage heating /cooling thermostat] [one stage heating/cooling thermostat] with [manual] [automatic] changeover.] [Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]~~

Controls must include a control system interface to a BACnet Control

system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23. ~~02~~13 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

~~Controls must include a control system interface to a LonWorks control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~[~~

~~Communication networks between physically separate units in a split system must be in accordance with either Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. and must match the protocol used by the control system interface.~~

~~]~~2.2.1.1.5 Condensing Coil

Provide coils with ~~[~~nonferrous~~]~~~~[~~copper~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~ tubes of 3/8 inch minimum diameter with ~~[~~copper~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~ fins that are mechanically bonded or soldered to the tubes. ~~[~~Protect coil in accordance with paragraph CORROSION PROTECTION.~~]~~ Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal eacj coil after testing and prior to evaluation and charging. Provide separate expansion devices for each compressor circuit.

2.2.1.1.6 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 120 degrees F at 104 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of ~~[20][55][~~15~~____]~~ degrees F. Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Fan and condenser motors must have ~~[open][drip-proof][~~totally enclosed~~]~~~~[explosion proof]~~ enclosures. ~~[~~Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.~~]~~

~~[2.2.1.1.6.1 Sound Rating~~

~~Provide units of capacities less than 135,000 Btu/h with a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 270.~~

]2.2.1.1.6.1 Air-Cooled Condenser

Provide Unit in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit; complete with casing, [propeller] [or] [centrifugal] type fans, heat rejection coils, connecting piping and wiring, and all necessary accessories.

2.2.1.1.7 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

[2.2.1.1.7.1 Electric Heating

[Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.][

Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]

][2.2.1.1.7.2 Gas-Fired Heating Section

[Construct the gas-fired heat exchanger and burner of stainless steel suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [pilot ignition]. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.][

Construct the gas-fired furnace and burner of materials suitable for [natural gas][liquid propane gas] fuel supply. Furnace must have [direct spark] [pilot ignition]. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Gas valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount burner to

~~eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54. Gas furnaces must have the Energy Star Label and a minimum efficiency of [78][85][90][___] percent AFUE.]~~

~~][2.2.1.1.7.3 Hot Water Coils~~

~~Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.~~

~~][2.2.1.1.7.4 Steam Coils~~

~~Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.~~

~~]~~2.2.1.1.7 Air Filters

Provide filters of the ~~[~~sectional~~]~~ ~~[~~or~~]~~ ~~[~~panel~~]~~ ~~[~~cleanable~~]~~ type that are capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible ~~[by hinged access panel(s)]~~. ~~[1] [2] inch MERV [7][8][13], provide throwaway filter on all units below 6 Tons.~~

~~Provide filter rack that can be converted to 2.0 inch capability. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.~~

2.2.1.1.8 Fans

Provide direct driven, statically and dynamically balanced, ~~[~~centrifugal~~]~~~~[~~_or~~]~~ _~~[~~propeller~~]~~ type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

~~2.2.1.2 Large-Capacity Split-System Air Conditioners (Greater Than 65,000 Btu/h)~~

~~Provide an air-cooled, split system which employs a remote condensing unit, a separate [floor mounted][wall mounted][ceiling mounted] indoor unit, and interconnecting refrigerant piping. Provide the [air conditioning][heat pump] type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][AHRI 340/360 I-P]. Provide unit with necessary fans, air filters, and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Provide double-width, double inlet, [forward curved] [backward inclined] [airfoil blade] centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type condenser or outdoor fans. Enclose fan condenser motors in [open][drip proof][totally enclosed][explosion proof] enclosures [and permanently lubricate ball bearings]. [Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of~~

[_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.2.1.2.1 Air-To-Refrigerant Coil

Provide coils with [nonferrous][copper] [or] [aluminum] tubes tubes of 3/8 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. Provide casing of [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil] [or] [a holding charge]. Field charge unit shipped with a holding charge with refrigerant and oil. Provide separate expansion devices for each compressor circuit. [Condenser coil must have an integral sub-cooler.] [Condenser coil must have special coating for corrosion resistance.] [Condenser coil must be copper finned.]

Coat [condenser] [evaporator] [condenser and evaporator] coil with a uniformly applied [epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum [500][1,000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.2.1.2.2 Compressor

Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Equip compressors of 10 tons and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start compressors in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, thermal overloads,[lubrication pump,] [high][high and low] pressure safety cutoffs and protection against short cycling.

2.2.1.2.3 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves and connections, and pumpdown valves for each circuit. Provide reversible-flow type filter-drier in each liquid line. Refrigerant flow control devices must be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. Provide a refrigerant suction line [thermostatic][thermostatic and water flow switch] control to prevent freeze-up in event of loss of water flow during heating cycle.

~~2.2.1.2.4 Primary/Supplemental Heat~~

~~Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.~~

~~[2.2.1.2.4.1 Electric Heating~~

~~[Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.][~~

~~Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]~~

~~][2.2.1.2.4.2 Gas-Fired Heating Section~~

~~[Construct the gas-fired heat exchanger and burner of stainless steel suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [pilot ignition]. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.][~~

~~Construct the gas-fired furnace and burner of materials suitable for [natural gas][liquid propane gas] fuel supply. Furnace must have [direct spark] [pilot ignition]. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Gas valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount burner to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54. Gas furnaces must have the Energy Star Label and a minimum efficiency of [78][85][90][___] percent AFUE.]~~

~~][2.2.1.2.4.3 Hot Water Coils~~

~~Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.~~

~~][2.2.1.2.4.4 Steam Coils~~

~~Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.~~

~~]2.2.1.2.5 Unit Controls~~

~~Provide unit internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Unit must have cutoffs for [high][high and low] pressure,[and] low oil pressure for compressors with positive displacement oil pumps, [supply fan failure], [and safety interlocks on all service panels]. Head pressure controls must sustain unit operation with ambient temperature of [20][55][_____]degrees F. Adjustable-cycle timers must prevent short-cycling. Stage multiple compressors by means of a time delay. Internally protect unit by [fuses] [or] [a circuit breaker] in accordance with UL 1995. Make low cost cooling possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.~~

~~Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~Controls must include a control system interface to a LonWorks control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.~~

~~[~~

~~Communication networks between physically separate units in a split system must be in accordance with either Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. and must match the protocol used by the control system interface.~~

~~]~~

~~2.2.1.2.6 Remote Condenser or Condensing Unit~~

~~Units with capacities 135,000 Btuh or greater must produce a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 370. Fit each remote condenser coil with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 120 degrees F at 95 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [20] [55] [_____] degrees F. Provide fan and cabinet construction must be provided as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Fan and condenser motors must have [open][dripproof][totally enclosed][explosion proof] enclosures. [Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.]~~

~~2.2.1.2.6.1 Air-Cooled Condenser~~

~~Provide unit rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit. Unit must be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.~~

~~a. Provide interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit as required and as indicated. Provide electrical and refrigeration piping terminal connections between [condenser][condensing unit] and evaporator units.~~

~~b. Low ambient control for multi-circuited units serving more than one evaporator coil must provide independent condenser pressure controls for each refrigerant circuit. Set controls to produce a minimum of 95 degrees F saturated refrigerant condensing temperature. Provide unit with a liquid subcooling circuit that ensures proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit must be provided with [manufacturer's standard] [not less than [8][_____] degrees F] liquid subcooling. Liquid seal the subcooling circuit.~~

~~c. Coils must have [nonferrous][copper or aluminum] tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide separate expansion devices for each compressor circuit.~~

~~d. Provide a complete control system with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Construct unit mounted control panels or enclosures in accordance with applicable requirements of NFPA 70 and house in NEMA ICS 6, Class 1 or 3A enclosures. Controls must include [control transformer,] [fan motor~~

[starters,]] [solid-state speed control,] [electric heat tracing controls,] [time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.2.1.2.6.2 Evaporative Condenser

[Provide a counter-flow blow-through design, with single-side air entry.]The unit must have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section and the cabinet must not be lighter than 16-gauge steel, protected against corrosion by a zinc coating. Conform the zinc coating ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 2.5 ounces/square foot of surface. Give cut edges a protective coating of zinc-rich compound. After assembly, apply the manufacturer's standard zinc chromatized aluminum or epoxy paint finish to the exterior of the unit. Unit must be rated in accordance with AHRI 490 I-P and tested in accordance with the requirements of ASHRAE 64.

a. Provide a watertight pan complete with drain, overflow, and make-up water connections. Provide standard pan accessories to include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

b. Provide a direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fan. Do not locate fan and fan motor in the discharge airstream of the unit. Enclose motors in [open] [splashproof] [totally enclosed] enclosure that is suitable for the indicated service. Design the condensing unit design to prevent water from entering into the fan section.

c. Provide condensing coils with [nonferrous][copper] [or] [aluminum] tubes of 3/8 inch minimum diameter without fins. [Protect coil in accordance with paragraph CORROSION PROTECTION.] Provide [galvanized steel] [or] [aluminum] casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil] [or] [a holding charge]. [Field charge unit shipped with a holding charge with refrigerant and oil.]

d. Provide a water distribution system that distributes water uniformly over the condensing coil to ensure complete wetting of the coil at all times. Provide [brass,] [stainless steel,] [or] [high-impact plastic] spray nozzles that are the cleanable, non-clogging, removable type. Design nozzles to permit easy disassembly and arrange for easy access.

e. Provide [a][two] bronze-fitted [centrifugal] [or] [turbine] type water pump[s] that may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps must have cast-iron casings. Impellers must be bronze, and shafts stainless steel with bronze casing wearing rings. Use mechanical type shaft seals. Factory coat the pump casing with epoxy paint. Pump motors must have [open][drip proof][totally enclosed][explosion proof] enclosures. Provide a bleed line with a flow valve or fixed orifice in the pump discharge line and extend to the nearest drain for continuous discharge. Fully submerge pump suction and provide with a

[galvanized steel] [or] [monel] screened inlet.

f. Provide drift eliminators to limit drift loss to not over 0.005 percent of the specified water flow. Construct eliminators of [zinc-coated steel] [or] [polyvinyl chloride (PVC)]. Eliminators must prevent carry over into the unit's fan section.

g. Provide the evaporative condenser unit with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers must modulate to reduce the airflow through the evaporative condenser. Controls must include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycle a fan motor on and off in accordance with the manufacturer's instructions.

2.2.1.2.6.3 Compressor

Provide compressor rated in accordance with AHRI 540. Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide units 120,000 Btuh and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor must have an independent refrigeration circuit through the condenser and evaporator. Each compressor must start in the unloaded position. Provide each compressor with vibration isolators, crankcase heater,[lubrication pump,] thermal overloads, and [high][high and low] pressure safety cutoffs and protection against short cycling.

2.2.1.2.6.4 Fans

Provide fan wheel shafts supported by either maintenance-accessible grease lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Mount fan motor and fan assembly on a common base to allow consistent belt tension with no relative motion between fan and motor shafts. The entire fan motor and fan assembly must be completely vibrationally isolated from the unit. Select unit fans to produce the cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a [open drip-proof][totally enclosed][explosion proof] enclosure. Provide [manual] [or] [automatic-reset] type thermal overload protection. Construct fan wheels of [aluminum] [or] [galvanized steel]. Provide centrifugal fan wheel housings of galvanized steel, and construct centrifugal fan casings of [aluminum] [or] [galvanized steel]. Steel elements of fans, except fan shafts, must be [hot-dipped galvanized after fabrication] [or] [fabricated of mill galvanized steel]. Recoat mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Statically and dynamically balance [fan wheels] [or] [propellers]. Provide double inlet [forward-curved] [air foil] type fan wheels. Fan must reach rated rpm before the fan shaft passes through the first critical speed. Fans must be belt-driven with adjustable sheaves. Select the sheave size so that the fan speed at the approximate midpoint of the sheave adjustment produces the specified air quantity. Provide centrifugal scroll-type fans with streamlined orifice inlet and V-belt drive. Each drive must be

~~independent of any other drive. Condenser fans must be propeller type, direct drive, statically balanced with galvanized steel blades and permanently lubricated ball bearings. Protect condenser fan motor drive bearings with water slingers or shields. Fit all belt drives with guards where exposed to contact by personnel.~~

~~2.2.1.2.7 Filters~~

~~Provide filters of the [sectional] [or] [panel] [cleanable] type, capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. Factory supply 2.0 inch, MERV [8][13], throwaway filters. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][__] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.~~

~~2.2.2 Air-Source Unitary Heat Pumps~~

~~Provide air source unitary heat pumps with capacity up to 65,000 Btu/hr that comply with ANSI/AHRI 210/2400. Provide air source heat pumps with capacity above above 65,000 Btu/hr that comply with ANSI/AHRI 340/360.~~

~~Provide units with assembled refrigerant circuit or circuits [packaged unit][or][split system having remote outdoor section separate from indoor section]. [Provide unit with hot gas reheat.]~~

~~2.2.2.1 Energy Efficiency~~

~~Provide unitary heat pumps that bear the Energy Star label. [Heat pumps must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]~~

~~2.2.2.2 Casing~~

~~Construct the casing of zinc coated, heavy-gage (14-gage minimum) galvanized steel. Clean, phosphatize and finish exterior surfaces with a weather-resistant baked enamel finish. Test unit surfaces [500] [1,000] [_____] hours in a salt spray test in compliance with ASTM B117. Fabricate cabinet panels with lifting handles and water- and air-tight seal. Insulate all exposed vertical, top covers and base pan [1/2-inch] [1-inch] [2-inch], [matt-faced,] [fire-resistant,] [odorless,] [glass fiber material]. Surfaces in contact with the airstream must comply with requirements in ASHRAE 62.1. Provide for forklift and crane lifting the base of the unit.~~

~~2.2.2.3 Filters~~

~~Provide[1 inch][2 inch], MERV [7][8][13], throwaway filter on all units below 6 Tons. Filter rack may be converted to 2.0 inch capability. Factory supply 2.0 inch, MERV [8][13], throwaway filters on all units above 6 Tons.~~

~~2.2.2.4 Compressors~~

~~Provide direct-drive, [variable speed] [digital scroll] [hermetic scroll] type compressors with centrifugal type oil pumps. Motor must be suction gas-cooled. Use internal overloads and crankcase heaters with all~~

compressors.

2.2.2.5 Refrigerant Circuit

A minimum of two circuits are required. Provide each refrigerant circuit with independent fixed orifice or thermostatic expansion devices, service pressure ports, and refrigerant line filter driers factory installed as standard. An area must be provided for replacement suction line driers.

2.2.2.6 Evaporator and Condenser Coils

Provide internally finned, DN 10 (NPS 3/8) copper tubes mechanically bonded to a configured aluminum plate fin. Leak test the evaporator coil and condenser coil at the factory to 200 psig and pressure test to 400 psig. All dual compressor units must have intermingled evaporator coils. Provide sloped condensate drain pans.

2.2.2.7 Outdoor Fans

Direct driven, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motors must be permanently lubricated and have built-in thermal overload protection.

2.2.2.8 Indoor Fan

Provide forward-curved, centrifugal, v-belt driven fan with adjustable motor sheaves and adjustable idler-arm assembly for quick-adjustment of fan belts and motor sheaves. Thermally protect motors. Provide oversized motors for high static application.

2.2.2.9 Defrost Controls

Provide a time initiated, temperature terminated defrost system shipped with a setting of 70-minute cycle, and a choice of 50 or 90-minute cycle. Timed override limits defrost cycle to 10 minutes must be available on units from 10 to 20 tons. Provide adaptive demand defrost on units below 10 Tons.

2.2.2.10 Unit Electrical

a. Provide single point unit power connection.

b. Locate the Unit control box within the unit that contains controls for compressor, reversing valve and fan motor operation and must have a 50 VA 24-volt control circuit transformer and a terminal block for low voltage field wiring connections.

c. Wire high pressure, low temperature, and low pressure safety switches through a latching lockout circuit to hold the conditioner off until it is reset electrically by interrupting the power supply to the conditioner. All safety switches must be normally closed, opening upon fault detection.

2.2.2.11 Operating Controls

a. Provide unit with [low voltage electric controls][factory supplied DDC control system].

b. Low voltage, adjustable room thermostat to control heating and cooling

in sequence with delay between stages, compressor and supply fan to maintain temperature setting. Include system selector switch [(heat-off-cool)][(off-heat-auto-cool)][and] [fan control switch (auto-on)].

2.2.2.11.1 Unit DDC Controller

a. Unit controller must include input, output and self-contained programming as needed for complete control of unit.

d. All program sequences must be stored on board in EEPROM. Batteries cannot be used to retain logic program. Execute all program sequences by controller 10 times per second and must be capable of multiple PID loops for control of multiple devices. Programming of logic controller must be completely modifiable in the field over installed [BACnet LANs][LonWorks LANs].

e. Temperature Control System Interface: Points must be available from the unit controller for service access and display or control.

f. The wall mounted space temperature sensor must include occupied and unoccupied set point control, pushbutton unoccupied override, space temperature offset and space temperature indication. Refer to [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] for additional requirements.

2.2.2.11.2 Control System Interface

Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.2.2.12 Corrosion Protection

2.2.2.12.1 Remote Outdoor Condenser Coils

Epoxy Immersion Coating - Electrically Deposited: The multi-stage corrosion-resistant coating application comprised of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. Maintain the coating thickness between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, treat to permeate immersion rinse and spray. Where the coils are subject to UV exposure, apply UV protection spray treatment comprising

~~of UV-resistant urethane mastic topcoat. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process must be such that uniform coating thickness is maintained at the fin edges. Comply with the applicable ASTM Standards for the following:~~

~~a. Salt Spray Resistance (Minimum 6,000 Hours)~~

~~b. Humidity Resistance (Minimum 1,000 Hours)~~

~~c. Water Immersion (Minimum 260 Hours)~~

~~d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)~~

~~e. Impact Resistance (Up to 160 Inch/Pound)~~

~~2.2.2.12.2 Exposed Outdoor Cabinet~~

~~Casing Surfaces (Exterior and Interior): Protect all exposed and accessible metal surfaces with a water-reducible acrylic with stainless steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness must be 2-4 mils and provide minimum salt-spray resistance of [500][1,000][____] hours (ASTM B117) and [500][1,000][____] hours UV resistance (ASTM D4587).~~

2.2.2 DEHUMIDIFIERS

Dehumidifer shall be as indicated on plans / drawing equipment schedules. Dehumifider shall be permanenty installed (not portable) with piped connection to drain system. Unit shall be provided with adjustable control to maintain humidity levels between 35% to 65% with automatic unit operation when space conditions are within 5% of the unit setpoint. Unit shall have integral defrost cycle to prevent frost formation on the unit - when frost is detected the unit shall cease dehumidifying operations and run the fan until normal operating conditions are restored. Unit shall be provided with replacable MERV-13 filtration, provide with 2 extra filters at time of building acceptance.

2.3 COMPONENTS

2.3.1 Refrigerant and Oil

Refrigerant must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants must meet the requirements of AHRI 700 as a minimum. Provide a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil must be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge must be in accordance with manufacturer's recommendation.

~~2.3.2 Fans~~

~~Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a [open][dripproof][totally enclosed][explosion-~~

proof] enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Forward curved fan wheels must be limited to [_____] inches. Direct-drive fan motors must be of the multiple-speed variety. Belt-driven fans must have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size must be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans must be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans must be [direct-drive][V-belt] drive type with [adjustable][fixed] pitch blades. V-belt driven fans must be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields. V-belt drives must be fitted with guards where exposed to contact by personnel and [fixed pitch] [adjustable pitch] sheaves.

2.3.3 Primary/Supplemental Heating

2.3.3.1 Water Coil

Coil must conform to the provisions of AHRI 410. Coil must be fin-and-tube type constructed of seamless copper tubes and [aluminum][or][copper] fins mechanically bonded or soldered to tubes. Headers must be constructed of cast iron, welded steel or copper. Coil must be constructed to float within the casing to allow free expansion and contraction of tubing. Casing and tube support sheets must not be lighter than 16 gauge galvanized steel formed to provide structural strength. When required, multiple tube supports must be provided to prevent tube sag. Coil must be circuited for suitable water velocity without excessive pressure drop and properly pitched for drainage where required or indicated. Each coil must be tested at the factory under water at not less than 300 psi air pressure, tested hydrostatically after assembly of the unit and proved tight under a gauge pressure of 200 psi. Coil must be suitable for use with water up to 250 degrees F. Coil must allow complete coil drainage with a pitch of not less than 1/8 inch/foot slope to drain.

2.3.3.2 Steam Coil

Coil must conform to the provisions of AHRI 410. Coil must be constructed of cast semi-steel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered. Tubes must be rolled and bushed and brazed or welded into headers. Coil casings and tube support sheets, with collars of ample width, must be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports must be provided to prevent tube sag. The fin tube and header section must float within the casing to allow free expansion of tubing for coils subject to high pressure-steam service. Coils must be factory pressure tested and capable of withstanding

~~250 psi hydrostatic test pressure or 250 psi air pressure, and be for [100][200] psi steam working pressure. Preheat coils must be steam-distributing tube type. Condensing tubes must be not less than 5/8 inch outside diameter. Distribution tubes must be not less than 3/8 inch outside diameter, and be equipped with orifices to discharge steam to condensing tubes. Distribution tubes must be installed concentrically inside of condenser tubes and be held securely in alignment. The maximum length of a single coil must be limited to 120 times the diameter of the outside tube. Other heating coils must be minimum 1/2 inch outside diameter single-tube type. Supply headers must distribute steam evenly to all tubes at the indicated steam pressure. Coil must allow complete coil drainage with a pitch of not less than 1/8 inch/foot slope to drain.~~

~~2.3.3.3 Electric Heating Coil~~

~~Coil must be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be duct- or unit-mounted. Coil must be of the [nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil must be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets must be of galvanized steel or aluminum. Coil must be mounted to eliminate noise from expansion and contraction and be completely accessible for service. Supplemental Electric Resistance Heating controls must be provided to prevent operation when the heating load can be met by the primary source.~~

~~2.3.3.4 Gas-Fired Heating Section~~

~~Gas-fired heat exchanger must be constructed of aluminized steel, ceramic coated cold-rolled steel or stainless steel suitable for [natural gas][liquid propane gas] fuel supply. Burner must have direct spark or hot surface ignition. Valve must include a pressure regulator. Combustion air must be supplied with a centrifugal combustion air blower. Safety controls must include a flame sensor and air pressure switch. Heater section must be mounted to eliminate noise from expansion and contraction and must be completely accessible for service. Gas equipment must bear the AGA label for the type of service involved. Burner must be in accordance with NFPA 54.~~

~~2.3.4 Air Filters~~

~~Provide filters to filter outside air and return air and locate [as indicated] [inside air conditioners] [inside filter box] [inside combination air filter mixing box]. Provide [replaceable (throw-away)] [high efficiency] [cleanable (reusable)] type. Filters must conform to UL 900, [Class 1] [or] [Class 2]. Polyurethane filters cannot be used on units with multiframe filters.~~

~~Air filters must be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method must be as listed under the label service and must meet the requirements of UL 586.~~

~~2.3.4.1 Extended Surface Pleated Panel Filters~~

~~Filters must be 2 inch depth sectional type of the size indicated and must have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.2. Initial resistance at 500 feet/minute must not exceed~~

0.36 inches water gauge. Filters must be UL Class 2. Media must be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media must be attached to a moisture resistant fiberboard frame. Four edges of the filter media must be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.3.4.2 Replaceable Media Filters

Provide replaceable media filters of the [dry-media] [viscous adhesive] type, of the size required to suit the application. Filtering media must not be less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad must be enclosed in a holding frame of not less than 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [300][_____] feet/minute, with initial resistance of [0.13][_____] inches water gauge. Average efficiency must be not less than [_____] percent when tested in accordance with ASHRAE 52.2.

2.3.4.3 Sectional Cleanable Filters

Provide sufficient oil to coat filters six times based on 1 pint of oil per each 10 square feet of filter area. Provide washing and charging tanks for cleaning and coating filters. Filters must have a MERV of [6] [8] [_____] when tested in accordance with ASHRAE 52.2.

Cleanable filters must be [1][2] inches thick. Viscous adhesive must be provided in 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one quart for each filter section. One washing and charging tank must be provided for every 100 filter sections or fraction thereof. Each washing and charging unit must consist of a tank and [single] [double] drain rack mounted on legs. Drain rack must be provided with dividers and partitions to properly support the filters in the draining position.

2.3.4.4 High Efficiency Filters

Filters must have a MERV of 17 when tested in accordance with ASHRAE 52.2. Filter assembly must include; holding frame and fastener assembly, filter cartridge, mounting frame, and retainer assembly. Reinforce filter media with glass fiber mat. Pressure drop across clean filter shall not exceed [_____] inches of water gage. Precede high efficiency filters with a UL Class 2 replaceable type filter.

2.3.4.5 Manometers

Provide inclined-type manometers for filter stations of 2,000 cfm capacity or larger including filters furnished as integral parts of air-handling units and filters installed separately. Provide sufficient length to read at least one inch of water column with 10 major graduations, and equipped with spirit level. Equip manometers with overpressure safety traps to prevent loss of fluid, and two three-way vent valves for checking zero setting. [Mercury cannot be used as the operating fluid.]

2.3.5 Coil Frost Protection

Provide each circuit with a manufacturer's standard coil frost protection system. The coil frost protection system must use a temperature sensor in the suction line of the compressor to shut the compressor off when coil

frosting occurs. Use timers to prevent the compressor from rapid cycling.

2.3.6 Pressure Vessels

Pressure vessels must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.3.6.1 Hot Gas Muffler

Unit must be selected by the manufacturer for maximum noise attenuation. Units rated for 30 tons capacity and under may be field tunable type.

2.3.6.2 Liquid Receiver

A liquid receiver must be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver must be designed, filled, and rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver must be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves;[thermal well for thermostat;][float switch column;][external float switches;] and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be provided with a relief valve of capacity and setting in accordance with ASHRAE 15 & 34.

2.3.6.3 Oil Separator

Separator must be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator must not exceed [10][_____] psi during the removal of hot gas entrained oil. Connections to compressor must be as recommended by the compressor manufacturer. Separator must be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, [filter for removal of all particulate sized 10 microns and larger,][thermometer and low temperature thermostat fitted to thermal well,] [immersion heater,][external float valve fitted with three-valve bypass,] and strainer.

2.3.6.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Reservoir must be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header must be provided with a 5 psi pressure differential relief valve. Reservoir must be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.3.7 Internal Dampers

Dampers must be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions must be provided for each

~~outside air intake, exhaust, economizer, and mixing boxes. Dampers must [have minimum position stops][be linked together][have [manual][automatic] modulation] and operate as specified.~~

~~2.3.8 Mixing Boxes~~

~~Mixing boxes must match the base unit in physical size and must include equally-sized[flanged] openings, each capable of full air flow. Arrangement must be as indicated.~~

~~2.3.9 Cabinet Construction~~

~~Casings for the specified unitary equipment must be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces must be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing must be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness must be 20 gauge. Provisions to permit replacement of major unit components must be incorporated. Penetrations of cabinet surfaces, including the floor, must be sealed. Unit must be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan must be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071. Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING.~~

~~2.3.9.1 Indoor Cabinet~~

~~Indoor cabinets must be suitable for the specified indoor service and enclose all unit components.~~

~~2.3.9.2 Outdoor Cabinet~~

~~Outdoor cabinets must be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.~~

~~2.3.10 Condenser Water Piping And Accessories~~

~~Provide condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.~~

~~2.3.11 Refrigerant Piping~~

~~Provide refrigerant piping in accordance with Section 23 23 00 REFRIGERANT PIPING.~~

~~2.3.12 Cooling Tower~~

~~Provide cooling towers in accordance with Section 23 65 00 COOLING TOWERS.~~

2.3.2 Condensate Drain Piping

~~provide condensate drain piping in accordance with Section 23 05 15 COMMON PIPING FOR HVAC.~~
Refer to 22 00 00 Plumbing, General Purpose for condensate drain piping.

2.3.3 Ductwork

Provide ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.3.4 Temperature Controls

Temperature controls shall be ~~[~~in accordance with ~~[Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]~~[Section 23 09 23.~~02~~13 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDNG CONTROL SYSTEMS~~]][fully coordinated with and integrated into the existing air-conditioning system]~~.

~~2.4 UNITARY EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT~~

~~2.4.1 Air Economizer~~

~~Provide [down flow][horizontal flow][field][factory] installed economizer with fully modulating 0-100 percent motor and dampers, barometric relief, minimum position setting and fixed dry bulb. [Field install solid state enthalpy and differential enthalpy control.]~~

~~2.4.2 Humidifier~~

~~Provide humidifiers that meet the requirements of ANSI/AHRI 640~~

~~2.4.2.1 Steam Spray Type Humidifier~~

~~Provide steam spray humidifiers that inject steam directly into the [surrounding air][or][air stream]. [Single grid humidifiers must consist of a single copper distribution grid with pipe connection on one end and cap on the other end. Field install automatic steam control valves and condenser traps.][House enclosed grid in a copper enclosure with a built-in condensate drain connection.] [Exposed grid must be wick wrapped.][Equip package type steam spray humidifiers to trap out and to evaporate condensate and to supply dry steam to a single distribution grid. Grid must be steam jacketed and condensate drained. Unit must trap excess condensate to return system. Package type steam spray humidifiers must have modulating electric, electronic, or pneumatic steam control valve.] Steam spray humidifiers must be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.~~

~~2.4.2.2 Steam-Diffuser Type Humidifier~~

~~Provide diffuser units that separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. Materials must be [noncorrosive materials][Type 30X stainless steel].~~

2.4.2.3 Electrode Canister Type Humidifier

Provide humidifier of the self-contained steam generating electrode type utilizing a [plastic] [disposable] canister with full probes connected to electric power via electrode screw connectors. Construct the electrodes from expanded low carbon steel, zinc plated and dynamically formed for precise current control. The humidifier assembly must include integral fill cup, fill and drain valves and associated piping. Design the canister to collect the mineral deposits in the water and provide clean particle free steam to the air stream. Water chemistry requirements must be provided with humidifier submittal data.

2.4.2.4 Ultrasonic Type Humidifier

Provide self-contained ultrasonic type humidifier operating on the principle of ultrasonic nebulization of water. Make the casing of high-quality stainless steel. The ultrasonic humidifier must not produce any unacceptable noise radiation or frequency interference with communications or other electronic equipment. Water chemistry requirements must be provided with humidifier submittal data.

2.4.2.5 Gas-Fired Steam Humidifiers (Stand-Alone)

Provide a stand-alone gas-fired steam humidifier that includes an enclosed cabinet of [powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each burner, capable of modulation at a [5:1][_____] ratio must provide steam production as indicated on the HUMIDIFIER SCHEDULE. Provide burner in accordance with NFPA 54.

c. [Control system must seamlessly interface with temperature control system as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.] Ensure that all controls equipment meets the requirements of UFC 4-010-06.

2.4.2.6 Electrically Heated Steam Humidifiers (Stand-Alone)

Provide a stand-alone electrically heated steam humidifier that includes an enclosed cabinet of [powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each humidifier must operate at the voltage and provide steam production as indicated on the HUMIDIFIER SCHEDULE.

c. [Control system must seamlessly interface with temperature control system as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.] Ensure that all controls equipment meets the requirements of UFC 4-010-06.

2.4.2.7 Refrigerant Leak Detector

Provide continuously-operating, halogen-specific type refrigerant leak detector. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include [a single sampling point][[_____] sampling points] installed where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay must be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy or utility management and control system (EMCS/UMCS). The EMCS/UMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.4.2.8 Refrigerant Relief Valve/Rupture Disc Assembly

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.4.2.9 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 0.5 inches in height.

2.4.2.9.1 Installation Identification

Provide each new refrigeration system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.4.2.9.2 Controls and Piping Identification

Provide refrigerant systems containing more than 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow[, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device(s).

2.4.2.10 Heat Recovery Devices

2.4.2.10.1 Hot Air Reclaim

Provide a [built in] heat recovery unit, factory-fabricated in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.2.10.2 Hot Water Reclaim

Unit must be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit must be constructed and refrigerant pressure/temperature rated in accordance with ASHRAE 15 & 34. Heat exchanger coil must consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Cabinet must be fabricated of zinc-protected steel and be internally insulated in coil space. The recovery device must be provided with a refrigerant compressor head pressure control and a interlocked, potable water circulating pump. Pump and motor assembly must be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Pump must be mounted [remotely][integral] to the exchanger and be rated for [115][208][230] volt ac power supply.

2.4.2.11 Gaskets

Provide gaskets conforming to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.4.2.12 Bolts and Nuts

Bolts and nuts must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

~~2.4.2.13 Bird Screen~~

~~Screen must be 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.~~

2.4 FINISHES

2.4.1 Coil Corrosion Protection

Provide coil with a uniformly applied ~~[epoxy electrodeposition] [phenolic] [vinyl] [~~epoxy electrodeposition, phenolic, or vinyl~~]~~ type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum ~~1~~6,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.4.2 Equipment and Components Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand 6,000~~[125][500]~~ hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.4.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 2.5 to 3.0 mils.

2.4.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method,

provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.4.2.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

a. Total dry film thickness, 6.5 mils maximum

b. Vinyl Primer, 24 percent solids by volume: One coat 2 mils thick

c. Vinyl Copolymer, 30 percent solids by volume: One coat 4.5 mils thick

2.4.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the ~~Contracting Officer~~QC Manager of any discrepancy before performing any work.

3.2 INSTALLATION

Perform work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is

specified to conform to the requirements of ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the design, fabrication, and installation of the system must conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

Provide refrigeration equipment conforming to ASHRAE 15 & 34. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Isolate compressors from the building structure. ~~If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to [10] [10-20] [20-40] [_____] percent at lowest equipment rpm. Provide lines connected to pumps mounted on pedestal blocks with flexible connectors. Provide foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.~~ Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

~~3.2.2 Mechanical Room Ventilation~~

~~Provide mechanical ventilation systems in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.~~

3.2.2 Field Applied Insulation

Apply field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed

indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing must be as specified in Section 23 05 93.00 22 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total ~~[~~4~~8] [_____]~~ hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. Submit a schedule, at least ~~[~~2~~] [_____]~~ weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

b. Submit the field posted instructions, at least ~~[~~2~~] [_____]~~ weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

c. The posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. ~~[~~Submit ~~[~~6~~] [_____]~~ complete copies of an operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least ~~[~~4~~] [_____]~~ weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.~~]~~

d. Submit ~~[[~~6~~] [_____]~~ complete copies of maintenance manual in bound 8-1/2 by 11 inch booklets listing~~]~~ routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems must be tested and charged in accordance with the manufacturer's requirements ~~as specified in Section 23 23 00 REFRIGERANT PIPING~~. Packaged refrigerant systems which are factory charged must be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems must be tested for leaks with a halide torch or an electronic leak detector. ~~[Submit [6] [_____] copies of each test containing the information described below in bound 8-1/2 by 11 inch booklets. Individual reports must be submitted for the refrigerant system tests.]~~

~~a. The date the tests were performed.~~
~~b. A list of equipment used, with calibration certifications.~~
~~c. Initial test summaries.~~

~~d. Repairs/adjustments performed.~~
~~e. Final test results.~~

3.5.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances must the refrigerant be discharged into the atmosphere.

3.5.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. ~~[~~Six~~]~~ ~~[_____]~~ copies of the report provided in bound 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons.

a. Submit a schedule, at least ~~[~~2~~]~~ ~~[_____]~~ weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than ~~[~~48~~]~~ ~~[_____]~~ hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points. Replace any refrigerant lost during the system startup.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the ~~Contracting Officer~~QC Manager. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Coordinate field tests with Section 23 05 93.00 22 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit ~~[~~6~~] [_____]~~ copies of the report provided in bound 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart):

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.
(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.7 MAINTENANCE

3.7.1 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than ~~[~~2~~] [_____]~~ months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

3.7.2 Maintenance Service

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the

equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

-- End of Section --

SECTION 23 82 00.00 20

TERMINAL HEATING UNITS
02/16, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.8/CSA 2.6	(2016; Errata 2017) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
ANSI Z83.19/CSA 2.35	(2017) Gas-Fired High-Intensity Infrared Heaters

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 33	(2016) Method of Testing Forced Circulation Air Cooling and Air Heating Coils

ASTM INTERNATIONAL (ASTM)

ASTM A109/A109M	(2016; R 2018) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2020) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A463/A463M	(2015; R 2020; E 2020) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021 18) National Fuel Gas Code
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 90A	(2018) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2018) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	(2020) Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UNDERWRITERS LABORATORIES (UL)

UL 441	(2016; Reprint Jul 2016) UL Standard for SafetyGas Vents

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ┼

for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN-BUILD and Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-03 Product Data

Unit Heaters

Infrared Heaters

SD-10 Operation and Maintenance Data

Unit Heaters, Data Package 2

Infrared Heaters, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 UNIT HEATERS

Self-contained and factory assembled, ~~[~~propeller~~]~~ ~~[~~or~~]~~ ~~[~~centrifugal~~]~~ fan with capacities expressed as Btu per hour output and cubic foot-per-minute air delivery, operating conditions, and mounting arrangements as indicated. Average fan bearing life must be minimum 200,000 hours at operating conditions. Provide fan motor with ~~[~~direct~~]~~ ~~[~~or~~]~~ ~~[~~belt~~]~~ drive. Construct fan-guard motor mount of steel wire. Equip each heater with individually adjustable package discharge louver. Louvers may be substituted by discharge cones or diffusers. Provide thermostats ~~[~~as indicated~~]~~. Furnish circuit breaker disconnect switch.

2.1.1 Gas-Fired Unit Heater

ANSI Z83.8/CSA 2.6 and AGA label.

2.1.1.1 Casing

Minimum ~~[~~22~~]~~ ~~[_____]~~ gage ~~[~~steel~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~. Provide removable access panels.

2.1.1.2 Heat Exchanger

Minimum ~~[~~20~~]~~ ~~[_____]~~ gage all-welded steel construction with corrosion-resistant aluminum finish.

2.1.1.3 Burners

Die-formed, slot ports, and steel construction with aluminum paint.

2.1.1.4 Draft Diverter

All-welded steel construction and an integral part of each heat exchanger section. Allows backdrafts to bypass burner assembly without affecting normal operation.

2.1.1.5 Controls

Consisting of a combination pressure regulator, ~~[two-stage gas valve in 100 percent and [55] [_____] percent of full rating,]~~ main shutoff valve, pilot cock, pilot safety switch for 100 percent shutoff, high temperature limit switch, and time-delay fan switch. Include power and control connections in an integral junction box.

2.1.1.6 Efficiency

Unit heater must have a minimum combustion efficiency of 80 percent when tested in accordance with ANSI Z83.8/CSA 2.6.

~~[2.1.1.7 Accessories~~

~~Provide [propane-gas conversion kit] [automatic electric pilot recognition kit].~~

~~]2.1.2 Oil-Fired Unit Heater~~

~~UL 731 and UL labeled.~~

~~2.1.2.1 Casing~~

~~Minimum [22] [_____] gage [aluminum] [or] [[enamel] [or] [vinyl] coated steel]. Provide removable access door.~~

~~2.1.2.2 Heat Exchanger~~

~~Minimum 16 gage primary combustion chamber constructed of [perlite-clad steel] [, aluminum-clad steel] [, or] [400 series stainless steel]; minimum 14 gage secondary heating section composed of aluminized, mild, or hot-rolled steel. Provide a flame observation port on the burner side of the heater.~~

~~2.1.2.3 Burner~~

~~Provide pressure oil-atomizing burner with mechanically forced draft, suitable for fuel oil No. 2. Provide two-stage oil pump. Equip burner motor with a combustion air damper.~~

~~2.1.2.4 Controls~~

~~Include fan and limit switch, low voltage (24-volt) transformer, electronic flame safeguard with flame safety relay, and electric spark ignition.~~

~~2.1.2.5 Accessories~~

~~Provide [power exhauster,] oil filter, oil pressure regulator, and barometric damper.~~

~~2.1.2.6 Efficiency~~

~~Unit heater must have a minimum combustion efficiency of 80 percent when tested in accordance with UL 731.~~

2.1.2 ~~[Steam] [or] [~~Hot-Water~~]~~ Unit Heater

ASHRAE 33 tested for heating coils; UL listed for motor and controls.

2.1.2.1 Casing

Minimum ~~[~~20~~] [_____]~~ gage ~~[~~steel~~] [~~or~~]~~ ~~[~~aluminum~~]~~ with removable access panels or means to remove, service, and maintain major components.

2.1.2.2 Coil

Fin-and-tube coil constructed of ~~[~~copper~~,] [red brass,] [90-10 copper-nickel,] [or] [steel]~~ tubes and ~~[~~copper~~] [~~or~~]~~ ~~[~~aluminum~~]~~ fins. ~~Use maximum design pressure of [steam at [_____] pounds per square inch gage (psig)] [and] [hot water at [_____] psig and [_____] degrees F]~~.

2.1.2.3 Controls

~~[~~Automatic controls of ~~[modulating] [on-off-auto] [or] [~~combination of modulating and on-off-auto~~]~~ system~~]~~ ~~[~~aAs indicated~~]~~. ~~[Provide a three-position selector switch.]~~

2.1.3 Electric Unit Heater

UL listed; wattage, voltage, phase, and number of steps as indicated. Provide control-circuit terminals and single source of power supply. Heater 5 Kw and larger must be three-phase, with load balanced on each of the three phases. Limit leaving air temperature below 140 degrees F at 60 degrees F entering air.

2.1.3.1 Casing

Minimum ~~[~~21~~] [_____]~~ gage steel.

2.1.3.2 Heating Element

Nickel-chromium heating wire element, free from expansion noise and 60 Hz hum. Embed element in magnesium-oxide insulating refractory. Seal element in high-mass steel or corrosion-resisting metallic sheath with fins. Enclose element ends in terminal box. Space fins at maximum six fins per inch. Limit fin surface temperature 550 degrees Fat any point during normal operation.

2.1.3.3 Controls

Include limit controls for thermal overheat protection of heaters. For remote thermostatic operation, provide contactor rated for 100,000 duty cycles. ~~[Provide a control transformer to supply 120-volt thermostat control circuit for each heater.]~~ Provide room thermostat for pilot duty.

2.1.3.4 Wiring

Completely factory-prewired to terminal strips, ready to receive branch circuit and control connections for 140 degrees F ~~[~~copper~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~ wiring.

~~[2.1.3.5 Accessories~~

~~Provide fan switching devices to independently operate fan motor for~~

summer ventilation and winter heat recovery.

]2.2 INFRARED HEATERS

[Reflector-beam spread] [and] Operating conditions as indicated. Provide pre-wired control boxes, thermostats, and reflector [and duct] hangers.

2.2.1 Sheet Metal

[a. Aluminum-Clad Steel: ASTM A463/A463M, nominal thickness of minimum 16 gage for radiant tubing between burners and vacuum pump or vent.

]b. Aluminum: ASTM B209, manufacturer's standard thickness.

]c. Stainless Steel: ASTM A240/A240M, nominal thickness of not less than 20 gage.

]d. [Ceramic-Coated or] [Enamel-Coated] Steel: ASTM A1011/A1011M hot rolled or ASTM A109/A109M cold rolled, low-carbon steel. Provide coating able to withstand infrared heater operating temperatures.

]2.2.2 Unvented Gas Infrared Heater

ANSI Z83.19/CSA 2.35 and AGA approved.

2.2.2.1 Heating Element

Perforated ceramic capable of withstanding thermal shock in [3] [_____] minutes from 2000 to 32 degrees F without fatigue and of minimum 1600 degrees F operating temperature. When re-radiating screens are used to obtain operating temperature, provide [stainless-steel] [or] [chromized-steel] matching screen.

2.2.2.2 Reflector

[Polished [aluminum] [stainless steel]] [or] [approved high infrared reflector materials]. Provide reflector supports of manufacturer's standard.

2.2.2.3 Controls

Provide either an intermittent pilot ignition system or a solid-state direct ignition system. Provide automatic gas safety valve capable of withstanding a 10 percent voltage fluctuation.

2.2.2.4 Ventilation

Section 23 30 00 HVAC AIR DISTRIBUTION.

2.2.2 Vented Gas Infrared Heater

ANSI Z83.19/CSA 2.35 with AGA label, [single-burner power vented] [single-burner vacuum vented] [or] [multiple-burner vacuum vented].

2.2.2.1 Vent

NFPA 54 and NFPA 211, [Type 316 stainless steel] [or] [high-temperature corrosion-resistant plastic rated for minimum 400 degrees F]. Vent flue gas to outdoors by induced draft.

2.2.2.2 Reflector

[Polished [aluminum] [stainless steel]] [or] [approved high infrared reflector materials]. Provide manufacturer's standard reflector supports.

2.2.2.3 Heat Exchanger and Combustion Chamber

Construct heat exchanger and combustion chamber of [aluminum-clad steel] [ceramic-coated steel] [or] stainless steel.

2.2.2.4 Controls

Incorporate either an intermittent pilot ignition system or a solid-state direct ignition system. Provide safety air-flow switch for each burner.

2.2.2.5 Fan or Vacuum Pump

Heater manufacturer's standard.

~~2.2.2.6 Performance~~

~~Provide sufficient radiant heating surface to attain a minimum steady-state thermal efficiency of [80] [85] percent and a maximum heat release of [2,750] [2,900] [2,100] Btu per square foot.~~

~~2.2.3 Electric Infrared Heater~~

~~Self-contained, factory assembled, and UL listed and including the heating element, reflector, heater housing, mounting brackets, element holders, wire guards, and high-temperature internal wiring.~~

~~2.2.3.1 Heating Element~~

~~Minimum 3/8 inch diameter quartz tube or metal sheath with coiled resistor wire. Element operating temperature range must be 1200 to 1800 degrees F.~~

~~2.2.3.2 Heater Housing~~

~~[Weatherproof] [aluminum-clad steel] [stainless-steel] [aluminum] [or] [low-carbon steel] construction. Provide a baked enamel finish over a corrosion-resistant primer. Provide a chrome-plated or stainless-steel wire guard to prevent heating elements from accidental damage. Furnish swivel brackets to position heater in any horizontal angle.~~

~~2.2.3.3 Reflector~~

~~Polished [aluminum] [or] [stainless steel].~~

~~2.2.3.4 Wiring~~

~~Fully enclosed internal wiring. Provide minimum 6 inch slack fixture (heater) wire for connection to branch circuit wiring.~~

~~[2.2.3.5 Accessories~~

~~Provide electric-clock controller with self-starting synchronous motors and snap acting switch, rated for 125 percent of the load which it controls. Provide a 30-second time cycle with an infinitely adjustable~~

~~"on-off" period each cycle. Equip controller with external indicating knob for manual adjustment from zero to 100 percent. If surface mounted, furnish steel enclosure with a baked enamel finish over a corrosion-resistant primer. If flush mounted, furnish galvanized steel enclosure with knockouts for conduit in bottom and sides. Provide a connection wiring diagram on the inside cover of the enclosure. Where loads exceed the maximum available rating of controller, provide high duty-cycle contactors serving as pilot devices.~~

~~]~~2.3 FAN

Provide ~~[~~steel~~]~~ ~~[~~or~~]~~ ~~[~~aluminum~~]~~ fans with ball or roller bearings for motors over 1/8 horsepower (hp) and sleeve bearings for motors 1/8 hp and under. Provide sleeve bearings with oil reservoir, if not permanently lubricated.

2.4 MOTOR AND STARTER

NEMA MG 1, and NEMA ICS 2, and NEMA ICS 6, respectively. ~~[Provide explosion-proof motors and motor starters where indicated.]~~ Provide continuous-duty motor with built-in automatic reset thermal overload protection. For motor 1/2 hp and larger, use three-phase. Provide single-phase motor of permanent split capacitor or capacitor start. Limit motor speed at 1800 r/min. Wire motor to heater power supply source.

~~[2.5 NOISE, VIBRATION AND SEISMIC CONTROLS~~

~~Section 22 05 48.00 20 MECHANICAL SOUND VIBRATION AND SEISMIC CONTROL.~~

~~][~~2.5 GAS PIPING SYSTEM AND FLUE VENT

Comply with Section 23 11 20 FACILITY GAS PIPING~~, Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM DISTRIBUTION PIPELINES,~~ for gas valves and piping. Use UL 441 flue vents ~~[~~and~~]~~ ~~[~~gas-vent roof jacks~~]~~, of ~~[~~galvanized steel~~,]~~ ~~[~~aluminum~~,]~~ ~~[~~or~~]~~ ~~[~~stainless steel~~]~~.

~~][2.6 FUEL OIL [TANK] AND PIPING SYSTEM~~

~~Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).~~

~~][~~2.6 HOT WATER PIPING SYSTEM

Section 23 21 13.00 20 LOW TEMPERATURE WATER ~~[~~(LTW~~]~~) HEATING SYSTEMS.

~~][2.7 STEAM AND CONDENSATE PIPING SYSTEM~~

~~Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS.~~

~~]~~2.7 SOURCE QUALITY CONTROL

Special protection is not required for equipment that has a zinc coating conforming to ~~[~~ASTM A123/A123M~~]~~ or ~~[~~ASTM A653/A653M~~]~~. Otherwise, protect affected equipment items by manufacturers' corrosion-inhibiting coating or paint system that has proved capable of withstanding salt-spray test in accordance with ASTM B117. Test indoor and outdoor equipment for 125 hours; test outdoor equipment used in a marine atmosphere for 500 hours. For each specimen, perform a scratch test as defined in ASTM D1654.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment where indicated and as recommended by manufacturer's recommendations, NFPA 54, NFPA 90A, NFPA 90B, NFPA 91 and NFPA 211.

3.1.1 Suspensions of Equipment

Provide equipment supports including beam clamps, turnbuckles and twist links or weld-wire chains, wire ropes with rope clips and rope thimbles, threaded-eye rod hangers with lock nuts and heat-duct hangers, threaded-eye bolts with expansion screws, brackets, platform and mounting frame, and vibration isolators. Locate equipment in such a manner that working space is available for servicing, such as vacuum pump and burner removal, access to automatic controls, and lubrication. Provide electrical isolation of dissimilar metals. Clean interior of casings or cabinets before and after completion of installation.

3.1.2 Vents

NFPA 54 and NFPA 211. Provide vents with weatherproofing flashings in accordance with Section 07 60 00 FLASHING AND SHEET METAL.

3.1.3 Electrical Work

NFPA 70 and Division 26, "ELECTRICAL." When replacing original control wires, provide No. 16 AWG with minimum 105 degrees C insulation.

3.2 FIELD QUALITY CONTROL

Administer, schedule, and conduct specified tests. Furnish personnel, instruments and equipment for such tests. Correct defects and repeat the respective inspections and tests. Conduct inspections and testing in the presence of the ~~Contracting Officer~~QC Manager.

3.2.1 Test Instruments and Apparatus

Provide instruments and apparatus currently certified as being accurate to within one percent of their full scale. Use gages with a maximum scale between 1 1/2 and 2 times test pressure.

3.2.2 Field Inspection

Prior to initial operation, inspect equipment installation to ensure that indicated and specified requirements have been met.

3.2.3 Field Tests

3.2.3.1 Fuel Piping Pressure Tests

~~[~~Pneumatically test gas piping at 1 1/2 times operating pressure and check for leakage with soap solution.~~] [Hydrostatically test fuel oil piping at 1 1/2 times maximum working pressure.]~~

3.2.3.2 Fire Tests for Nonelectrical Heating Equipment

Test combustion controls and equipment with specified fuel at 100 percent full rated load. During tests, verify proper operation of controls.

Adjust burners for maximum efficiency using Orsat or similar apparatus. Maintain firing for at least four hours~~[~~, and where high-low-off combustion controls are provided, operate the heating equipment for one hour at low fire and 3 hours at high fire~~]~~. For acceptable combustion efficiency, allow maximum 4.5 percent carbon dioxide in flue gases.

3.2.3.3 Insulation-Resistance Tests for Electrical Equipment

At the completion of wiring, test 600 volt wiring to verify that no short circuits exist before or after the attachment of electrical heating equipment to the power source. Make tests with an instrument which applies a voltage of approximately 500 volts for a direct reading of insulation resistance.

3.2.3.4 Operational Tests

After completing fire tests and insulation-resistance tests, operate equipment continuously under varying load conditions to verify functioning of combustion controls, electrical controls, flame safeguard controls, safety interlocks, and specified operating sequence. Run each test for a minimum period of one hour.

-- End of Section --

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SECTION 25 05 11

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS
05/21

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

{1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: HVAC control systems{_____}.

}1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the {Contracting Officer Representative }[_____] to determine which requirement applies to the project.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Aministrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch. ~~For Fire Protection systems this includes fire alarm control panels, remote operating consoles, and remote annunciators.~~

1.4.4 Mission Space

~~[~~A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.~~][Mission space is shown on the drawings.]~~

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.8.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.10 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.11 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its

user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.11.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

1.4.11.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.11.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.11.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.11.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.11.3.4 View-Only User Interface

See Read-Only User Interface

1.4.11.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.11.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.11.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. ~~Full User interfaces for Fire Alarm Systems are privileged user interfaces as indicated and shown, or when another requirement of this Section establishes they are privileged. For all other systems,~~ Full

User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

~~e. For Fire Protection Systems, User Interfaces that can inhibit or force the activation of a fire suppression system (e.g. such as for a pre-action or deluge system) are privileged user interfaces.~~

~~f. Writeable User Interfaces in Electronic Security Systems (ESS) are privileged user interfaces.~~

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.12 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and IR.

1.4.13 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with Enrique J Segoviano: 910-450-7577 ~~[The Contracting Office Representative (COR)][_____]~~.

a. Government Computer Access Point of Contact: ~~[~~The Contracting Office Representative (COR)~~][_____]~~

b. HTTPS Certificate Point of Contact: ~~[~~The Contracting Office Representative (COR)~~][_____]~~

c. Email Address Point of Contact: ~~[~~The Contracting Office Representative (COR)~~][_____]~~

d. Password Point of Contact: ~~[~~The Contracting Office Representative (COR)~~][_____]~~

e. Mobile Code Point of Contact: ~~[~~ The Contracting Office Representative (COR)~~][_____]]~~

f. PKI Infrastructure Point of Contact: ~~[~~ The Contracting Office Representative (COR)~~][_____]]~~

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

h. Passwords must be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When~~

~~used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

~~[~~ Wireless and Wired Broadcast Communication Request; G~~[, [_____]]~~

~~]~~ Device Account Lock Exception Request; G~~[, [_____]]~~

Multiple Ethernet Connection Device Request; G~~[, [_____]]~~

Contractor Computer Cybersecurity Compliance Statements; G~~[, [_____]]~~

Contractor Temporary Network Cybersecurity Compliance Statements; G~~[, [_____]]~~

Cybersecurity Interconnection Schedule; G~~[, [_____]]~~

~~Protection of Information At Rest Proposal; G[, [_____]]~~

Proposed STIG and SRG Applicability Report; G~~[, [_____]]~~

SD-02 Shop Drawings

Network Communication Report; G~~[, [_____]]~~

Cybersecurity Riser Diagram; G~~[, [_____]]~~

SD-03 Product Data

Control System Cybersecurity Documentation; G~~[, [_____]]~~

SD-06 Test Reports

~~[~~

Wireless Communication Test Report; G~~[, [_____]]~~

~~]~~

Control System Cybersecurity Testing Procedures; G~~[, [_____]]~~

Control System Cybersecurity Testing Report; G~~[, [_____]]~~

SD-07 Certificates

Software Licenses; G~~[, [_____]]~~

SD-11 Closeout Submittals

~~[~~ Confidential Password Report; G~~[, [_____]]~~

~~]~~~~[~~ Password Change Summary Report; G~~[, [_____]]~~

~~]~~ Enclosure Keys; G~~[, [_____]]~~

Software and Configuration Backups; G~~[, [_____]]~~

Auditing Front End Software; G[, [_____]]

Device Audit Record Upload Software; G[, [_____]]

System Maintenance Tool Software; G[, [_____]]

Control System Scanning Tools; G[, [_____]]

STIG, SRG and Vendor Guide Compliance Result Report; G[, [_____]]

Control System Inventory Report; G[, [_____]]

[Integrity Verification Software; G[, [_____]]

1.7 QUALITY CONTROL

[1.7.1 Regulatory Requirements

For the [_____] control system: [_____].

][1.7.2 [Certifications][Qualifications]

For the [_____] control system: [_____].

][1.7.3 Pre-Construction Testing

For the [_____] control system: [_____].

][1.8 DELIVERY, STORAGE, AND HANDLING

[_____]

]1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

[1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer

Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. [For communication with other authorized systems also provide the Foreign Destination and POC for Destination.] For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

]1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-003075; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, SC-8 and SC-41 including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Control System Inventory report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all [networked devices, including network infrastructure devices][devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators)]. For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in ~~[~~one-line format~~][one-line format overlayed on a facility schematic][tabular format][_____]~~.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5 (a),(b),(c); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Software Applications

For all software applications running on computers provide:

a. administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}

b. administrator documentation that describes secure installation of the software {For Government Reference Only: relates to CCI-003125}

c. administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}

d. administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}

e. administrator documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software {For Government Reference Only: relates to CCI-003128}

f. user documentation that describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. user documentation that describes methods for user interaction which enables individuals to use the software in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. user documentation that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}

1.8.8.2 For HVAC Control System Devices

1.8.8.2.1 HVAC Control System Devices FULLY Supporting User Accounts

For all HVAC Control System Devices which FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no

user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}

f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.8.8.2.2 All Other HVAC Control System Devices

For all HVAC Control System Devices which do not FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}

c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

~~1.8.8.3 For Lighting Control System Devices~~

~~1.8.8.3.1 Lighting Control System Devices FULLY Supporting User Accounts~~

~~For all Lighting Control System Devices which FULLY support user accounts, provide:~~

~~a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}~~

~~b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}~~

~~c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}~~

~~d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}~~

~~e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}~~

~~f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}~~

~~1.8.8.3.2 All Other Lighting Control System Devices~~

~~For all Lighting Control System Devices which do not FULLY support user accounts, provide:~~

~~a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}~~

~~b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}~~

~~c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}~~

~~[1.8.8.4 [_____] Control System Devices~~

~~[_____]~~

~~]~~1.8.8.3 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the ~~{~~Government~~}[project site][_____]~~ for a period ~~{~~of no less than 5 years~~}[___]~~, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, SA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special

character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

~~c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.[~~

c. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.~~]~~[

~~d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819]~~[

~~e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.]~~[

~~f. Support authentication via RADIUS server (for management and 802.1x)]~~[

~~g. Support IEEE 802.1x network login.]~~

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.~~[~~

~~d. Support the ability to lock configuration capability to a dedicated management port.]~~

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

~~2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS~~

~~{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}~~

~~All computer-based databases must use [Microsoft SQL Server][or][Oracle][or][MySQL]. All computer-based web interfaces must use [Internet Information Services (IIS)][or][Apache] as the web server.~~

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with requireed functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

~~3.2.1 Information Flow Enforcement In MODERATE Impact Systems~~

~~{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}~~

~~Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.~~

~~3.2.2 Wireless and Wired Broadcast Communication for Fire Protection Systems~~

~~The use of wireless and wired broadcast communication for fire protection systems within a facility is prohibited. Wireless communication may be used to provide communication from the fire protection system in a facility to the central monitoring station. [Communication between the fire protection system and the central monitoring station must be via FIPS 140-2 certified devices.]~~

~~[~~3.2.1 Wireless and Wired Broadcast Communication ~~for Systems Other than Fire Protection Systems~~

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-002252}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication. ~~[If requesting authorization for wireless or wired broadcast communication, wired broadcast media such as powerline carrier is preferred to wireless.]~~

3.2.1.1 Wireless and Wired Broadcast IP Communications

~~[Unless specifically approved and installed in accordance with the project site requirements,]~~Do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

3.2.1.2 Non-IP Wireless Communication

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

~~For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.~~

3.2.1.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the

device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

~~3.2.1.4 Wireless Communication Testing~~

~~As part of [Performance Verification Testing (PVT)][Functional Performance Testing (FPT)][___], conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.~~

~~To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is [the building exterior walls][the facility fence line][_____]. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.~~

~~]~~3.2.2 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.3 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. ~~For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095~~}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

~~For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.~~

3.2.3.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.3.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so

is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.4 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.~~[~~

~~For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that [all][IP][_____] network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.]~~

3.2.5 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. ~~For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.~~}

All computers must support ~~[and implement]~~IEEE 802.1x for device authentication to the network.

3.2.5.1 For HVAC Control System Devices

Devices using HTTP as a control protocol must use HTTPS instead. ~~[Devices using Ethernet must support IEEE 802.1x.][Devices using Fox Protocol must support IEEE 802.1x.][Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.]~~

~~3.2.5.2 For Lighting Control System Devices~~

~~Devices using HTTP as a control protocol must use HTTPS instead. [Devices using Fox Protocol must support IEEE 802.1x.][Devices using Ethernet must support IEEE 802.1x.][Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.]~~

~~[3.2.5.3 [_____] Control System Devices~~

~~[_____]~~

~~]~~3.2.5.2 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: ~~[Devices using Ethernet must support IEEE 802.1x.]~~Devices using HTTP as a control protocol must use HTTPS instead.

3.2.6 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-002235, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. ~~For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.~~}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Computers

All computer operating systems must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers shall not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no

interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.2.1 HVAC Control Systems

User Interface Requirements for LOW Impact HVAC Control Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	~~[~~None Required~~][MINIMALLY]~~
Local Limited, Privileged	~~[~~MINIMALLY~~][Physical Security]~~
Local Full	MINIMALLY
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY

User Interface Requirements for LOW Impact HVAC Control Systems	
User Interface Type	**Access Control Requirement**
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

~~User Interface Requirements for MODERATE Impact HVAC Control Systems~~

~~**User Interface Type**~~	~~**Access Control Requirement**~~ ~~(See note 3)~~
~~Local Read Only (see note 1)~~	~~None Required~~
~~Local Limited, Non-privileged~~	~~[None Required][MINIMALLY]~~
~~Local Limited, Privileged~~	~~[MINIMALLY and Physical Security][FULLY]~~
~~Local Full~~	~~MINIMALLY and Physical Security~~
~~Remote Read Only~~	~~[None Required][MINIMALLY]~~
~~Remote Limited, Non-Privileged~~	~~FULLY~~
~~Remote Limited, Privileged~~ ~~AND~~ ~~Remote Full (see note 2)~~	~~FULLY~~
~~Notes:~~ ~~1)Local Read Only User Interfaces are always Non-Privileged~~ ~~2)Remote Full User Interfaces are always Privileged~~ ~~3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")~~	

~~3.3.1.2.2 Lighting Control Systems~~

~~User Interface Requirements for LOW Impact Lighting Control Systems~~

~~**User Interface Type**~~	~~**Access Control Requirement**~~
~~Local Read Only (see note 1)~~	~~None Required~~
~~Local Limited, Non-privileged~~	~~[None Required][MINIMALLY]~~
~~Local Limited, Privileged~~	~~[MINIMALLY][Physical Security]~~
~~Local Full~~	~~MINIMALLY~~

User Interface Requirements for LOW Impact Lighting Control Systems	
User Interface Type	**Access Control Requirement**
Remote Read Only	None Required
Remote Limited, Non Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

User Interface Requirements for MODERATE Impact Lighting Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY and Physical Security][FULLY]
Local Full	MINIMALLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.3 Electronic Security Systems (ESS)

User Interface Requirements for LOW Impact Electronic Security Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	[KEY][MINIMALLY]
Local Limited, Non privileged	NA

User Interface Requirements for LOW Impact Electronic Security Systems	
User Interface Type	**Access Control Requirement**
Local Limited, Privileged	[MINIMALLY and KEY][FULLY]
Local Full	FULLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non Privileged 2)Remote Full User Interfaces are always Privileged	

User Interface Requirements for MODERATE Impact Electronic Security Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	[KEY][MINIMALLY]
Local Limited, Non privileged	NA
Local Limited, Privileged	FULLY
Local Full	FULLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

~~3.3.1.2.4 Fire Protection Systems~~

~~User Interface Requirements for LOW Impact Fire Protection Systems~~	
~~**User Interface Type**~~	~~**Access Control Requirement**~~
~~Local Read Only (see note 1)~~	~~None Required~~
~~Local Limited, Non-privileged~~	~~[None Required][KEY or MINIMALLY]~~
~~Local Limited, Privileged~~	~~KEY and Physical Security~~
~~Local Full~~	~~KEY~~
~~Remote Read Only~~	~~None Required~~
~~Remote Limited, Non-Privileged~~	~~MINIMALLY~~
~~Remote Limited, Privileged AND Remote Full~~	~~FULLY~~
~~Notes: 1)Local Read Only User Interfaces are always Non-Privileged~~	
~~User Interface Requirements for MODERATE Impact Fire Protection Systems~~	
~~**User Interface Type**~~	~~**Access Control Requirement** (See note 2)~~
~~Local Read Only~~	~~None Required~~
~~Local Limited, Non-privileged~~	~~[None Required][KEY or MINIMALLY]~~
~~Local Limited, Privileged~~	~~[KEY and Physical Security][FULLY]~~
~~Local Full~~	~~KEY~~
~~Remote Read Only~~	~~[None Required][MINIMALLY]~~
~~Remote Limited, Non-Privileged~~	~~FULLY~~
~~Remote Limited, Privileged AND Remote Full~~	~~FULLY~~
~~Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")~~	

[3.3.1.2.5 [_____] Control Systems

User Interface Requirements for LOW Impact [_____] Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	[_____]
Local Limited, Non-privileged	[_____]
Local Limited, Privileged	[_____]
Local Full	[_____]
Remote Read Only	[_____]
Remote Limited, Non-Privileged	[_____]
Remote Limited, Privileged AND Remote Full (see note 2)	[_____]
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

User Interface Requirements for MODERATE Impact [_____] Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only	[_____]
Local Limited, Non-privileged	[_____]
Local Limited, Privileged	[_____]
Local Full	[_____]
Remote Read Only	[_____]
Remote Limited, Non Privileged	[_____]
Remote Limited, Privileged AND Remote Full (see note 2)	[_____]

User Interface Requirements for MODERATE Impact [_____] Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Notes: 1)Local Read Only User Interfaces are always Non Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

]3.3.1.2.2 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for LOW Impact Control Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	[None Required][MINIMALLY]
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY][Physical Security]
Local Full	[MINIMALLY][FULLY]
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	[None Required][MINIMALLY]
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY and Physical Security][FULLY]

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Full	[MINIMALLY and Physical Security][FULLY]
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity .

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support

accounts ~~[are not required to lock based on unsuccessful logon attempts] [must lock the user account [after [five][_____] consecutive failed login attempts][_____] and must unlock the user account after [15][_____] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account]~~.

~~For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account account[after [five][_____] consecutive failed login attempts][_____] and must unlock the user account after [60][_____] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.~~

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when ~~[~~three~~][_____]~~ unsuccessful logon attempts occur within a ~~[~~15 minute~~][_____]~~ interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for ~~[~~1 hour~~][_____]~~ and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

~~[~~There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.~~][The following high availability interfaces are exempt from unsuccessful logon attempts requirements:~~

~~High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements~~

~~User Interface~~	~~Location~~	~~Action to take in lieu of locking screen~~
~~[_____]~~	~~[_____]~~	~~[_____]~~
~~[_____]~~	~~[_____]~~	~~[_____]~~
~~[_____]~~	~~[_____]~~	~~[_____]~~

~~]~~

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

~~3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:~~

~~{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}~~

~~3.3.4.1 Session Termination~~

~~When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.~~

~~Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.~~

~~3.3.4.2 Session Lock~~

~~When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.~~

~~Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface shall be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.~~

~~3.3.4.3 Session Lock and Termination for Computers~~

~~[Except as shown in the Session Lock and Session Termination Exception Table,]User Interface sessions provided by computer operating systems~~

must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after [15][___] minutes of inactivity, and Session Termination must occur after [30][___] minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to [1][_____].

[Except as shown in the Session Lock and Session Termination Exception Table,]Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination[and session lock. Session lock may be initiated by user initiation or automatically after [15][___] minutes of inactivity]. In addition, remote User Interface sessions must also initiate Session Termination after [30][_____] minutes of inactivity [unless otherwise indicated in the Session Lock and Termination Exceptions table].

3.3.4.4 Session Lock and Termination for Controllers

[Except as shown in the Session Lock and Session Termination Exception Table,]Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after [30][___] minutes of inactivity.

[Except as shown in the Session Lock and Session Termination Exception Table,]Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination[, unless otherwise indicated in the Session Lock and Termination Exceptions table], with Session Termination initiated at [30][___] minutes of inactivity.[They must also support session lock, where session lock may be initiated by user initiation or automatically after [15][___] minutes of inactivity.]

[3.3.4.5 Session Lock and Termination Exceptions

Table: Session Lock and Termination Exceptions		
Device	**Location**	**Session Lock and Termination Requirements for Device (or "none" to indicate session lock or session termination is not required)**
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]3.3.4 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before

allowing any actions[except read-only actions] by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.5 Pysical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.5.1 Physical Security for Media

3.3.5.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.5.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.5.1.3 Physical Security for Non-Network Media in Fire Protection Systems

For Fire Supression Systems which can be be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.

3.3.5.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.5.2.1 Physical Security for Devices in Fire Protection Systems

For Fire Supression systems with a release panel, install all components of the supression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.

3.3.5.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceeding paragraphs of this Section.

[3.3.5.4 Additional Physical Security for Confidentiality of User Interfaces and Printers

For each user interface or printer indicated in the "User Interfaces and

Printers Requiring Additional Security Controls" table, implement the additional confidentiality controls indicated.

User Interfaces and Printers Requiring Additional Security Controls		
User Interface or Printer	Location	Additional Confidentially Control to be Implemented
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]3.3.5 Enclosures

Prior to final acceptance of the sytsem, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

[For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.]

For MODERATE Impact Systems:[User interfaces provided by computer operating systems must implement multifactor authentication via PIV.][User interfaces supporting accounts (FULLY or MINIMALLY) on computers must implement multifactor authentication via PIV.][Devices with

writable remote user interfaces must implement multifactor authentication via PIV.][Devices with Privileged Remote User Interfaces must implement multifactor authentication via PIV.] Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.2.1 HVAC Control Systems Devices

[No additional system specific requirements apply.][User Interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.]

3.4.2.2 Lighting Control Systems Devices

[No additional system specific requirements apply][User Interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.]

3.4.2.3 Electronic Security System Devices

User interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.[Other user interfaces which FULLY support accounts must use multifactor authentication via PIV.][User interfaces which MINIMALLY support accounts must use either passwords or multifactor authentication via PIV.]

[3.4.2.4 [_____] Control System Devices

[_____]

]3.4.3 User Identification and Authentication for Specific Devices

[There are no additional device specific user interface requirements][Additional user identification and authentication requirements are defined in the TABLE.

TABLE: Additional Device Specific User Identification and Authentication Requirements

User Interface Device or Description	Identification and Authorization Requirements
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

TABLE: Additional Device Specific User Identification and Authentication Requirements	
User Interface Device or Description	**Identification and Authorization Requirements**
[_____]	[_____]

]
[3.4.3.1 [_____]

[_____]

]

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a minimum lifetime of 24 hours.

g. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password must differ from previous five passwords, where differ is

defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of ~~[~~four~~][_____]~~ characters.

3.4.5.5 Password Configuration and Reporting

~~[For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.~~

~~Do not provide the Password Summary Report in electronic format. Provide [two][_____] hardcopies of the Password Summary Report, each copy in its own sealed envelope.~~

~~][~~For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.
~~]~~

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

~~[3.4.7 Implementation of PKI Infrastructure in MODERATE Impact Systems~~

~~Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.~~

~~]~~3.5 CYBERSECURITY AUDITING

Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, configure the system for these notifications for future support of outgoing email.

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-13(3), AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-00133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. ~~For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488~~}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Privileged activities or other system level access

e. Concurrent logons from different workstations

f. Successful and unsuccessful accesses to objects

g. All program initiations

h. All direct access to the information system

i. All account creations, modifications, disabling, and terminations.

~~For MODERATE Impact Systems, also provide email notification when these audit events occur.~~

j. All kernel module load, unload, and restart

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred

b. When the event occurred

c. Where the event occurred

d. The source of the event

e. The outcome of the event

f. The identity of any individuals or subjects associated with the event

~~h. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command~~

~~For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.~~

3.5.1.2 For HVAC Control System Controllers

3.5.1.2.1 HVAC Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller

b. Successful logouts

c. All account creations, modifications, disabling, and terminations. ~~For MODERATE Impact Systems, also provide email notification when these audit events occur.~~

d. All controller shutdown and startup

~~e. For privileged user interfaces in MODERATE Impact Systems: All user commands.~~

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. the identity of any individuals or subjects associated with the event

~~d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.~~

~~For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.~~

3.5.1.2.2 Other HVAC Control System Controllers

There are no requirements to perform auditing at HVAC field controllers that do not FULLY support accounts.

~~3.5.1.3 For Lighting Control System Controller~~

~~3.5.1.3.1 Lighting Control System Controllers FULLY Supporting User Accounts~~

~~For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.~~

~~3.5.1.3.1.1 Audited Events~~

~~Configure each controller to audit the following events:~~

~~a. Successful and unsuccessful logon attempts to the controller~~

~~b. Successful logouts~~

~~c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.~~

~~d. All controller shutdown and startup~~

~~e. For privileged user interfaces in MODERATE Impact Systems: All user commands.~~

~~3.5.1.3.1.2 Audit Event Information To Record~~

~~Configure each controller to record, for each auditable event, the following information (where applicable to the event):~~

~~a. what type of event occurred~~

~~b. when the event occurred~~

~~c. the identity of any individuals or subjects associated with the event~~

~~d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.~~

~~For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation~~

~~3.5.1.3.2 Other Lighting Control System Controllers~~

~~There are no requirements to perform auditing at Lighting field controllers that do not FULLY support accounts.~~

~~[3.5.1.4 [_____] Control System Controllers~~

~~[_____]~~

~~]~~3.5.1.3 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.3.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.3.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. ~~For MODERATE Impact Systems, also provide email notification when these audit events occur.~~

f. All kernel module load, unload, and restart

~~g. For privileged user interfaces in MODERATE Impact Systems: All user commands.~~

3.5.1.3.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

~~g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.~~

~~For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation~~

3.5.1.3.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. ~~For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.~~}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: ~~[~~none~~][_____]~~. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license ~~[~~for subsequent Government installation~~][and install the software on [_____]][the control system front end computer in [_____]]~~ Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over

the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

~~3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems~~

~~The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.~~

~~3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems~~

~~{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}~~

~~Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to [2][_____] seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.~~

~~The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.~~

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide ~~[~~60 ~~][_____]~~ days worth of secure local storage, assuming ~~[~~10~~][_____]~~ auditable events per day.~~[~~

~~c. For computers, provide storage for at least [_____] audit records.]~~

~~3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems~~

~~{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}~~

~~Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.~~

3.5.4.1 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

~~[When Device Audit Record Upload Software is capable of uploading audit logs over the network, install Device Audit Record Upload Software on the same computer as the Auditing Front End Software.]~~ Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing must provide email notification~~[and must [_____]]~~. ~~For MODERATE Impact systems, the computer must also notify the associated auditing front end software.~~ In case of an audit failure, if possible, continue to collect audit records by ~~[~~overwriting existing audit records~~][_____]~~.

~~For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device must notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by [overwriting existing audit records][_____] if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.~~

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-00382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. ~~For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380,~~

~~CCI-00382, CCI-001761, CCI-001762~~}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

~~For Lighting Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required.~~

For Other Control Systems: For LOW Impact Systems: ~~[Do not provide devices with remote user interfaces or with full user interfaces where one was not required.] [~~Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.~~]~~

~~For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.~~

~~Unless specifically required by the government, do not provide a capability to update device firmware over the network.~~

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

~~For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software that is not specifically required to meet contract requirements.~~

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection~~ and Application Partitioning In MODERATE Impact Systems:~~

{For Government Reference Only: This subpart relates to SC-5, SC-39,

SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. ~~For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.~~}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. ~~For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.~~

~~3.7.2.1 Network Reliance in MODERATE Impact HVAC Control Systems~~

~~Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command..~~

~~Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.~~

~~3.7.2.2 Network Reliance in MODERATE Impact Lighting Control Systems~~

~~Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.~~

~~Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.~~

~~[3.7.2.3 Network Reliance in MODERATE Impact [_____] Control Systems~~

~~[_____]~~

~~]~~3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

~~3.7.3 Mobile Code In MODERATE Impact Systems:~~

~~{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}~~

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

[Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.]

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199,
CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.7.5 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems

{For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098, CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}

3.7.5.1 Radio Interfaces for Fire Protection Systems

When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message[or causing the system to play a live audio message]. [Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal][Install relays using the normally closed contact such that they pass a signal when they open, and so that a relay that loses power or has a failed coil passes the signal]

~~3.7.5.2 Fire Supression System Network Isolation~~

~~For fire suppression systems including a release panel, any network used in these systems shall be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems. [Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal][Install relays using the normally closed contact such that they pass a signal when they open, and so that a relay that loses power or has a failed coil passes the signal]~~

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit ~~[~~one hard copy~~][[_____] hard copies]~~ of the software user manual for each piece of software.

3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. ~~For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.~~}

For LOW Impact Systems: ~~[~~Provide emergency power in accordance with the control system and equipment specification Sections, ~~[_____]]~~

~~For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this~~

~~requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.~~

~~3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:~~

~~Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.~~

~~In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.~~

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. ~~For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.~~}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Computers and Software Running on Computers

Computers and applications running on computers must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Controllers shall be scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information shall contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): ~~[~~NONE~~][electronic security systems(ESS)][_____]~~.

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. [Provide malware protection software licenses.][Malware protection software licenses will be Government furnished.]

b. [Provide malware protection software media.][Malware protection software media will be Government furnished.]

c. [Install and configure malware protection software in accordance with the relevant STIGs.][Malware protection software will be Government installed.]

3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

If there exists Integrity Verification Software that can check software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

[3.13.3 Information System Monitoring

{For Government Reference Only: This subpart relates to SI-4 (a),(b); CCI-001253, CCI-002645}

[_____]

]3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit [4] [_____] copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit ~~[~~four~~][_____]~~ copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of 8~~[_____]~~ hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

Provide ~~[~~eight~~][___]~~ hours of classroom~~[and hands-on]~~ training for ~~[~~six ~~][___]~~ Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered. ~~[See SECTION 01 11 01.00 28 SUPPLEMENTARY REQUIREMENTS for additional training requirements.]~~

-- End of Section --

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance Tests and Inspections; G~~[, [_____]]~~

SD-07 Certificates

Qualifications of Organization, and Lead Engineering Technician; G ~~[, [_____]]~~

Acceptance Test and Inspections Procedure; G~~[, [_____]]~~

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall

have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA (Level III) or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

~~[a. Section 26 32 15.00 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES. Functional engine shutdown tests, vibration base-line test, and load bank test shall not be performed by the testing organization. These tests shall be performed by the start-up engineer.~~

~~][b~~a. Section 26 12 19.10 THREE-PHASE, LIQUID-FILLED PAD-MOUNTED

TRANSFORMERS

~~][c. Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS~~

~~][d~~b. Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

~~][e~~c. Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Medium voltage cables and grounding systems only.

~~][f. Section 26 13 00 SF6/HIGH-FIREPOINT FLUID INSULATED PAD-MOUNTED SWITCHGEAR~~

~~][g. Section 26 11 16 SECONDARY UNIT SUBSTATIONS~~

~~][h. Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION~~

~~][i. Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH~~

~~][j. Section 26 23 00 LOW VOLTAGE SWITCHGEAR~~

~~][k. Section 26 24 13 SWITCHBOARDS~~

~~][l. Section 26 35 43 400 HERTZ ((HZ) SOLID STATE FREQUENCY CONVERTER. The NETA ATS representative must coordinate with the Contractor and the Converter Manufacturers' representative to witness, document, and validate the Converter Field Quality Control, Inspection and Testing. These tests will be performed by the converter manufacturers' representative, however include the documentation in the overall NETA report as well.~~

~~][m. Section 26 35 44 270 VDC SOLID STATE CONVERTER. The NETA ATS representative must coordinate with the Contractor and the Converter Manufacturers' representative to witness, document, and validate the Converter Field Quality Control, Inspection and Testing. These tests will be performed by the converter manufacturers' representative, however include the documentation in the overall NETA report as well.~~

~~]~~3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

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SECTION 26 12 19.10

THREE-PHASE, LIQUID-FILLED PAD-MOUNTED TRANSFORMERS
05/19, CHG 1: 11/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7-9 2017) Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2020a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2017b) Standard Test Method for Pour Point of Petroleum Products
ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D877/D877M	(2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
IEEE C37.47	(2011) Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2015) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.12.34	(2015) Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2015; Corr 2017) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 260	(1996; R 2004) Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas

NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted Transformer Drawings; G~~[, [_____]]~~

SD-03 Product Data

Pad-mounted Transformers; G~~[, [_____]]~~

SD-06 Test Reports

Acceptance Checks and Tests; G~~[, [_____]]~~

SD-07 Certificates

Transformer Efficiencies; G~~[, [_____]]~~

SD-09 Manufacturer's Field Reports

Transformer Test Schedule; G~~[, [_____]]~~

Pad-mounted Transformer Design Tests; G~~[, [_____]]~~

Pad-mounted Transformer Routine and Other Tests; G~~[, [_____]]~~

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G~~[, [_____]]~~

~~[1.4.1 Government Submittal Review~~

~~[Code CI44, NAVFAC LANT, Naval Facilities Engineering Command][_____] will review and approve all submittals in this section requiring Government approval.~~

~~]~~1.4.1 Reduced Submittal Requirements

Transformers designed and manufactured by ABB in Jefferson City, MO; by Eaton's Cooper Power Series Transformers in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not submit the entire submittal package requirements of this contract. Instead, submit the following items:

a. A certification, signed by the manufacturer, stating that the manufacturer will meet the technical requirements of this specification.

b. An outline drawing of the transformer with devices identified (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item a).

c. ANSI nameplate data of the transformer (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item b).

~~[~~ d. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the ~~[EasyPower]~~ ~~[~~SKM PowerTools for Windows~~]~~ ~~[_____]~~ computer program of the transformer high side fuses (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item e).

~~]~~ e. Provide transformer test schedule and routine and other tests required by submittal item "SD-09 Manufacturer's Field Reports".

f. Provide acceptance test reports required by submittal item "SD-06 Test Reports".

g. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data".

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

Include the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. IEEE nameplate data.

c. Elementary diagrams and wiring diagrams~~[~~ with terminals identified of watthour meter and current transformers~~]~~.

d. One-line diagram, including switch(es)~~[~~, current transformers, meters, and fuses~~]~~.

~~[~~ e. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the ~~[EasyPower]~~ ~~[~~SKM PowerTools for Windows~~] [_____]~~ computer program of the transformer high side fuses.

~~]~~1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, except of NFPA 70 when more stringent requirements are specified or indicated, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

~~[~~ f. Information on watthour demand meter, CT's, and fuse block

~~]~~ g. Actual nameplate diagram

h. Date of purchase

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in~~[~~ Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,~~][~~ Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,~~][~~ and~~]~~ Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein. Submit manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

2.2.1 Compartments

Provide high- and low-voltage compartments separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

High-voltage compartment contains: the incoming line, insulated high-voltage ~~[~~load-break ~~][dead-break ~~connectors, ~~[~~bushing well inserts, ~~][feed-thru inserts,]~~ six high-voltage ~~[~~bushing wells~~][one-piece bushings]~~ configured for loop feed application, load-break switch handle(s),

~~[access to oil-immersed bayonet fuses,]~~[dead-front surge arresters,~~]~~ tap changer handle, connector parking stands~~[~~ with insulated standoff bushings~~]~~, ~~[~~ protective caps,~~]~~ and ground pad.

~~[~~ Minimum high-voltage compartment dimensions: IEEE C57.12.34, Figures 16 and 17.

~~][~~a. Insulated high-voltage load-break connectors: IEEE 386, rated ~~[~~15 kV, 95 kV BIL~~][25 kV, 125 kV BIL][35 kV, 150 kV BIL]~~. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

~~][b. Insulated high-voltage dead-break connectors: IEEE 386, rated [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Current rating: 600 amperes rms continuous. Short time rating: 25,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector must have a [200 ampere bushing interface for surge arresters,] steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.~~

~~][~~b~~c~~. Bushing well inserts~~[and feed-thru inserts]~~: IEEE 386, 200 amperes, ~~[~~15~~][25]~~ kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.~~[Provide feed-thru inserts as indicated.]~~

~~][d~~c. One-piece bushings: IEEE 386, ~~[~~200~~][600]~~ amperes, ~~[~~15~~][25][35][_____]~~ kV Class.

~~]~~ ~~e~~d. Load-break switch

~~[~~ Radial-feed two-position oil-immersed type rated at ~~[~~15 kV, 95 kV BIL ~~][25 kV, 125 kV BIL][35 kV, 150 kV BIL]~~, with a continuous current rating and load-break rating of ~~[~~200~~][300][_____]~~ amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

~~][~~ ~~Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch must be rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches must be as follows:~~

~~ARRANGEMENT NO.~~	~~DESCRIPTION OF SWITCH ARRANGEMENT~~	~~SWITCH POSITION~~					
		~~LINE A SW.~~		~~LINE B SW~~		~~XFMR. SW~~	
		~~OPEN~~	~~CLOSE~~	~~OPEN~~	~~CLOSE~~	~~OPEN~~	~~CLOSE~~
~~1~~	~~Line A connected to Line B and both lines connected to transformer~~		~~X~~		~~X~~		~~X~~

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION					
		LINE A SW.		LINE B SW		XFMR. SW	
		OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line Bonly	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

]][fe. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.[Connect current-limiting fuses ahead of the radial-feed load-break switch.]

]][gf. Surge arresters: IEEE C62.11, rated [3][6][9][10][12][15][18][21][24][27][30][36][_____] kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap.[Provide three arresters for radial feed circuits.]][Provide [three][six] arresters for loop feed circuits.]

] hg. Parking stands: Provide a parking stand near each bushing.[Provide insulated standoff bushings for parking of energized high-voltage connectors on parking stands.]

[ih. Protective caps: IEEE 386, [200][600] amperes, [15][25][35][_____] kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushings.

][2.2.1.2 High Voltage, Live-Front

High-voltage compartment contains: the incoming line, transformer

high-voltage bushings, load-break switch handle(s),[access to oil-immersed bayonet fuses,][surge arresters,] tap changer handle, insulated phase barriers, and ground pad.

a. Cable terminators: Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

b. Load-break switch

[Radial-feed two-position oil-immersed type rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

][Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch must be rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches must be as follows:

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION					
		LINE A SW.		LINE B SW		XFMR. SW	
		OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

][c. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil

spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.[Connect current-limiting fuses ahead of the radial-feed load-break switch.]

][d. Surge arresters: IEEE C62.11, rated [3][6][9][10][12][15][18][21][24][27][30][36][_____] kV.[Provide three arresters for radial feed circuits.][Provide [three][six] arresters for loop feed circuits.]

] e. Insulated phase barriers: NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Provide vertical barriers between the high-voltage bushings and a single horizontal barrier above the high-voltage bushings.

]2.2.1.2 Low Voltage

Low-voltage compartment contains: low-voltage bushings with NEMA spade terminals, accessories, metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Include the following accessories: drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

[b. Metering: Provide as specified in Section [26 27 14.00 20 ELECTRICITY METERING][26 27 13.10 30 ELECTRIC METERS].

][c. Metering: NEMA/ANSI C12.10. Provide a socket-mounted electronic programmable outdoor watthour meter, surface mounted flush against the side of the low-voltage compartment as indicated. Program the meter at the factory or in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Coordinate the meter to system requirements.

(1) Design: Provide meter designed for use on a 3-phase, 4-wire, [208Y/120][480Y/277] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS)[as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC].

(2) Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

(3) Class: 20; Form: [9S][_____]; Accuracy: plus or minus 1.0 percent; Finish: Class II

(4) Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.

(5) Kilowatt-hour Register: five digit electronic programmable type

(6) Demand Register:

~~(a) Provide solid state~~

~~(b) Meter reading multiplier: Indicate multiplier on the meter face.~~

~~(c) Demand interval length: programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.~~

~~(7) Meter fusing: Provide a fuse block mounted in the secondary compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.~~

~~(8) Socket: ANSI C12.7. Provide NEMA Type 3R, box-mounted socket having automatic circuit-closing bypass and having jaws compatible with requirements of the meter. Cover unused hub openings with blank hub plates. Paint box [Munsell 7GY3.29/1.5 green][Munsell 5BG7.0/0.4 sky gray (ANSI 70)] [_____] to match the pad-mounted transformer to which the box-mounted socket is attached. The Munsell color notation is specified in ASTM D1535.~~

~~(9) Current transformers: IEEE C57.13. Provide butyl-molded window type current transformers with 600-volt insulation, 10 kV BIL and mount on the low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters. Provide three current transformers per power transformer with characteristics listed in the following table.~~

~~kVA~~	~~Sec. Volt~~	~~CT Ratio~~	~~RF~~	~~Meter Acc. Class~~
~~[500]~~	~~[208Y/120]~~	~~[1200/5]~~	~~[1.5]~~	~~[0.3 thru B-0.5]~~
~~[750]~~	~~[480Y/277]~~	~~[800/5]~~	~~[2.0]~~	~~[0.3 thru B-0.5]~~

~~]~~2.2.2 Transformer

a. Less-flammable ~~[~~bio-based~~]~~ liquid-insulated~~[~~ or oil-insulated~~]~~, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer rated ~~[~~300~~_____]~~ kVA.

c. Transformer voltage ratings: ~~[_____] V [Delta][_____] - [_____] V [GrdY][_____].[For GrdY - GrdY transformers, provide transformer with five-legged core design for third harmonic suppression.]~~12470 V - 480Y/277V.

d. Tap changer: externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Indicate which tap setting is in use, clearly visible when the compartment is opened.

e. Minimum tested percent impedance at 85 degrees C:

2.50 for units rated 75kVA and below
2.87 for units rated 112.5kVA to 300kVA
4.03 for 500kVA rated units
5.32 for units rated 750kVA and above

f. Comply with the following audible sound level limits:

kVA	DECIBELS (MAX
75	51
112.5	55
150	55
225	55
300	55
500	56
750	57
1000	58
1500	60
2000	61
2500	62

g. Include:

(1) Lifting lugs and provisions for jacking under base, with base construction suitable for using rollers or skidding in any direction.

(2) An insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

(3) Provide transformer top with an access handhole.

(4) kVA rating conspicuously displayed using 3 inch high yellow letters on its enclosure.

2.2.2.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer

indicating conformance.

kVA	EFFICIENCY (percent)
15	98.65
30	98.83
45	98.92
75	99.03
112.5	99.11
150	99.16
225	99.23
300	99.27
500	99.35
750	99.40
1000	99.43
1500	99.48
2000	99.51
2500	99.53
above 2500	99.54

2.2.3 Insulating Liquid

a. Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

Provide a fluid that is a biodegradable, electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

(1) Pour point: ASTM D97, less than -15 degree C

(2) Aquatic biodegradation: EPA 712-C-98-075, ultimately biodegradable as designated by EPA.

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass

~~f~~ b. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II

mineral oil" on the nameplate.

~~]~~2.2.3.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Corrosion Protection

~~[~~ Provide corrosion resistant bases and cabinets of transformers, fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Base includes any part of pad-mounted transformer that is within 3 inches of concrete pad.

~~]~~[Provide entire transformer assembly, including tank and radiator, base, enclosure, and metering enclosure fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Form enclosure of stainless steel sheets. The optional use of aluminum is permitted for the metering enclosure.

~~]~~ Paint entire transformer assembly ~~[~~Munsell 7GY3.29/1.5 green~~]~~[~~Munsell 5BG7.0/0.4 sky gray (ANSI 70)~~]~~[_____], with paint coating system complying with IEEE C57.12.28 ~~[~~and IEEE C57.12.29 ~~]~~regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

2.3 WARNING SIGNS AND LABELS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts in accordance with NEMA Z535.4 and NEMA 260.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning labels on the outside of the high voltage compartment door(s)with nominal dimensions of 7 by 10 inches with the legend "WARNING HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Include the work "WARNING" in white letters on an orange background and the words "HIGH VOLTAGE" in black letters on a white background.

~~[~~ b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "WARNING HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on an orange and black field.

~~]~~2.4 ARC FLASH WARNING LABEL

Provide arc flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.5 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

~~[~~2.6 PADLOCKS

Provide padlocks for pad-mounted equipment~~[and for each fence gate]~~, keyed ~~[~~alike~~][as directed by the Contracting Officer]~~. Comply with Section 08 71 00 DOOR HARDWARE.

~~]~~2.7 CAST-IN-PLACE CONCRETE

~~[~~ Provide concrete associated with electrical work for other than encasement of underground ducts rated for 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.
~~]~~
~~[~~ Provide concrete associated with electrical work as follows:

a. Composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture.

b. Fine aggregate: hard, dense, durable, clean, and uncoated sand.

c. Coarse aggregate: reasonably well graded from 3/16 inch to 1 inch.

d. Fine and coarse aggregates: free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances.

e. Water: fresh, clean, and free from salts, alkali, organic matter, and other impurities.

f. Concrete associated with electrical work for other than encasement of underground ducts: 4000 psi minimum 28-day compressive strength unless specified otherwise.

g. Slump: Less than 4 inches. Retempering of concrete will not be permitted.

h. Exposed, unformed concrete surfaces: smooth, wood float finish.

i. Concrete must be cured for a period of not less than 7 days, and concrete made with high early strength portland cement must be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer.

j. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M.

k. Air content: between 4 and 6 percent.

~~]~~2.8 SOURCE QUALITY CONTROL

2.8.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

(1) Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

(2) Accuracy: Traceable to the National Institute of Standards and Technology.

(3) Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

(4) Dated calibration labels: visible on all test equipment.

(5) Calibrating standard: higher accuracy than that of the instrument tested.

(6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.8.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for~~[each of]~~ the specified transformer(s), with design tests performed prior to the award of this contract.

a. Tests: certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (KNAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests includes the primary windings only of that transformer.

(1) IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

(2) State test voltage levels.

(3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.8.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests: performed in accordance with IEEE C57.12.90 by the manufacturer on~~[each of]~~ the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence as follows:

a. Phase relation

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

(1) Impulse

(2) Applied voltage

(3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding ~~[~~25~~][_____]~~ ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide

compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

Provide a ground ring around the transformer with ~~[1/0][~~4/0~~]~~ AWG bare copper.~~[Provide four ground rods in the ground ring, one per corner.][~~ Provide two ground rods in the ground ring at opposite corners.~~][Provide one ground rod in the ground ring with the ground rod located in the transformer cabinet.]~~ Install the ground rods at least 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

~~[3.3.1 Meters and Current Transformers~~

~~ANSI C12.1.~~

~~]~~3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

~~[~~3.5 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

~~]~~3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 8 inches thick, reinforced with a 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 4 inches from the top of the slab.

b. Place slab on a 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.6.1 Cast-In-Place Concrete

Provide cast-in-place concrete work in accordance with the requirements of ~~[Section 03 30 00 CAST-IN-PLACE CONCRETE][~~ ACI 318~~][ACI 318M]~~.

~~[~~3.6.2 Sealing

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

~~]~~3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

(3) Inspect anchorage, alignment, and grounding.

(4) Verify the presence of PCB content labeling.

(5) Verify the bushings and transformer interiors are clean.

(6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(7) Verify correct liquid level in tanks and bushings.

(8) Verify that positive pressure is maintained on gas-blanketed transformers.

(9) Perform specific inspections and mechanical tests as recommended

by manufacturer.

(10) Verify de-energized tap changer position is left as specified.

[(11) Verify the presence of transformer surge arresters.

] b. Electrical tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

[(3) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Calculate polarization index. Verify that the tap changer is set at the specified ratio.

(43) Perform turns-ratio tests at all tap positions.

(54) Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data.

(65) Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests.

(76) Measure the resistance of each high-voltage winding in each de-energized tap-changer position. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.

(87) Remove and test a sample of insulating liquid for the following: Dielectric breakdown voltage, Acid neutralization number, Specific gravity, Interfacial tension, Color, Visual Condition, Water in insulating liquids (Required on 25 kV or higher voltages and on all silicone-filled units.), and Power factor or dissipation factor.

(98) Perform dissolved-gas analysis (DGA) on a sample of insulating liquid.

][3.7.1.2 Current Transformers

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit wiring.

(5) Verify the unit is clean.

~~(6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.~~

~~(7) Verify that all required grounding and shorting connections provide good contact.~~

~~(8) Verify correct operation of transformer withdrawal mechanism and grounding operation.~~

~~(9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.~~

~~b. Electrical tests~~

~~(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.~~

~~(2) Perform insulation-resistance test.~~

~~(3) Perform a polarity test.~~

~~(4) Perform a ratio-verification test.~~

~~][3.7.1.3 Watthour Meter~~

~~a. Visual and mechanical inspection~~

~~(1) Compare equipment nameplate data with specifications and approved shop drawings.~~

~~(2) Inspect physical and mechanical condition.~~

~~(3) Verify tightness of electrical connections.~~

~~b. Electrical tests~~

~~(1) Calibrate watthour meters according to manufacturer's published data.~~

~~(2) Verify that correct multiplier has been placed on face of meter, where applicable.~~

~~(3) Verify that current transformer secondary circuits are intact.~~

~~]~~3.7.1.2 Grounding System

a. Visual and mechanical inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before

any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

[3.7.1.3 Surge Arresters, Medium- and High-Voltage

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, grounding, and clearances.

(4) Verify the arresters are clean.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform an insulation-resistance test on each arrester, phase terminal-to-ground.

(3) Test grounding connection.

]3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times of checking and testing.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
08/19, CHG 3: 11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)
ANSI C80.5	(2020) American National Standard for Electrical Rigid Aluminum Conduit

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA MG 1	(2018) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2017) Metal Cable Tray Systems
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace
NFPA 780	(2020) Standard for the Installation of Lightning Protection Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-569	(2019e) Telecommunications Pathways and Spaces
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.303	Electrical, General

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jan 2020) UL Standard for Safety Flexible Metal Conduit
UL 5	(2016; Reprint Aug 2020) UL Standard for Safety Surface Metal Raceways and Fittings
UL 5A	(2015; Reprint Aug 2020) Nonmetallic Surface Raceways and Fittings
UL 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 6A	(2008; Reprint Mar 2021) UL Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2015) UL Standard for Safety Enclosures

	for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Jul 2020) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 248-4	(2010; Reprint Apr 2019) Low-Voltage Fuses - Part 4: Class CC Fuses
UL 248-8	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 8: Class J Fuses
UL 248-10	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 10: Class L Fuses
UL 248-12	(2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses
UL 248-15	(2018) Low-Voltage Fuses - Part 15: Class T Fuses
UL 360	(2013; Reprint Aug 2021) UL Standard for Safety Liquid-Tight Flexible Metal Conduit
UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2017; Reprint Feb 2021) UL Standard for Safety Attachment Plugs and Receptacles
UL 506	(2017) UL Standard for Safety Specialty Transformers
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 510	(2020) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings

UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint Mar 2020) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 674	(2011; Reprint Dec 2020) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL 797	(2007; Reprint Mar 2021) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Mar 2019) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; Reprint Feb 2018) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 984	(1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors
UL 1063	(2017) UL Standard for Safety Machine-Tool Wires and Cables
UL 1203	(2013; Reprint Mar 2021) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 1242	(2006; Reprint Aug 2020) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1699	(2017; Reprint Nov 2020) UL Standard for Safety Arc-Fault Circuit-Interrupters
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 4248-1	(2017) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018) UL Standard for Safety Fuseholders - Part 12: Class R

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[~~for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.~~]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G~~[, [_____]]~~

Transformers; G~~[, [_____]]~~

~~Busway; G[, [_____]]~~

Cable Trays; G~~[, [_____]]~~

~~Motor Control Centers; G[, [_____]]~~

~~Wireways; G[, [_____]]~~

~~[~~ ~~Load Centers for Housing Units; G[, [_____]]~~

~~]~~ Marking Strips Drawings; G~~[, [_____]]~~

SD-03 Product Data

Receptacles; G~~[, [_____]]~~

Circuit Breakers; G~~[, [_____]]~~

Switches; G~~[, [_____]]~~

Transformers; G~~[, [_____]]~~

Enclosed Circuit Breakers; G~~[, [_____]]~~

Motor Controllers; G~~[, [_____]]~~

~~[~~ Combination Motor Controllers; G~~[, [_____]]~~

~~][~~ ~~Load Centers for Housing Units; G[, [_____]]~~

~~]~~ Manual Motor Starters; G~~[, [_____]]~~

~~[~~ ~~Residential Load Centers; G[, [_____]]~~

~~][~~ ~~Metering; G[, [_____]]~~

~~][~~ ~~Meter Base Only; G[, [_____]]~~

] CATV Outlets; G[, [_____]]

Secondary Bonding Busbar; G[, [_____]]

Surge Protective Devices; G[, [_____]]

Cable Trays; G[, [_____]]

[SD-05 Design Data

Cable Tray Design; G[, [_____]]

] SD-06 Test Reports

600-volt Wiring Test; G[, [_____]]

Grounding System Test; G[, [_____]]

Transformer Tests; G[, [_____]]

Ground-fault Receptacle Test; G[, [_____]]

Arc-fault Receptacle Test; G[, [_____]]

SD-07 Certificates

Fuses; G[, [_____]]

SD-09 Manufacturer's Field Reports

Transformer Factory Tests

[SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G[, [_____]]

[Metering, Data Package 5; G[, [_____]]

]]1.4 QUALITY ASSURANCE

1.4.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 shall be considered the minimum standard for workmanship.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal

material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

~~[~~1.5.1 ~~Electrical Systems~~Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

~~]~~1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

~~[1.7 SEISMIC REQUIREMENTS~~

~~Provide seismic details[conforming to[Section 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT][and to][Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][as indicated].~~

~~]~~PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40~~[, and EPC-80]~~ in accordance with NEMA TC 2,UL 651~~[, or fiberglass conduit, in accordance with NEMA TC 14]~~.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40(40 mils thick).

2.2.6 Flexible Metal Conduit

UL 1, limited to 6 feet.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 6 feet.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

~~[Die Cast]~~[Steel~~]~~ compression type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC[and NEMA TC 14 for fiberglass], and UL 514B.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 SURFACE RACEWAY

2.3.1 Surface Metal Raceway

UL 5, two-piece painted steel, totally enclosed, snap-cover type.[Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every [18] [_____] inches.][Wire alternate receptacles on different circuits.]

2.3.2 Surface Nonmetallic Raceway

UL 5A, nonmetallic totally enclosed, snap-cover type.[Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every [18] [_____] inches.][Wire alternate receptacles on different circuits.]

2.4 BUSWAY

NEMA BU 1.1, UL 857. Provide the following:

a. Buses: [copper][or][aluminum].

b. Busways: rated [_____] volts, [_____] continuous current amperes, three-phase,[three-][four-]wire, and include integral or internal[50-percent] ground bus.

c. Short circuit rating: [[_____] root mean square (rms) symmetrical amperes minimum][as indicated].

[d. Busway systems: suitable for use indoors.

] e. Enclosures: [steel] [aluminum] [metallic].

f. Hardware: plated or otherwise protected to resist corrosion.

g. Joints: one-bolt type with through-bolts, which can be checked for tightness without de-energizing system.

h. Maximum hot spot temperature rise at any point in busway at continuous rated load: do not exceed 55 degrees C above maximum ambient temperature of 40 degrees C in any position.

i. Internal barriers to prevent movement of superheated gases.

j. Coordinate proper voltage phasing of entire bus duct system, for example where busway interfaces with transformers, switchgear, switchboards, motor control centers, and other system components.

~~2.4.1 Feeder Busways~~

~~Provide[ventilated, except that vertical busways within 6 feet of floors must be unventilated,][unventilated, totally enclosed] low-impedance busway. Provide bus bars fully covered with insulating material, except at stabs. Provide an entirely polarized busway system.~~

~~2.4.2 Plug-In Busways~~

~~Unventilated type. Provide the following:~~

~~a. Plug-in units: [fusible, handle-operated, switch type, horsepower-rated][circuit breaker-type][handle-operated, switch type, equipped with high interrupting-capacity, current-limiting fuses].~~

~~b. Bus bars: covered with insulating material throughout, except at joints and other connection points.~~

~~[c. A hook stick of suitable length for operating plug-in units from the floor.~~

~~]~~2.4 CABLE TRAYS

NEMA VE 1. Provide the following:

~~[Submit cable tray design, including dimensional layout, load and seismic calculations, and fill calculations. Dimensional layout includes cable spacings, cable tray splices, and supports. Fill calculations include an index of cables for each section and identification of the lb/ft, cross sectional area, and insulation voltage class for each cable.~~

~~]~~ a. Cable trays: form a wireway system, with a nominal~~[[3] [4] [6]~~ inch~~]~~ depth~~[as indicated]~~.

b. Cable trays: constructed of~~[~~ aluminum~~]~~[copper-free aluminum][steel that has been zinc-coated after fabrication]~~.~~

c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.

d. Edges, fittings, and hardware: finished free from burrs and sharp edges.

e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

f. Radius of bends: ~~[[12] [24] [~~36~~]~~ inches.~~]~~[as indicated.]~~

2.4.1 Basket-Type Cable Trays

Provide~~[~~ size as indicated~~]~~[of nominal~~ [2,][4,][6,][8,]~~[12,~~]~~[18,]~~[and~~]~~[24~~]~~ inch width and ~~[1,][2,][and]~~[4~~]~~ inch depth~~]~~ with maximum wire mesh spacing of 2 by 4 inch.

~~2.4.2 Trough-Type Cable Trays~~

~~Provide[size as indicated][of nominal [6] [12] [18] [24] [30] [36] inch width].[Cable tray must be suitable for use as an equipment grounding~~

conductor.]

2.4.2 Ladder-Type Cable Trays

Provide[size as indicated][of nominal [6] [12] [18] [24] [30] [36] inch width] with maximum rung spacing of [6] [9] [12] [18] inches.[Cable tray must be suitable for use as an equipment grounding conductor.]

2.4.3 Channel-Type Cable Trays

Provide[size as indicated][of nominal [3] [4] [6] inch width]. Provide trays with one-piece construction having slots spaced not more than 4 1/2 inches on centers.[Cable tray must be suitable for use as an equipment grounding conductor.]

2.4.4 Solid Bottom-Type Cable Trays

Provide[size as indicated][of nominal [6][12][18][24][30][36] inch width].[Provide solid covers.][Do not provide solid covers.]

[2.4.5 Cantilever

Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

]2.5 OPEN TELECOMMUNICATIONS CABLE SUPPORT

2.5.1 Open Top Cable Supports

Provide open top cable supports in accordance with UL 2043. Provide[[galvanized][zinc-coated][stainless] steel] open top cable supports[as indicated].

2.5.2 Closed Ring Cable Supports

Provide closed ring cable supports in accordance with UL 2043. Provide[[galvanized][zinc-coated][stainless] steel] closed ring cable supports[as indicated].

]2.6 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.6.1 Floor Outlet Boxes

Provide the following:

a. Boxes: [adjustable][nonadjustable] and concrete tight.

b. Each outlet: consisting of [nonmetallic][or][cast-metal] body with threaded openings,[or sheet-steel body with knockouts] for conduits,[adjustable][,][brass flange] ring, and cover plate with [3/4][1][1 1/4][2 1/8] inch threaded plug.

c. Telecommunications outlets: consisting of[surface-mounted, horizontal][flush], aluminum or stainless steel housing with a receptacle as specified and[one inch bushed side opening][3/4 inch top opening].

d. Receptacle outlets: consisting of~~[surface-mounted, horizontal][~~ flush ~~]~~ aluminum or stainless steel housing with duplex-type receptacle as specified herein.

e. Provide gaskets where necessary to ensure watertight installation.

~~[~~ f. Provide plugs with installation instructions to the Contracting Officer for ~~[~~5~~]~~ ~~[_____]~~ percent of outlet boxes for the capping of outlets upon removal of service fittings.

~~]~~2.6.2 Outlet Boxes for Telecommunications System

Provide the following:

a. Standard type~~[4 inches square by 2 1/8 inches deep][4 11/16 inches square by 2 1/8 inches deep]~~ Telecommunication outlet boxes should be 5 inches square by 2 7/8 except in CMU. In CMU, provide 4 11/16 inches square boxes with 2 inch mud rings.~~.~~

~~[~~ b. ~~Outlet boxes for wall-mounted telecommunications outlets: 4 by 2 1/8 by 2 1/8 inches deep~~Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.~~.~~

~~]~~ ~~c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.~~

~~[~~ ~~d~~c. Outlet boxes for fiber optic telecommunication outlets: include a minimum 3/8 inch deep single or two gang plaster ring as shown and installed using a minimum one inch conduit system.

~~][e. Outlet boxes for handicapped telecommunications station: 4 by 2 1/8 by 2 1/8 inches deep.~~

~~][2.6.3 Clock Outlet for Use in Other Than Wired Clock System~~

~~Provide the following:~~

~~a. Outlet box with plastic cover, where required, and single receptacle with clock outlet plate.~~

~~b. Receptacle: recessed sufficiently within box to allow complete insertion of standard cap, flush with plate.~~

~~c. Suitable clip or support for hanging clock: secured to top plate.~~

~~d. Material and finish of plate: as specified in paragraph DEVICE PLATES of this section.~~

~~]~~2.7 CABINETS, JUNCTION BOXES, AND PULL BOXES

UL 50; volume greater than 100 cubic inches, NEMA Type 1 enclosure; sheet steel, hot-dip, zinc-coated. Where exposed to wet, damp, or corrosive environments, NEMA Type ~~[~~3R~~][4X][_____][as indicated]~~.

2.8 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or

indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

2.8.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. [All conductors: copper.][Conductors indicated to be No. 6 AWG or smaller diameter: copper. Conductors indicated to be No. 4 AWG and larger diameter: either copper or aluminum, unless type of conductor material is specifically indicated, or specified, or required by equipment manufacturer.]

[2.8.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

][2.8.1.2 Aluminum Conductors

Provide aluminum conductors of AA-8000 series electrical grade aluminum alloy conductors. Type EC/1350 aluminum is not acceptable. If Contractor chooses to provide aluminum for conductors No. 4 AWG and larger diameter, Contractor is responsible for increasing conductor size to have same ampacity as copper size indicated; increasing conduit and pull box sizes to accommodate larger size aluminum conductors in accordance with NFPA 70; ensuring that pulling tension rating of aluminum conductor is sufficient; providing panelboards[and motor control centers] that are UL listed for use with aluminum, and so labeled; relocating equipment, modifying equipment terminations, resizing equipment; and resolving problems that are direct results of providing aluminum conductors in lieu of copper.

]2.8.1.1 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

e. Digital low voltage lighting control (DLVLC) system at 24 Volts or less: Category [5 UTP][_____] cables[in EMT conduit][in accordance

~~with DLVLC system manufacturer requirements]~~.

2.8.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

2.8.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.8.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

~~[d. On three-phase, four-wire delta system, high leg: orange, as required by NFPA 70.~~

~~]~~2.8.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts,~~[~~ Type THWN/THHN conforming to UL 83~~][or][Type[XHHW][or][RHW] conforming to UL 44]~~, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where equipment or devices require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.8.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger

diameter.

2.8.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with TIA-607 with No. 6 AWG minimum size, and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil.~~[Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.]~~

2.8.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (PBB) and the electrical service ground in accordance with TIA-607. Size the bonding conductor for telecommunications the same as the TBB.

~~[2.8.5 Service Entrance Cables~~

~~Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.~~

~~][2.8.6 Nonmetallic Sheathed Cable~~

~~UL 719, Type NM or NMC.~~

~~][2.8.7 Wire and Cable for 400 Hertz (Hz) Circuits~~

~~Insulated copper conductors.~~

~~][2.8.8 Metal-Clad Cable~~

~~UL 1569; NFPA 70, Type MC cable.~~

~~][2.8.9 Armored Cable~~

~~UL 4; NFPA 70, Type AC cable.~~

~~][2.8.10 Mineral-Insulated, Metal-Sheathed Cable~~

~~UL listed; NFPA 70, Type MI cable. Do not use sheathing containing asbestos fibers.~~

~~][2.8.11 Flat Conductor Cable~~

~~UL listed; NFPA 70, Type FCC.~~

~~][2.8.12 Cable Tray Cable or Power Limited Tray Cable~~

~~UL listed; type TC or PLTC.~~

~~][2.8.13 Cord Sets and Power-Supply Cords~~

~~UL 817.~~

~~]~~2.9 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on

splicing connector). Provide solderless terminal lugs on stranded conductors.

2.10 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

~~[~~ d. Plates on finished walls: nylon or lexan, minimum 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.

~~][~~e. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick.

~~]~~ f. Screws: machine-type with countersunk heads in color to match finish of plate.

g. Sectional type device plates are not be permitted.

h. Plates installed in wet locations: gasketed and UL listed for "wet locations."

~~[i. Device plates in areas normally accessible to prisoners: brown or ivory finish nylon-device plates rated for high abuse. Test device plates for compliance with UL 514A and UL 514C for physical strength. Attach device plates with spanner head bolts.~~

~~]~~2.11 SWITCHES

2.11.1 Toggle Switches

NEMA WD 1, UL 20,~~[~~ single pole~~][, double pole][, three-way][, and four-way]~~, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: ~~[~~white~~][ivory][brown]~~ thermoplastic.

b. Wiring terminals: screw-type, side-wired~~[or of the solderless pressure type having suitable conductor-release arrangement]~~.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.11.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's

handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts or 277 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

~~2.11.3 Breakers Used as Switches~~

~~For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.~~

2.11.3 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA~~[1][~~ 3R~~] [4X Type 304 stainless steel][4X fiberglass][4X plastic][_____]~~, enclosure~~[as indicated]~~ per NEMA ICS 6.

2.12 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible~~[~~ switch~~][panel][and control center]~~. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers ~~[~~ or other circuit protective devices~~]~~ for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.12.1 Fuseholders

Provide in accordance with UL 4248-1.

2.12.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 248-12, Class~~[RK-1][RK-5][~~ time-delay type~~]~~. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.12.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 248-8, UL 248-10, UL 248-4, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.12.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 248-15, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.13 RECEPTACLES

Provide the following:

a. ~~[~~UL 498, general purpose specification grade,~~][~~ UL 498, hospital grade,

] grounding-type. Residential grade receptacles are not acceptable.

b. Ratings and configurations: as indicated.

c. Bodies: [white][ivory][brown] as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

[i. Controlled receptacles: as required per ASHRAE 90.1. Provide marking for controlled receptacle per NFPA 70.

]2.13.1 Split Duplex Receptacles

Provide separate terminals for each ungrounded pole. One receptacle must be controlled separately.

2.13.2 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations" with integral GFCI protection. Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, [polycarbonate, UV resistant/stabilized][die-cast metal/aluminum] cover plate.

2.13.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak when the current to ground is 6 milliamperes or higher, and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.13.4 Special Purpose Receptacles

Receptacles serving [_____] are special purpose.[Provide in ratings indicated.][NEMA [_____] configuration, rated [_____] amperes, [_____] volts.][Furnish one matching plug with each receptacle.]

[2.13.5 Plugs

Provide heavy-duty, rubber-covered[three-,][four-,][or][five-]wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

]2.13.6 Range Receptacles

NEMA 14-50 configuration,[flush mounted for housing units,] rated 50 amperes, 125/250 volts.[Furnish one matching plug with each receptacle.]

~~2.13.7 Dryer Receptacles~~

~~NEMA 14-30 configuration, rated 30 amperes, 125/250 volts.[Furnish one matching plug with each receptacle.]~~

2.13.4 Tamper-Resistant Receptacles

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.13.5 Arc-Fault Circuit Interrupter Receptacles

UL 1699, duplex type for mounting in standard outlet box. Provide device capable of detecting series arcing current when the current to ground is 5 amperes or higher, and tripping per requirements of UL 1699.

2.14 PANELBOARDS

Provide panelboards in accordance with the following:

~~[~~ a. UL 67 and UL 50 having a short-circuit current rating~~[~~ as indicated~~]~~[~~of 10,000 amperes symmetrical minimum for voltages 240 V and below] [of 14,000 amperes symmetrical minimum for 480 V]~~.~~

~~b. Panelboards for use as service disconnecting means: additionally conform to UL 869A.~~

~~c~~b. Panelboards: circuit breaker-equipped.

~~d~~c. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

~~e~~d. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the design drawings. If it is not possible to match "specific breaker placement" during construction, obtain Government approval prior to device installation.

~~f~~e. Use of "Subfeed Breakers" is not acceptable.

~~g~~f. Main breaker: "separately" mounted~~[~~ "above"~~]~~[or~~]~~["below"~~]~~ branch breakers.

~~h~~g. Where "space only" is indicated, make provisions for future installation of breakers.

~~i~~h. Directories: indicate load served by each circuit in panelboard.

~~j~~i. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).

~~[k. Provide new directories for existing panels modified by this project as indicated.~~

~~]~~ ~~l~~j.Type directories and mount in holder behind transparent protective covering.

[mk. Panelboards: listed and labeled for their intended use.

] nl. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

][a. UL 67 and UL 50.

b. Panelboards for use as service disconnecting: additionally conform to UL 869A.

c. Panelboards: circuit breaker-equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated.

f. Directories: indicate load served by each circuit of panelboard.

g. Directories: indicate source of service (e.g. upstream panel, switchboard, motor control center) to panelboard.

h. Type directories and mount in holder behind transparent protective covering.

i. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

]2.14.1 Enclosure

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: [hot-dipped galvanized after fabrication] [fiberglass enclosure].

c. Cabinets: painted in accordance with paragraph PAINTING.

d. Outdoor cabinets: [NEMA 3R raintight] [NEMA 4x] with[conduit hubs welded to the cabinet][a removable steel plate 1/4 inch thick in the bottom for field drilling for conduit connections].

e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.

h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

i. Each door: fitted with a combined catch and lock latch.

j. Keys: two provided with each lock, with all locks keyed alike.

k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.14.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.~~[In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.]~~

~~[2.14.2.1 Panelboard Neutrals for Non-Linear Loads~~

~~Provide in accordance with the following:.~~

~~a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.~~

~~b. Panelboard: heat rise tested in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.~~

~~c. Verification of the testing procedure: provided upon request.~~

~~d. Two neutral assemblies paralleled together with cable is not acceptable.~~

~~e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.~~

~~f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.~~

~~]~~2.14.3 Circuit Breakers

UL 489,~~[thermal magnetic-type]~~[solid state-type~~]~~ having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided.~~[~~ Where indicated on the drawings, provide circuit breakers with shunt trip devices.~~]~~ Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.14.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.14.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

2.14.3.3 Arc-Fault Circuit Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.~~[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.]~~ Provide with "push-to-test" button.

~~[~~2.14.4 Fusible Switches for Panelboards

NEMA KS 1, hinged door-type. Provide switches serving as motor disconnect means rated for horsepower.

~~][2.14.5 400 Hz Panelboard and Breakers~~

~~Provide panelboards and breakers for use on 400 Hz systems rated and labeled "400 Hz."~~

~~][2.14.6 Branch Circuit Monitoring Panelboards~~

~~Provide a microprocessor-based panelboard monitoring system having the following features:~~

~~a. ANSI C12.1 and IEC 62053-21 Class 1 energy revenue metering accuracy.~~

~~b. Direct reading metered or calculated values for up to forty-two branch circuits.~~

~~c. Monitored values at the branch circuit level for current (A), power (kW), and energy (kWh).~~

~~d. Four user-configurable alarm thresholds.~~

~~e. Communications with building automation system using Modbus RTU protocol via RS-485 cable connection.~~

~~][~~2.14.5 Lighting Control Panelboards

Provided a lighting control panelboard having the following features:

a. Minimum sixteen schedules including a 7-day repeating schedule with sixteen daily on/off periods.

b. Minimum sixteen lighting zones grouping branch breakers that are controlled by schedules, manual inputs, or override commands.

c. Electronic clock including real-time, astronomical clock, and leap year and daylight savings time adjustments.

d. Burn-hour tracking.

e. Remote circuit breaker operation.

[f. Master Lighting Control Panelboard with controller to control up to [8] [_____] control bussed located [individually][in slave panelboard] up to [400] [_____] feet away from the master panelboard.

] g. Communications with building automation system using Modbus RTU protocol via RS-485 cable connection.

][2.15 RESIDENTIAL LOAD CENTERS

Provide residential load centers (RLCs) in accordance with the following:

a. UL 67 and UL 50.

b. RLCs for use as service disconnecting means: additionally conform to UL 869A.

c. Circuit breaker equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. Where "space only" is indicated, make provisions for future installation of breakers sized as indicated.

[f. Provide load centers with keyed locks.

] g. Provide printed directories.

2.15.1 RLC Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated groundable neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.15.2 Circuit Breakers

UL 489, thermal magnetic-type with interrupting capacity[as indicated][of 10,000 minimum amperes rms symmetrical]. Breaker terminals: UL listed as suitable for the type of conductor provided.

2.15.2.1 Multipole Breakers

Provide common trip-type with single operating handle. Provide a breaker design such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any two adjacent breaker poles are connected to alternate phases in sequence.

[2.15.2.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition,

and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

]2.15.2.3 Arc-Fault Circuit-Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

][2.16 LOAD CENTERS FOR HOUSING UNITS

Provide single-phase panelboards for housing units on this project in accordance with the following:

a. Load center type, circuit breaker equipped, conforming to UL 67 and UL 50.

b. Panelboards series short-circuit current rating: 22,000 amperes symmetrical minimum for the main breaker and the branch breakers.

c. Panelboards for use as service disconnecting means: additionally conform to UL 869A.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.

f. Where "space only" is indicated, make provisions for future installation of breakers.

g. Provide cover with latching door.

h. Directories: indicate load served by each circuit in panelboard.

i. Directories: indicate source of service to panelboard (e.g., Panel PA served from panel MDP)

j. Type directories and mount behind in holder with transparent protective covering on inside of panel door.

2.16.1 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide copper or aluminum bus bars, either tin plated or silver plated. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

~~2.16.2 Circuit Breakers~~

~~UL 489 thermal magnetic type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Half-size and tandem breakers are not acceptable. Provide switch duty rated 15 and 20 ampere breakers. Breakers must not require use of panel trim to secure them to the bus.~~

~~2.16.2.1 Multipole Breakers~~

~~Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any two adjacent breaker poles are connected to Phases A and B respectively.~~

~~2.16.2.2 Arc-Fault Circuit-Interrupters~~

~~UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.~~

~~]~~2.15 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.~~[~~ Provide solid neutral.~~]~~

~~[~~2.16 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs): UL 508 and UL 489, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with the requirements of NFPA 70.

~~]~~2.17 TRANSFORMERS

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled,~~[~~ ventilated~~][~~ unventilated~~][~~ sealed~~]~~.

b. Provide transformers in NEMA~~[~~ 1~~][~~ 3R~~][~~_____~~]~~ enclosure.

c. Taps for transformers 15 kVA and larger: ~~[~~ Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and four 2.5 percent taps Full Capacity Below Nominal (FCBN)~~] [~~Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and two 2.5 percent taps Full Capacity Below Nominal (FCBN)~~] [~~_____~~]~~.

d. Transformer insulation system:

(1) 220 degrees C insulation system for transformers 15 kVA and

greater, with temperature rise not exceeding [115] [80] degrees C under full-rated load in maximum ambient of 40 degrees C.

(2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient of 40 degrees C.

[e. Transformer of 150 degrees C temperature rise is not acceptable.

][f. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

][g. Transformer of 80 degrees C temperature rise: capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

][h. Transformers: quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

]2.17.1 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in 10 CFR 431, Subpart K.

[2.17.2 Transformers With Non-Linear Loads

Provide transformers for non-linear loads in accordance with the following:

a. Transformer insulation: UL recognized 220 degrees C system. Neither the primary nor the secondary temperature is allowed to exceed 220 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load.

b. Transformers are to be UL listed and labeled for[K-4][K-9][K-13][K-Factor rating as indicated] in accordance with UL 1561.

c. Transformers evaluated by the UL K-Factor evaluation: listed for[115][80] degrees C average temperature rise only.

d. Transformers with K-Factor ratings with temperature rise of 150 degrees C rise are not acceptable.

e. K-Factor rated transformers impedance: allowed range of 3 percent to 5 percent, with a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

]2.18 MOTORS

Provide motors in accordance with the following:

a. NEMA MG 1[except provide fire pump motors as specified in Section 21 30 00] FIRE PUMPS.

ba. Hermetic-type sealed motor compressors: Also comply with UL 984.

~~c~~b. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.

~~d~~c. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.

~~e~~d. Rate motors for operation on 208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.

~~f~~e. Use motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

~~g~~f. Unless otherwise indicated, use continuous duty type motors if rated 1 HP and above.

~~h~~g. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

~~i~~h. Use ~~[~~Inverter-Rated~~] [Inverter-Duty]~~ motors designed to operate with adjustable speed drive (ASD).

2.18.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors: high efficiency types are not acceptable. In exception, for special purpose motors and motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.18.2 Premium Efficiency Polyphase and Single-Phase Motors

Select polyphase and continuous-duty single phase motors based on high efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 10 and NEMA MG 11. In addition, continuous rated, polyphase squirrel-cage medium induction motors must meet the requirements for premium efficiency electric motors in accordance with NEMA MG 1, including the NEMA full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.18.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

2.18.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment ~~[~~using adjustable speed drive (ASD) manufacturer required wiring type and length~~] [, and motor control equipment forming part of motor control centers or switchgear assemblies, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment] as specified herein. Power wiring and conduit: conform to the requirements specified herein.~~ Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

2.19 MOTOR CONTROLLERS

Provide motor controllers in accordance with the following:

a. UL 508, NEMA ICS 1, and NEMA ICS 2~~[, except fire pump controllers as specified in Section 21 30 00 FIRE PUMPS]~~.

b. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

c. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.

d. Provide protection for motors from immediate restart by a time adjustable restart relay.

e. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.

f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.

g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.

h. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.

~~[~~ i. Provide selector switch with the means for locking in any position.

~~]~~ j. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

k. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.

l. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

~~[m. Minimum short-circuit withstand rating of combination motor controller: [_____] rms symmetrical amperes.~~

~~]~~[~~n~~m. Provide controllers in hazardous locations with classifications as indicated.

~~]~~2.19.1 Control Wiring

Provide control wiring in accordance with the following:

a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards.

b. Hinge wire: Class K stranding.

c. Current transformer secondary leads: not smaller than No. 10 AWG.

d. Control wire minimum size: No. 14 AWG.

e. Power wiring for 480-volt circuits and below: the same type as control wiring with No. 12 AWG minimum size.

f. Provide wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.19.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

a. NEMA ICS 4.

b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.

c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.

d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.

e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.

f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.

g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity,

and are constructed to assure positive contact between current-carrying parts.

2.19.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.19.3 Control Circuits

~~[~~ Control circuits: maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers: conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side.~~[~~ Provide fuses in each ungrounded primary feeder~~]~~. Provide one fused secondary lead with the other lead grounded.~~[~~ For designated systems, as indicated, provide backup power supply~~, including transformers connected to[emergency power source][_____]~~. Provide for automatic switchover and alarm upon failure of primary control circuit.~~]~~

~~][Control circuits: maximum voltage of 120 volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. Provide one fused secondary lead with the other lead grounded.[For designated systems, as indicated, provide backup power supply, including connection to[emergency power source][_____]. Provide for automatic switchover and alarm upon failure of primary control circuit.]~~

~~]~~2.19.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.19.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers: include compelling relays and multiple-button, station-type with pilot lights for each speed.

2.19.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and

one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

2.19.7 Pilot and Indicating Lights

[Provide LED cluster lamps.][Provide transformer, resistor, or diode type.]

[2.19.8 Reduced-Voltage Controllers

Provide for polyphase motors [_____] horsepower and larger. Reduced-voltage starters: single-step, closed transition[autotransformer,][reactor,][primary resistor-type,][solid state-type,] or as indicated, with an adjustable time interval between application of reduced and full voltages to motors.[Wye-delta reduced voltage starter or part winding increment starter having adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced-voltage starters for starting of[motor-generator sets,][centrifugally operated equipment,][or][reciprocating compressors provided with automatic unloaders].]

]2.20 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

[Single][Double][Three] pole designed for[flush][surface] mounting with overload protection[and pilot lights].

2.20.1 Pilot Lights

[Provide yoke-mounted, seven element LED cluster light module. Color:[green][red][amber][in accordance with NEMA ICS 2].][Provide yoke-mounted, candelabra-base sockets rated 125 volts and fitted with glass or plastic jewels. Provide clear, 6 watt lamp in each pilot switch. Jewels for use with switches controlling motors: green; jewels for other purposes:[white][red][amber].]

2.21 MOTOR CONTROL CENTERSMOTOR CONTROL CENTERS

Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices.

Provide motor control centers in accordance with the following:

a. UL 845, NEMA ICS 2, NEMA ICS 3.

b. Wiring: Class[I][II], Type[A][B][C], in NEMA Type[1][3R][12][_____] enclosure.

c. Provide control centers suitable for operation on [_____]-volt, [_____]-phase, [_____]-wire, [_____] Hz system with minimum short-circuit withstand and interrupting rating of[100,000][65,000][42,000][25,000][_____] amperes rms symmetrical.

d. Incoming power feeder: [bus duct][cable] entering at the[top][bottom] of enclosure and terminating on[terminal lugs][main

protective device].

[e. Main protective device: [molded case circuit breaker][low-voltage power circuit breaker][fusible switch] rated at [_____] amperes rms symmetrical interrupting capacity.

][f. Arrange busing so that control center can be expanded from both ends.

] g. Interconnecting wires: copper.

h. Terminal blocks: plug-in-type so that controllers may be removed without disconnecting individual control wiring.

2.21.1 Bus Systems

Provide the following bus systems. Power bus: be braced to withstand fault current of[100,000][65,000][42,000][25,000][_____] amperes rms symmetrical. Wiring troughs: isolated from horizontal and vertical bus bars.

2.21.1.1 Horizontal and Main Buses

Horizontal bus: continuous current rating of[600][800][1000][1200][_____] amperes. Main bus: [aluminum, tin-plated][copper, silver-plated] enclosed in isolated compartment at top of each vertical section. Main bus: isolated from wire troughs, starters, and other areas.

2.21.1.2 Vertical Bus

Vertical bus: continuous current rating of[300][450][600][_____] amperes, and [aluminum, tin-plated][copper, tin-plated][copper, silver-plated]. Vertical bus: enclosed in flame-retardant, polyester glass "sandwich."

2.21.1.3 Ground Bus

Copper ground bus: provided full width of motor control center and equipped with necessary lugs.

[2.21.1.4 Neutral Bus

Insulated neutral bus: provided continuous through the motor control center; neutral full rated. Provide lugs of appropriate capacity, as required.

][2.21.1 Combination Motor Controllers

UL 508 and other requirements in paragraph, MOTOR CONTROLLERS. Provide in controller a[molded case circuit breaker][fusible switch with clips for [R_____]-type fuses for branch circuit protection].[Minimum short circuit withstand rating of combination motor controller: [_____] rms symmetrical amperes.][Circuit breakers for combination controllers: [thermal magnetic][magnetic only].]

][2.21.2 Space Heaters

Provide space heaters where indicated on the drawings, controlled using an adjustable 50 to 90 degrees F thermostat, magnetic contactor, and a molded-case circuit breaker[and a 480-120 volt single-phase

~~transformer]. Provide space heaters equipped with 250-watt, 240 volt strip elements operated at 120 volts and[supplied from the motor control center bus][wired to terminal blocks for connection to 120-volt single-phase power sources located external to the control centers]. Contactors: open type, electrically-held, rated 30 amperes, 2-pole, with 120-volt ac coils.~~

~~]~~2.22 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.23 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires~~[~~ wireways,~~]][~~ cable trays, ~~]~~ and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein.~~[Additional telecommunications requirements are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.]~~

~~[2.24 COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM~~

~~[Additional CATV requirements are specified in Section 27 05 13.43 TELEVISION DISTRIBUTION SYSTEM.~~

~~][2.24.1 CATV Outlets~~

~~Provide flush mounted, 75-ohm, F-type connector outlet rated from 5 to 1000 MHz in standard electrical outlet boxes[with isolation barrier] with mounting frame.~~

~~][2.24.2 CATV Faceplates~~

~~Provide modular faceplates for mounting of CATV Outlets.[Faceplate: include designation labels and label covers for circuit identification.] Faceplate color: match outlet and switch coverplates.~~

~~][2.24.3 Backboards~~

~~[Provide void-free, fire rated interior grade plywood, 3/4 inch thick, [4 by 8 feet][as indicated]. Do not cover the fire stamp on the backboard.][Coordinate CATV backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING.]~~

~~]]~~2.24 GROUNDING AND BONDING EQUIPMENT

2.24.1 Ground Rods

UL 467. Ground rods: cone pointed~~[~~ copper-clad steel~~][solid copper][stainless steel]~~, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional type rods may be used for rods 20 feet or longer.

~~[~~2.24.2 Ground Bus

Copper ground bus: provided in the electrical equipment rooms as indicated.

~~]2.24.3 Secondary Bonding Busbar~~

~~Provide corrosion-resistant grounding busbar suitable for[indoor][outdoor] installation in accordance with TIA-607. Busbars: plated for reduced contact resistance. If not plated, clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance. Provide a Primary bonding busbar (PBB) in the telecommunications entrance facility[and a Secondary bonding busbar (SBB) in all other telecommunications rooms and equipment rooms]. The Primary bonding busbar (PBB)[and the Secondary bonding busbar (SBB)]: sized in accordance with the immediate application requirements and with consideration of future growth. Provide Secondary bonding busbars with the following:~~

~~a. Predrilled copper busbar provided with holes for use with standard sized lugs,~~

~~b. Minimum dimensions of 0.25 in thick by 4 in wide for the PBB[and 2 in wide for SBBs] with length as indicated;~~

~~c. Listed by a nationally recognized testing laboratory.~~

~~[~~2.25 HAZARDOUS LOCATIONS

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70: specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations: as indicated. Equipment in hazardous locations: comply with UL 1203 for electrical equipment and industrial controls and UL 674 for motors.

~~]~~2.26 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.27 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with ~~[~~black~~]~~ ~~[_____]~~ center core.

[e. Provide red laminated plastic label with white center core where indicated.

] f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: one by 2.5 inches.

h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.28 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.29 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00 FIRESTOPPING.

2.30 ~~WIREWAYS~~WIREWAYS

UL 870. Material: steel~~[epoxy painted][~~ galvanized~~]~~ 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length~~[~~ indicated~~][required for the application]~~ with~~[hinged-][~~ screw-~~]~~ cover NEMA~~[~~ 1~~][3R][12]~~ enclosure per NEMA ICS 6.

~~[2.31 METERING~~

~~ANSI C12.1. Provide a self-contained, socket-mounted, electronic programmable outdoor watthour meter. Meter: either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements. Coordinate meter, system components, and meter location to be compatible with the Activity's central advanced metering system.~~

~~a. Design: Provide watthour meter designed for use on a single-phase, three-wire,[240/120][480/240] volt system. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).~~

~~b. Class: 200; Form: [2S][_____], accuracy: plus or minus 1.0 percent; Finish: Class II.~~

~~c. Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.~~

~~d. Kilowatt-hour Register: five digit electronic programmable type.~~

~~e. Demand Register:~~

~~(1) Provide solid state.~~

~~(2) Meter reading multiplier: Indicate multiplier on the meter face.~~

~~(3) Demand interval length: programmed for[15][30][60] minutes with rolling demand up to six subintervals per interval.~~

~~f. Socket: ANSI C12.7. Provide NEMA Type 3R, box-mounted socket, ringless, having[manual circuit-closing bypass and having] jaws compatible with requirements of the meter. Provide manufacturers standard enclosure color unless otherwise indicated.~~

~~][2.32 METER BASE ONLY~~

~~ANSI C12.7. Provide NEMA Type 3R, box-mounted socket, ringless, having jaws compatible with requirements of a class: 200 and Form: [2S][_____] self contained watthour meter. Provide gray plastic closing cover and bypass links. Provide manufacturers standard enclosure color unless otherwise indicated.~~

~~]~~2.31 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance~~[, load centers] [~~, and panelboards~~] [, MCC] [and] [_____]~~. Provide surge protectors in a NEMA ~~[~~1~~]~~[_____]~~ enclosure per NEMA ICS 6. SPD must have the same short-circuit current rating as the protected equipment and must not be installed at a point of system where the available fault current is in excess of that rating. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker. Submit performance and characteristic curves.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase (L-L)
Each phase to neutral (L-N)
~~[~~Neutral to ground (N-G)~~]~~
~~[~~Phase to ground (L-G)~~]~~

~~[~~ ~~FOR DELTA CONNECTIONS-~~
~~Phase to phase (L-L)~~
~~Phase to ground (L-G)~~

~~]~~ SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G~~)[and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G)]~~).

~~[~~ Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, and N-G Voltage Protection Rating:

~~[600V for 120V, single phase system]~~
~~[1,000V for 120/240V, single phase system]~~
~~[600V for 120/240V, three phase system]~~
~~[~~600V for 208Y/120V, three phase system~~]~~

[1,200V for 480Y/277V, three phase system]

Maximum L-G Protection Rating:
[700V for 120V, single phase system]
[1,000V for 120/240V, single phase system]
[700V for 120/240V, three phase system]
[700V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-L Voltage Protection Rating:

[1,200V for 120/240V, three phase system]
[1,200V for 208Y/120V, three phase system]
[1,800V for 480Y/277V, three phase system]

]][Provide SPDs. Maximum L-N, L-G, and N-G Voltage Protection Rating:

[700V for 120V, single phase system]
[700V for 120/240V, single phase system]
[700V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-L Voltage Protection Rating:

[1,200V for 120V, single phase system]
[1,200V for 120/240V, single phase system]
[1,200V for 208Y/120V, three phase system]
[2,000V for 480Y/277V, three phase system]

] The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120 percent of nominal voltage for 240 volts and below; 115 percent of nominal voltage above 240 volts to 480 volts.

[Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

]2.32 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.

f. Equipment located indoors: ANSI Light Gray~~,[and equipment located outdoors: ANSI[Light Gray][Dark Gray]]~~.

g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.33 SOURCE QUALITY CONTROL

2.33.1 Transformer Factory Tests

Submittal: include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

~~[2.34 COORDINATED POWER SYSTEM PROTECTION~~

~~Prepare analyses as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.~~

~~]~~PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70~~[~~ and IEEE C2~~]~~ and to requirements specified herein.

~~[~~3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

~~][3.1.2 Overhead Service~~

~~Overhead service conductors into buildings: terminate at service entrance fittings or weatherhead outside building. Overhead service conductors and support bracket for overhead conductors are included in[Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.]~~

~~][~~3.1.2 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Provide conduit with tapered threads.

~~]~~3.1.3 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.3.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of

enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.4 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways.~~[~~ Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters.~~]~~ Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00 FIRESTOPPING.

3.1.4.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

~~[3.1.4.2 Metal-Clad Cable~~

~~Install in accordance with NFPA 70, Type MC cable.~~

~~][3.1.4.3 Armored Cable~~

~~Install in accordance with NFPA 70, Type AC cable.~~

~~][3.1.4.4 Flat Conductor Cable~~

~~Install in accordance with NFPA 70, Type FCC cable.~~

~~]~~3.1.5 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.~~[Run conduits[in crawl space][under floor slab] as if exposed.]~~

~~3.1.5.1 Restrictions Applicable to Aluminum Conduit~~

~~a. Do not install underground or encase in concrete or masonry.~~

~~b. Do not use brass or bronze fittings.~~

~~c. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).~~

3.1.5.1 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors.

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

~~[~~3.1.5.2 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40.

(1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, fire pump rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.

(2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

b. PVC Schedule 40 and Schedule 80.

(1) Do not use where subject to physical damage, including but not limited to, hospitals, power plant, missile magazines, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

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~~]~~3.1.5.3 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.5.4 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40~~[~~; or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab.~~]~~ Plastic coating: extend minimum 6 inches above floor.

~~[3.1.5.5 Conduit Interior to Buildings for 400 Hz Circuits~~

~~Aluminum or nonmetallic. Where 400-Hz circuit runs underground or through~~

~~concrete, provide PVC Schedule[40][80] conduit.~~

~~]~~3.1.5.5 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or IMC only.

3.1.5.6 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of ~~[~~12~~]~~ ~~[_____]~~ inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier. Use NECA NEIS 1 Table 2a (Minimum Raceway Spacing) to determine under floor slab conduit spacing unless greater spacing is required elsewhere in this section.

3.1.5.7 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab. Where conduit rises through slab-on grade, seal all electrical penetrations to address radon mitigation and prevent infiltration of air, insects, and vermin.

~~[3.1.5.8 Conduit Installed in Concrete Floor Slabs~~

~~[Rigid steel; steel IMC; fiberglass, or PVC, Type EPC-40.][PVC, Type EPC-40, unless indicated otherwise.]Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab.[Do not stack conduits.][Do not stack conduits more than two diameters high with minimum vertical separation of [_____] inches.] Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than one inch trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab.[Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.]~~

~~]~~3.1.5.8 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.5.9 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth

proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations.~~[~~ Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 10 foot maximum intervals.~~]~~ Where conduit crosses building expansion joints, provide suitable~~[watertight]~~ expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.5.10 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.5.11 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.5.12 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures~~[~~; for equipment subject to vibration, noise transmission, or movement; and for motors~~]~~. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2 inch diameter. Provide liquid tight flexible~~[nonmetallic]~~ conduit in wet and damp locations~~[and in fire pump rooms]~~ for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.5.13 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA-569.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length

requirements in accordance with TIA-568.1. Size conduits[, wireways][, and cable trays] in accordance with TIA-569[and][as indicated].

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits[, wireways][, and cable trays] for telecommunications risers in accordance with TIA-569[and][as indicated].

[3.1.5.14 Community Antenna Television (CATV) System Conduits

Install a system of CATV wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires[wireways,][cable trays,] and other accessories for CATV outlets and pathway in accordance with TIA-569. [Provide distribution system with star topology with empty conduit and pullwire from each outlet box to the telecommunications room and empty conduit and pullwire from each telecommunications room to the headend equipment location][Provide distribution system with star topology with empty conduit and pullwire from each outlet to the headend equipment location].

]3.1.6 Busway Installation

Comply at minimum with NFPA 70. Install busways parallel with or at right angles to ceilings, walls, and structural members. Support busways at 5 foot maximum intervals, and brace to prevent lateral movement. Provide fixed type hinges on risers; spring-type are unacceptable. Provide flanges where busway makes penetrations through walls and floors, and seal to maintain smoke and fire ratings. Provide waterproof curb where busway riser passes through floor. Seal gaps with fire-rated foam and caulk. Provide expansion joints, but only where bus duct crosses building expansion joints. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.7 Cable Tray Installation

[Install and ground in accordance with NFPA 70.[In addition, install and ground telecommunications cable tray in accordance with TIA-569, and TIA-607]. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Cable tray and tray supports must not partially nor completely obstruct access to the room. Support[in accordance with manufacturer recommendations but at not more than [6] [_____] foot intervals][as indicated].[Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly.] Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum. Terminate cable trays 10 inches from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

~~][Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Cable tray and tray supports must not partially nor completely obstruct access to the room. Support[as indicated][at maximum [6] [_____] foot] intervals.[In addition, install and ground telecommunications cable tray in accordance with TIA-569, and TIA-607][Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly.] Ensure edges, fittings, and hardware are finished free from burrs and sharp edges. Provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section. Use No. 1/0 aluminum wire if cable tray is aluminum. Install conductors that run though smoke and fire partitions in 4 inch rigid steel conduits with grounding bushing, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.~~

~~][~~3.1.6 Telecommunications Cable Support Installation

Install open top and closed ring cable supports on 4 ft to 5 ft centers to adequately support and distribute the cable's weight. Use these types of supports to support a maximum of 50 0.25 in diameter cables. Install suspended cables with at least 3 in of clear vertical space above the ceiling tiles and support channels (T-bars). Open top and closed ring cable supports: suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight.

~~]~~3.1.7 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces,~~[when surface mounted on interior walls exposed up to 7 feet above floors and walkways,][or when installed in hazardous areas]~~ and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic~~[sheathed cable]~~ conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel.~~[~~ Threaded studs driven in by powder charge and provided with lock washers and nuts~~[~~ or nail-type nylon anchors~~]~~ may be used in lieu of wood screws, expansion shields, or machine screws.~~]~~ In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers.

Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.7.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of ~~{4 inches square by 2 1/8 inches deep]{~~4 11/16 inches square by 2 1/8 inches deep~~]{~~, except for ~~{~~ wall mounted telephones~~] [and] [outlet boxes for handicap telephone stations]}~~. Mount outlet boxes flush in finished walls.

3.1.7.2 Pull Boxes

Construct of at least minimum size required by NFPA 70~~{~~ of code-gauge aluminum or galvanized sheet steel,~~]{~~ and~~]{~~ compatible with nonmetallic raceway systems,~~]~~ except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

~~{~~3.1.7.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

~~]~~3.1.8 Mounting Heights

Mount panelboards,~~{~~ enclosed~~]~~ circuit breakers,~~{~~ motor controller~~]~~ and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. Mount lighting switches~~{ and handicapped telecommunications stations]{~~ 48 inches above finished floor~~]~~. Mount receptacles~~{~~ and telecommunications outlets~~]~~ 18 inches above finished floor~~{~~, unless otherwise indicated~~]~~.~~{~~ Wall-mounted telecommunications outlets: mounted at height~~{ 60 inches above finished floor]{~~ indicated~~]~~.~~] {~~ Mount other devices as indicated.~~]{ Measure mounting heights of wiring devices and outlets[in non-hazardous areas]to center of device or outlet.]{ Measure mounting heights of receptacle outlet boxes in the[hazardous area][_____] to the bottom of the outlet box.]~~

~~{3.1.9 Nonmetallic Sheathed Cable Installation~~

~~Where possible, install cables concealed behind ceiling or wall finish. Thread cables through holes bored on approximate centerline of wood members; notching of end surfaces is not permitted. Provide sleeves through concrete or masonry for threading cables. Install exposed cables parallel to or at right angles to walls or structural members. Protect exposed nonmetallic sheathed cables less than 4 feet above floors from mechanical injury by installation in conduit or tubing. When cable is used in metal stud construction, insert plastic stud grommets in studs at each point through which cable passes, prior to installation of cable.~~

~~][3.1.10 Mineral Insulated, Metal Sheathed (Type MI) Cable Installation~~

~~Mineral-insulated, metal-sheathed cable system, Type MI, may be used in lieu of exposed conduit and wiring. Conductor sizes: not less than those indicated for the conduit installation. Fasten cables within 12 inches of each turn or offset and at 33 inches maximum intervals. Make cable terminations in accordance with NFPA 70 and cable manufacturer's recommendations. Terminate single-conductor cables of a circuit, having capacities of more than 50 amperes, in a single box or cabinet opening. Color code individual conductors in all outlets and cabinets.~~

~~]~~3.1.9 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. ~~Identify control circuit terminations in accordance with[Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.][Section [_____], [_____]][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][manufacturer's recommendations].[~~ Provide telecommunications system conductor identification as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.~~]~~

3.1.9.1 Marking Strips

Provide marking strips for identification of power distribution, control, data, and communications cables in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.10 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.10.1 Splices of Aluminum Conductors

Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

~~[~~3.1.11 Terminating Aluminum Conductors

3.1.11.1 Termination to Copper Bus

Terminate aluminum conductors to copper bus either by: (a) inline splicing a copper pigtail, of ampacity at least that of aluminum conductor, or (b) utilizing circumferential, compression-type, aluminum-bodied terminal lug UL listed for AL/CU, and steel Belleville cadmium-plated hardened steel spring washers, flat washers, bolts, and nuts. Carefully install Belleville spring washers with crown up toward nut or bolt head, with concave side of Belleville bearing on heavy-duty, wide series flat washer of larger diameter than Belleville. Tighten nuts sufficiently to flatten Belleville, and leave in position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

3.1.11.2 Termination to Aluminum Bus

Terminate aluminum conductors to aluminum bus by using aluminum nuts, bolts, washers, and compression lugs. Wire brush and apply joint compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection. When bus contact surface is unplated, scratch-brush and coat with joint compound, without grit.

~~]~~3.1.12 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.13 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.14 Grounding and Bonding

Provide in accordance with NFPA 70~~[~~ and NFPA 780~~]~~. Ground exposed, non-current-carrying metallic parts of electrical equipment,~~[access flooring support system,]~~ metallic raceway systems, grounding conductor in

metallic and nonmetallic raceways, telecommunications system grounds, ~~[grounding conductor of nonmetallic sheathed cables,]~~and neutral conductor of wiring systems.~~[~~ Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70.~~]~~[~~ Make ground connection to driven ground rods on exterior of building. Bond additional driven rods together with a minimum of 4 AWG soft bare copper wire buried to a depth of at least 12 inches.~~]~~[~~ Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system.~~]~~ In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.14.1 Ground Rods

Provide ground rods and measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, ~~[_____]~~ additional rods, spaced on center. Spacing for additional rods must be a minimum of 10 feet~~[, or if sectional type rods are used, [_____] additional sections may be coupled and driven with the first rod]~~.~~[~~ In high-ground-resistance, UL listed chemically charged ground rods may be used.~~]~~ If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.14.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible,~~[excepting specifically those connections for which access for periodic testing is required,]~~ by exothermic weld or high compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.14.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as

indicated. Noncurrent-carrying metal parts of~~[~~ transformer neutrals and other electrical~~][electrical]~~ equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment.~~[For raised floor equipment rooms in computer and data processing centers, provide a minimum of four, one at each corner, ground buses connected to the building grounding system. Use bolted connections in lieu of thermoweld, so they can be changed as required by additions and alterations.]~~

3.1.14.4 Resistance

Maximum resistance-to-ground of grounding system: do not exceed~~[5]~~ ~~[_____]~~ ohms under dry conditions. Where resistance obtained exceeds~~[5]~~ ~~[_____]~~ ohms, contact Contracting Officer for further instructions.

3.1.14.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a Primary bonding busbar (PBB) in the telecommunications entrance facility. Install the PBB as close to the electrical service entrance grounding connection as practicable.~~[~~ Provide a Secondary bonding busbar (SBB) in all other telecommunications rooms and telecommunications equipment rooms. Install the SBB as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, locate the SBB near the backbone cabling and associated terminations. In addition, locate the SBB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a SBB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the SBB.~~]~~ Install Secondary bonding busbars to maintain clearances as required by NFPA 70 and insulated from its support. A minimum of 2 inches separation from the wall is recommended to allow access to the rear of the busbar and adjust the mounting height to accommodate overhead or underfloor cable routing.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the PBB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, bond the conductors to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.~~[~~ Provide a telecommunications bonding backbone (TBB) that originates at the PBB extends throughout the building using the telecommunications backbone pathways, and connects to the SBBs in all telecommunications rooms and equipment rooms. Install the TBB conductors such that they are protected from physical and mechanical damage. The TBB conductors should be installed without splices and routed in the shortest possible straight-line path. Make the bonding conductor between a TBB and a SBB continuous. Where

splices are necessary, the number of splices should be a minimum. Make the splices accessible and located in telecommunications spaces. Connect joined segments of a TBB using exothermic welding, irreversible compression-type connectors, or equivalent. Install all joints to be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, bond the TBBs together with a grounding equalizer (GE) at the top floor and at a minimum of every third floor in between. Do not connect the TBB and GE to the pathway ground, except at the PBB or the SBB.~~]~~

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the PBB~~[~~ or SBB~~]~~: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the PBB~~[~~ or SBB~~]~~ to the PBB~~[~~ or SBB respectively~~]~~. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each PBB~~[~~ and SBB~~]~~ to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the SBB or PBB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the SBB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

3.1.15 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.16 Elevator

Instructions below apply to the Building P4639 new elevator.

Provide circuit to line terminals of elevator controller, and disconnect switch on line side of controller, outlet for control power, outlet receptacle and work light at midheight of elevator shaft, and work light and outlet receptacle in elevator pit.

~~[3.1.17 Government-Furnished Equipment~~

~~Contractor[rough-in for Government-furnished equipment][make connections to Government-furnished equipment] to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.~~

~~]~~3.1.17 Repair of Existing Work

~~Perform repair of existing work[, demolition, and modification of existing electrical distribution systems] as follows:~~

3.1.17.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.17.2 Existing Concealed Wiring to be Removed

Disconnect existing concealed wiring to be removed from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

~~[3.1.17.3 Removal of Existing Electrical Distribution System~~

~~Removal of existing electrical distribution system equipment includes equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings,[back to equipment's power source] as indicated.~~

~~][3.1.17.4 Continuation of Service~~

~~Maintain continuity of existing circuits of equipment to remain. Maintain existing circuits of equipment energized. Restore circuits wiring and power which are to remain but were disturbed during demolition back to original condition.~~

~~][3.1.18 Watthour Meters~~

~~ANSI C12.1.~~

~~]~~3.1.18 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet avoiding 90 degree bends. Do not locate surge protective devices inside a panelboard or switchboard enclosure.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. ~~[Painting: as specified in Section 09 90 00 PAINTS AND COATINGS.][Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or~~

~~specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.]~~

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer~~[~~ 5~~] [_____]~~ working days notice prior to ~~[~~ each~~] [_____]~~ test~~[s]~~. Where applicable, test electrical equipment in accordance with NETA ATS.

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

3.5.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

3.5.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 943.

3.5.5 Arc-Fault Receptacle Test

Test arc-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 1699.

3.5.6 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

~~[3.5.7 Watthour Meter~~

~~a. Visual and mechanical inspection~~

~~(1) Examine for broken parts, shipping damage, and tightness of connections.~~

~~(2) Verify that meter type, scales, and connections are in accordance with approved shop drawings.~~

~~b. Electrical tests~~

~~(1) Determine accuracy of meter.~~

~~(2) Calibrate watthour meters to one-half percent.~~

~~(3) Verify that correct multiplier has been placed on face of meter, where applicable.~~

~~]~~3.5.7 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

-- End of Section --

SECTION 26 27 14.00 20

ELECTRICITY METERING
02/21, CHG 1: 05/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90.1	(2013) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2014) Requirements for Watthour Meter Sockets
ANSI C12.18	(2006; R 2016) Protocol Specification for ANSI Type 2 Optical Port
ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA C12.19	(2012) Utility Industry End Device Data Tables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4)
National Electrical Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES~~[, the CONTRACT CLAUSES and DD Form 1423]~~:

~~[Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.~~

~~]~~ SD-02 Shop Drawings

Installation Drawings; G~~[, [_____]]~~

SD-03 Product Data

Electricity Meters; G~~[, [_____]]~~

~~[~~ The most recent meter product data must be submitted as a Technical Data Package and must be licensed to the project site. Any software must be submitted on CD-ROM and ~~[~~3_____~~]~~ hard copies of the software user manual must be submitted for each piece of software provided.

~~]~~ Current Transformer; G~~[, [_____]]~~

~~[~~ Potential Transformer; G~~[, [_____]]~~

~~]~~ External Communications Devices; G~~[, [_____]]~~

~~[~~ Configuration Software; G~~[, [_____]]~~

The most recent version of the configuration software for each type (manufacturer and model) must be submitted as a Technical Data Package and must be licensed to the project site. Software must be submitted on CD-ROM and ~~[~~3_____~~]~~ hard copies of the software user manual must be submitted for each piece of software provided.

~~]~~ SD-06 Test Reports

Acceptance Checks and Tests; G[, [_____]]

System Functional Verification; G[, [_____]]

Building Meter Installation Sheet, per Building; G[, [_____]]

Completed Meter Installation Schedule; G[, [_____]]

Completed Meter Data Schedule; G[, [_____]]

Meter Configuration Template; G[, [_____]]

Contractor must fill in the meter configuration template and submit to the Activity for concurrence.

Meter Configuration Report; G[, [_____]]

The meter configuration report must be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Electricity Meters and Accessories, Data Package 5; G[, [_____]]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

System Functional Verification; G[, [_____]]

1.3 QUALITY ASSURANCE

1.3.1 Installation Drawings

Drawings must be provided in hard-copy and [_____] electronic format, and must include but not be limited to the following:

a. Wiring diagrams with terminals identified of [kilowatt] [advanced] meter, [current transformers,] [potential transformers,][protocol modules,][communications interfaces,][Ethernet connections,][telephone lines].[For each typical meter installation, provide a diagram.]

b. One-line diagram, including meters, [switch(es),][current transformers,][potential transformers,] [protocol modules,][communications interfaces,][Ethernet connections,][telephone outlets,][and fuses].[For each typical meter installation, provide a diagram.] Provide one-line diagram to the local Public Works department.

1.3.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for one year prior to bid opening. The one-year period must include applications of equipment and materials under similar circumstances and of similar size. The product, or an earlier

release of the product, must have been on sale on the commercial market through advertisements, manufacturers catalogs, or brochures during the prior one-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.3.3 Material and Equipment Manufacturing Data

Products manufactured more than 1 year prior to date of delivery to site must not be used, unless specified otherwise.

1.4 MAINTENANCE

1.4.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual electricity meters and accessories provided:

a. A condensed description of how the system operates

b. Block diagram indicating major assemblies

c. Troubleshooting information

d. Preventive maintenance

e. Prices for spare parts and supply list

1.5 WARRANTY

The equipment items and software must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment and software on a regular and emergency basis during the warranty period of the contract.

1.6 SYSTEM DESCRIPTION

1.6.1 System Requirements

Electricity metering, consisting of meters and associated equipment, will be used to record the electricity consumption and other values as described in the requirements that follow and as shown on the drawings. Communication system requirements are contained in a separate specification section as identified in paragraph COMMUNICATIONS INTERFACES.

1.6.2 Selection Criteria

Metering components and software are part of a system that includes the physical meter, data recorder function and communications method. Every building site identified must include sufficient metering components to measure the electrical parameters identified and to store and communicate the values as required.

~~[Contractor must verify that the electricity meter installed on any building site is compatible with the base-wide metering system with respect to the types of meters selected and the method used to program the meters for initial use. Software and meter programming tools are necessary~~

~~to set up the meters described by this specification. New software tools different from the meter programming methods currently used by base personnel will require an Authority to Operate (ATO) by Command Information Office at the Enterprise level..~~

~~][~~Contractor must verify that the metering system installed on any building site is compatible with the facility-wide or base-wide communication and meter reading protocol system.

~~]~~PART 2 PRODUCTS

2.1 ELECTRICITY METERS AND ACCESSORIES

~~Provide meter(s) and connect the meter(s) to the existing AMI DAS. The contractor must use the existing government laptop computers to configure the meter using existing software loaded on the computer. The contractor will not be allowed to modify any software or add any additional software to the computer. Alternatively, the government will configure the meter(s), which must be compatible with the existing system, using existing software. Contractor must insure that the meter(s) will transmit the specified data to the DAS. The current meters being used by [_____] are: [ION 8600C] [ION 8650C] [PM 8000] [SHARK 270] [NEXUS 1272] [_____].~~

2.1.1 Physical and Common Requirements

a. Provide metering system components in accordance with the Metering System Schedule shown ~~[in this specification]][~~on the drawings~~]~~. Provide Meter configuration template.

~~b. [Replace all existing meter bases. For socket arrangements, use meter and base form of 9S unless installation-specific limitations require the use of a different form type. For panelboards, switchboards, and switchgear, match the existing installation with the new meter base.][Existing meter bases can be re-used if they are electrically functional, in physically good condition, and show no signs of corrosion on the electrical contacts. If the existing meter base is usable, the meter base determines meter form factor. If a new meter is being installed, use meter and base form factor of 9S unless installation-specific limitations require the use of a different form type.][If use of a socket adaptor arrangement has been approved by the activity, contractor must verify that all clearances are met and doors are able to be properly closed.]~~

~~[~~ ~~c~~b. Meter must have NEMA ~~[3R] [~~3R stainless steel~~]~~ enclosure for surface mounting with bottom or rear penetrations.

~~]~~ ~~d~~c. Surge withstand capability must conform to IEEE C37.90.1.

~~e~~d. Use #12 SIS (XHHW, or equivalent) wiring with ring lugs for all meter connections. Color code and mark the conductors~~[~~ as follows:

(1) Red - Phase A CT - C1
(2) Orange - Phase B CT - C2
(3) Brown - Phase C CT - C3
(4) Gray with white stripe - neutral current return - C0
(5) Black - Phase A voltage - V1
(6) Yellow - Phase B voltage - V2
(7) Blue - Phase C voltage - V3
(8) White - Neutral voltage

~~]~~

2.1.2 Potential Transformer Requirements

a. Meter must be capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.

b. Voltage input must be optically isolated to 2500 volts DC from signal and communications outputs. Components must meet or exceed IEEE C37.90.1.

c. Provide ~~[a pull-out type fuse block containing]~~ one fuse per phase, Class RK type, to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer. Fusing must either be inside the secondary compartment of the transformer or inside the same enclosure as the CT shorting device.

~~[~~ d. Potential transformers will be used to convert 480 volt inputs to 120 volts for the locations shown on the metering schedule. Potential transformers must be rated indoor or outdoor, as required for the specific application. Voltage rating must provide 120 volts, wye-connected, 3 phase, 4 wire, ~~[~~60 Hz~~]~~~~[50 Hz]~~, insulation class, 600 volts. Potential transformers BIL must be 10 kV and must have an accuracy class of 0.3 at burdens w, x, and y. Thermal rating must be 500 VA.

~~]~~

~~[e. The Contractor must be responsible for determining the actual voltage ratio of each potential transformer for medium voltage applications. Transformer must conform to IEEE C57.13 and the following requirements.~~

~~(1) Type: Dry type, of two-winding construction.~~

~~(2) Weather: Outdoor or indoor rated for the application.~~

~~(3) Frequency: Nominal [60 Hz][50 Hz].~~

~~(4) Accuracy: Plus or minus 0.3 percent at [60 Hz][50 Hz].~~

~~f. Potential transformers installed inside switchgear and panels must be rated for interior use. Voltage rating must provide 120 volts, wye-connected, 3 phase, 4 wire, [60 Hz][50 Hz], insulation class, 600 volts. Potential transformers BIL must be a minimum of 10 kV, and have an insulation class and BIL rating that equals or exceeds the ratings of the associated switchgear. Potential transformers must have an accuracy class of 0.15 at burdens w, x, and y. Thermal rating must be 500 VA. Potential transformers must be accessed from the front and mounted in a metering section.~~

~~]~~2.1.3 Current Transformer Requirements

a. Current transformer must be installed with a rating as shown in the schedule.

b. Current transformers must have an Accuracy Class of 0.15 (with a maximum error of plus/minus 0.3 percent at 5.0 amperes) when operating within the specified rating factor.

c. Current transformers must be solid-core, bracket-mounted for new

installations using ring-tongue lugs for electrical connections. Current transformers must be accessible and the associated wiring must be installed in an organized and neat workmanship arrangement. Current transformers that are retrofitted onto existing switchgear busbar can be a busbar split-core design.

d. Current transformers must have:

(1) Insulation Class: All 600 volt and below current transformers must be rated 10 KV BIL.~~[Current transformers for 2400 and 4160 volt service must be rated 25 KV BIL.]~~

(2) Frequency: Nominal ~~[~~60 Hz~~][50 Hz]~~.

(3) Burden: Burden class must be selected for the load.

(4) Phase Angle Range: 0 to 60 degrees.

e. Meter must accept current input from standard instrument transformers (5A secondary current transformers).

f. Current inputs must have a continuous rating in accordance with IEEE C57.13.

g. Provide one single-ratio current transformer for each phase per power transformer with characteristics listed in the following table.

Single-Ratio Current Transformer Characteristics				
kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
~~[~~500	~~[~~208Y:120	~~[~~1200:5	~~[~~1.33	~~[~~0.3 thru B0.05
~~[750]~~300	~~[~~480Y:277	~~[~~8300:~~/~~5	~~[1.33]~~20.	~~[~~0.3 thru B~~0.~~-0.2~~5~~

2.1.4 Meter Requirements

~~[Notwithstanding any other provision of this contract, meters must be [_____]; no other product will be acceptable. All meters must meet NAVFAC Cyber Security Requirements.~~

~~][~~Electricity meters must include the following features:

a. Meter must comply with ANSI C12.1, NEMA C12.19, and ANSI C12.20 and must match existing AMI meter system at the installation and be the newest version with ATO.

b. Meter sockets must comply with ANSI C12.7.

~~[c. Meter must comply with IEC 62053-22, certified by a qualified third party test laboratory.~~

~~d~~c. Meter must be certified by a qualified 3rd party test laboratory.

~~]~~ ~~e~~d. Provide socket-mounted or panel mounted meters as indicated on the meter schedule.

~~[(1) Panel-mounted meters must be semi-flush, back-connected, dustproof, draw-out switchboard type. Cases must have window removable covers capable of being sealed against tampering. Meters must be of a type that can be withdrawn through approved sliding contacts from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Necessary test devices must be incorporated within each meter and must provide means for testing either from an external source of electric power or from associated instrument transformers or bus voltage.~~

~~]~~

~~f~~e. Meter must be a Class 20, transformer rated design.

~~[g. Use Class 200 meters for direct current reading without current transformers for applications with an expected load less than 200 amperes, where indicated.~~

~~]~~ f~~h~~. Meter must be rated for use at temperature from minus 40 ~~[_____]~~ degrees Centigrade to plus 70 ~~[_____]~~ degrees Centigrade.

~~i~~g. The meters must have an electronic demand recording register and must be secondary reading as indicated. The register must be used to indicate maximum kilowatt demand as well as cumulative or continuously cumulative demand. Demand must be measured on a block-interval basis and must be capable of a 5 to 60 minute interval and initially set to a 15-minute interval. It must have provisions to be programmed to calculate demand on a rolling interval basis. Meter readings must be true RMS.

~~j~~h. The meter electronic register must be of modular design with non-volatile data storage. Downloading meter stored data must be capable via an ~~[~~optical~~][USB]~~ port. Recording capability of data storage with a minimum capability of 89 days of 15 minute, 2 channel interval data. The meter must be capable of providing at least 2 KYZ pulse outputs (dry contacts). Default initial configuration (unless identified otherwise by base personnel) must meet NAVFAC CIRCUITS Call for Consistency document located on the NAVFAC CIRCUITS Portal and must be:

(1) First channel - kWh
(2) Second channel - kVARh
(3) KYZ output #1 - kWh
(4) KYZ output #2 - kVARh

~~k~~i. All meters must have identical features available in accordance with this specification. The meter schedule identifies which features must be activated at each meter location.

~~l. Enable switches for Time of Use (TOU), pulse and load profile measurement module at the factory.~~

~~m~~j. Meter must have an optical port on front of meter. Optical device must be compatible with ANSI C12.18.

~~n~~k. Meters must be 120-480 volts auto ranging.

~~o~~l. Provide blank tag fixed to the meter faceplate for the addition of the meter multiplier, which will be the product of the current

transformer ~~[and potential transformer]~~ratio and will be filled in by base personnel on the job site. The meter's nameplate must include:

(1) Meter ID number.
(2) Rated voltage.
(3) Current class.
(4) Metering form.
(5) Test amperes.
(6) Frequency.
(7) Catalog number.
(8) Manufacturing date.

~~p~~m. On switchboard style installations, provide switchboard case with disconnect means for meter removal incorporating short-circuiting of current transformer circuits.

~~q~~n. Meter covers must be polycarbonate resins with an optical port and reset. Backup battery must be easily accessible for change-out after removing the meter cover.

~~r~~o. The normal billing data scroll must be fully programmable. The normal billing data scroll requirements provided in the CIRCUITS Call for Consistency Document located on the NAVFAC CIRCUITS Portal. Data scroll display must include the following.

(1) Number of demand resets.
(2) End-of-interval indication.
(3) Maximum demand.
(4) New maximum demand indication.
(5) Cumulative or continuously cumulative.
(6) Time remaining in interval.
(7) Kilowatt hours.

~~s~~p. The register must incorporate a built-in test mode that allows it to be tested without the loss of any data or parameters. The following quantities must be available for display in the test mode:

(1) Present interval's accumulating demand.
(2) Maximum demand.
(3) Number of impulses being received by the register.

~~t~~q. Pulse module simple I/O board with programmable ratio selection.

~~u~~r. Meters must be programmed after installation via an ~~[~~optical~~][USB]~~ port. Optical display must show TOU data, peak kWh, semi-peak kWh, off peak kWh, and phase angles.

~~v~~s. Self-monitoring to provide for:

(1) Unprogrammed register.
(2) RAM checksum error.
(3) ROM checksum error.
(4) Hardware failure.
(5) Memory failure.
(6) EPROM error.
(7) Battery status (fault, condition, or time in service).

~~w~~t. Liquid crystal alphanumeric displays, 9 digits, blinking squares confirm register operation. Six Large digits for data and smaller

digits for display identifier.

~~x~~u. Display operations, programmable sequence with display identifiers. Display identifiers must be selectable for each item. Continually sequence with time selectable for each item.

~~y~~v. The meters must support three modes of registers: Normal Mode, Alternate Mode, and Test Mode. The meter also must support a "Toolbox" or "Service Information" (accessible in the field) through an optocom port to a separate computer using the supplied software to allow access to instantaneous service information such as voltage, current, power factor, load demand, and the phase angle for individual phases.

~~z~~w. Meter must have a standard ~~[~~4~~]~~ ~~[_____]~~-year warranty.

~~]~~2.1.5 Disconnect Method

a. Provide a 10-pole safety disconnect complete with isolation devices for the voltage and current transformer inputs, including a shorting means for the current transformers.

~~[b. Disconnecting wiring blocks must be provided between the current transformer and the meter. A shorting mechanism must be built into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. The wiring blocks must be located where they are accessible without the necessity of disconnecting power to the transformer.~~

~~c~~b. Voltage monitoring circuits must be equipped with disconnect switches to isolate the meter base or socket from the voltage source.

~~]~~2.1.6 Installation Methods

a. Transformer Mounted ("XFMR" in Metering Systems Schedule). Meter base must be located outside on the secondary side of the pad-mounted transformer.

~~b. Stand Mounted Adjacent to Transformer ("STAND" in Metering Systems Schedule). Meter base must be mounted on a structural steel pole approximately 4 feet from the transformer pad. This can be used for multiple meters associated with a single transformers.~~

~~c. Building Mounted ("BLDG" in Metering Systems Schedule). Meter base must be mounted on the side of the existing building near the service entrance.~~

~~d. Panel Mounted. ("PNL" in Metering Systems Schedule). Meter must be mounted where directed.~~

~~e. Commercial meter pedestal ("PED" in Metering Systems Schedule).~~

2.2 COMMUNICATIONS INTERFACES

Meter must have two-way communication with the existing data acquisition system (DAS). Provide a communications interface utilizing ~~[_____]~~900 MHz high powered encoded radio transmission (ERT) module.~~[Refer to Section [_____] for the communication interface requirements for these meters.]~~

~~Provide interfacing software if a meter is used that is different than the existing meters at the Activity to ensure compatibility within the metering system.~~

Connect to the AMI network utilizing ~~[_____]~~Itron Choice Connect (Fixed Network) version 5.0.~~.~~

~~[Provide [_____].~~

~~][2.3 SPARE PARTS~~

~~Provide the following spare parts:~~

~~a. Power Meter - two for each type used with batteries.~~

~~b. Communications interface - one for each type used.~~

~~]2.4 METERING SYSTEM SCHEDULE~~

~~[_____]~~

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to ASHRAE 90.1 - IP, ASHRAE 90.1 - SI IEEE C2, NFPA 70 (National Electrical Code), and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

~~[~~3.1.1 Existing Condition Survey

The Contractor must perform a field survey, including inspection of all existing equipment, resulting clearances, and new equipment locations intended to be incorporated into the system and furnish an existing conditions report to the Government. The report must identify those items that are non-workable as defined in the contract documents. The Contractor must be held responsible for repairs and modifications necessary to make the system perform as required.

3.1.1.1 Existing Meter Sockets

In some cases, the existing meter sockets will have to be replaced to accommodate the new electrical meters. An existing socket is considered unacceptable for any of the following conditions:

a. It is a non-ANSI form factor meter socket.

b. It is weathered beyond the point of being safe to reuse.

c. It is installed incorrectly, such as a non-weather resistant enclosure installed outdoors.

d. It is not the correct form factor for the existing electrical service.

3.1.1.2 Existing Installations

As part of the existing condition survey, the following applies for installations with existing meters:

a. Replace any meters that do not comply with this section.

b. If CTs are installed, verify that they comply with this section. If they do not comply, replace them with CTs that comply with this section. One CT per phase is required for wye-connected systems.

~~[c. If potential transformers are installed on low-voltage systems, remove the PTs as part of the installation.~~

~~]~~ ~~d~~c. Install disconnect switches as specified in this section.

~~][~~3.1.2 Scheduling of Work and Outages

The Contract Clauses must govern regarding permission for power outages, scheduling of work, coordination with Government personnel, and special working conditions.~~[ ]~~

~~]~~3.1.3 Configuration Software

The standard meter must include the latest available version of firmware and software. Meter must either be programmed at the factory or must be programmed in the field. Meters must have a password that must be provided to the contracting officer upon project completion. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. When interfacing software is used for a meter that is different than the existing meters in use at the Activity, turn the software over to the Contracting Officer at completion of the project.

3.2 FIELD QUALITY CONTROL

Perform the following acceptance checks and tests on all installed meters.

3.2.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

a. Meter Assembly

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specifications and approved shop drawings.

(b) Inspect physical and mechanical condition. Confirm the meter is firmly seated in the socket, the socket is not abnormally heated, the display is visible, and the ring and seal on the cover are intact.

(c) Inspect all electrical connections to ensure they are tight. For Class 200 services, verify tightness of the service conductor terminations for high resistance using low-resistance ohmmeter, or by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(d) Record model number, serial number, firmware revision,

software revision, and rated control voltage.

(e) Verify operation of display and indicating devices.

(f) Record password and user log-in for each meter.

(g) Verify grounding of metering enclosure.

(h) Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements. Verify that the CT ratio and the PT ratio are properly included in the meter multiplier or the programming of the meter. Confirm that the multiplier is provided on the meter face or on the meter.

(i) Provide building meter installation sheet, per building for each facility. See example Graphic E-S1.

~~[(j) Provide the completed meter installation schedule for the installation if multiple meters are to be used. See example Graphic E-S2~~

~~]][(k) Provide the completed meter data schedule for the installation if multiple meters are to be used. See example Graphic E-S3.~~

~~]~~ (2) Electrical tests.

(a) Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.

(b) Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.

(c) After initial system energization, confirm measurements and indications are consistent with loads present.

(d) Make note of, and report, any "Error-Code" or "Caution-Code" on the meter's display.

(3) Provide meter configuration report.

b. Current Transformers

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specification and approved shop drawings.

(b) Inspect physical and mechanical condition.

(c) Verify correct connection, including polarity.

(d) Inspect all electrical connections to ensure they are tight.

(e) Verify that required grounding and shorting connections provide good contact.

(2) Electrical Tests.

Verify proper operation by reviewing the meter configuration report.

~~[c. Potential Transformers~~

~~(1) Visual and mechanical inspection.~~

~~(a) Verify potential transformers are rigidly mounted.~~

~~(b) Verify potential transformers are the correct voltage.~~

~~(c) Verify that adequate clearances exist between the primary and secondary circuit.~~

~~(2) Electrical Tests.~~

~~(a) Verify by the meter configuration report that the polarity and phasing are correct.~~

~~]~~3.2.2 System Functional Verification

Verify that the installed meters are working correctly in accordance with the meter configuration report:

a. The correct meter form is installed.

b. All voltage phases are present.

c. Phase rotation is correct.

d. Phase angles are correct.

e. The new meter accurately measures power magnitude and direction, and can communicate as required by paragraph COMMUNICATIONS INTERFACES.

-- End of Section --

SECTION 26 28 01.00 10

COORDINATED POWER SYSTEM PROTECTION
08/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis

1.2 SYSTEM DESCRIPTION

The power system covered by this specification consists of: ~~[_____]~~A New 480Y/277V, 3 phase, 4 wire electrical service and distribution system, at each of the new Buildings P4638 and P4639.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fault Current Analysis

Protective Device Coordination Study

System Coordinator

1.4 QUALITY ASSURANCE

1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis must be accomplished by a registered professional electrical power engineer with a minimum of ~~[~~3~~]~~ ~~[_____]~~ years of current experience in the coordination of electrical power systems. Submit verification of experience and license number, of a registered Professional Engineer as specified above. Provide experience data consisting of at least five references for work of a magnitude comparable

to this contract, including points of contact, addresses and telephone numbers.

PART 2 PRODUCTS

2.1 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. Include a load flow analysis, a fault current analysis, and a protective device coordination study. Submit the study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study. The studies must be performed by a registered professional engineer with demonstrated experience in power system coordination in the last ~~[~~3~~]~~ ~~[_____]~~ years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.1.1 Scope of Analyses

The fault current analysis and protective device coordination study must begin at: ~~[~~the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.~~]~~ ~~[the source bus and extended through the secondary side of transformers for medium voltage distribution feeders.] [the source bus and extend through [outgoing breakers] [outgoing medium voltage feeders, down to the individual protective devices for medium voltage radial taps] [outgoing medium voltage feeders, through the secondary side of transformers] [as indicated] for main electric supply substations.] [the nearest upstream device in the existing source system and extend through the downstream devices at the load end.]~~

2.1.2 Determination of Facts

Determine and document the time-current characteristics, features, and nameplate data for each existing protective device. ~~[~~Coordinate with the ~~[~~ commercial power company~~]~~ ~~[_____]~~ for fault current availability at the site.~~]~~ ~~[Utilize the fault current availability indicated as a basis for fault current studies.]~~

2.1.3 Single Line Diagram

Prepare a single line diagram to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point must have a unique identifier. If a fault-impedance diagram is provided, show impedance data. Show location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

2.1.4 Fault Current Analysis

2.1.4.1 Method

Perform the fault current analysis in accordance with methods described in IEEE 242, and IEEE 399.

2.1.4.2 Data

Utilize actual data in fault calculations. Bus characteristics and transformer impedance must be those proposed. Document data in the report.

2.1.4.3 Fault Current Availability

Provide balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values at each voltage transformation point and at each power distribution bus. Show the maximum and minimum values of fault available at each location in tabular form on the diagram or in the report.

2.1.5 Coordination Study

Demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Provide recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction). Provide composite coordination plots on log-log graph paper.

2.1.6 Study report

a. Include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. Include descriptive and technical data for existing devices and new protective devices proposed. Include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. Document ~~[utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings;] [and]~~ ~~[~~ existing power system data including time-current characteristic curves and protective device ratings and settings~~]~~.

d. The report must contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. Include recommended ratings and settings of all protective devices in tabulated form.

e. Provide the calculation performed for the analyses, including computer analysis programs utilized. Provide the name of the software package, developer, and version number.

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM
11/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 780	(2020) Standard for the Installation of Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 96	(2016) UL Standard for Safety Lightning Protection Components
UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 RELATED REQUIREMENTS

1.2.1 Verification of Dimensions

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer before making any departures from the design.

1.2.2 System Requirements

Provide a system furnished under this specification consisting of the latest UL Listed products of a manufacturer regularly engaged in production of lightning protection system components. Comply with NFPA 70, NFPA 780, and UL 96.

1.2.3 Lightning Protection System Installers Documentation

Provide documentation showing that the installer is certified with a

commercial third-party inspection company whose sole work is lightning protection, or is a UL Listed Lightning Protection Installer. In either case, the documentation must show that they have completed and passed the requirements for certification or listing, and have a minimum of 2 years documented experience installing lightning protection systems for DoD projects of similar scope and complexity.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall lightning protection system; G~~[, [_____]]~~

Each major component; G~~[, [_____]]~~

SD-06 Test Reports

Lightning Protection and Grounding System Test Plan; G~~[, [_____]]~~

Lightning Protection and Grounding System Test; G~~[, [_____]]~~

SD-07 Certificates

Lightning Protection System Installers Documentation; G~~[, [_____]]~~

Component UL Listed and Labeled; G~~[, [_____]]~~

Lightning protection system inspection certificate; G~~[, [_____]]~~

Roof manufacturer's warranty; G~~[, [_____]]~~

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" or "must" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.4.1 Installation Drawings

1.4.1.1 Overall System Drawing

Submit installation shop drawing for the overall lightning protection system. Include on the drawings the physical layout of the equipment (plan view and elevations), mounting details, relationship to other parts of the work, and wiring diagrams.

1.4.1.2 Major Components

Submit detail drawings for each major component including manufacturer's descriptive and technical literature, catalog cuts, and installation

instructions.

1.4.2 Component UL Listed and Labeled

Submit proof of compliance that components are UL Listed and Labeled. Listing alone in UL Electrical Construction, which is the UL Electrical Construction Directory, is not acceptable evidence. In lieu of Listed and Labeled, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

1.4.3 Lightning Protection and Grounding System Test Plan

Provide a lightning protection and grounding system test plan. Detail both the visual inspection and electrical testing of the system and components in the test plan. Identify (number) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted. As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure. Include the requirements specified in paragraph, "Testing of Integral Lightning Protection System" in the test plan.

~~[~~1.4.4 Lightning Protection System Inspection Certificate

~~[~~ Provide certification from a commercial third-party inspection company whose sole work is lightning protection, stating that the lightning protection system complies with NFPA 780. Third party inspection company cannot be the system installer or the system designer. Alternatively, provide a UL Lightning Protection Inspection Master Label Certificate for each facility indicating compliance to NFPA 780.

~~][Provide certification from a commercial third-party inspection company whose sole work is lightning protection, stating that the lightning protection system complies with NFPA 780 and AFI 32-1065. Third party inspection company cannot be the system installer or the system designer. Alternatively, provide a UL Lightning Protection Inspection Master Label Certificate for each facility indicating compliance to NFPA 780 and AFI 32-1065. In either case, AFI 32-1065 takes precedence over NFPA 780, whether or not it is more stringent.~~

~~]~~ Inspection must cover every connection, air terminal, conductor, fastener, accessible grounding point and other components of the lightning protection system to ensure 100% system compliance. This includes witnessing the tests for the resistance measurements for ground rods with test wells, and for continuity measurements for bonds. It also includes verification of proper surge protective devices for power, data and telecommunication systems. Random sampling or partial inspection of a facility is not acceptable.

~~]~~1.5 SITE CONDITIONS

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer before changing the design.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings, such as tin or lead, or oversize conductors. Where a mechanical hazard is involved, increase conductor size to compensate for the hazard or protect conductors. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic). All lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, chimney bands, clips, connector fittings, and fasteners are to comply with the requirements of UL 96 classes as applicable.

2.1.1 Main and Bonding Conductors

NFPA 780 and UL 96 Class I, Class II, or Class II modified materials as applicable.

~~{~~2.1.2 Copper Only

Provide copper conductors, except where aluminum conductors are required for connection to aluminum equipment.

~~}~~2.2 COMPONENTS

2.2.1 Air Terminals

Provide solid air terminals with a blunt tip. Tubular air terminals are not permitted. Support air terminals more than 24 inches in length by suitable brace, supported at not less than one-half the height of the terminal.

2.2.2 Ground Rods

Provide ~~{~~ground rods made of ~~{~~copper-clad steel~~}~~ ~~[solid copper]~~ conforming to conform to UL 467.~~}~~ Provide ground rods that are not less than 3/4 inch in diameter and 10 feet in length. Do not mix ground rods of copper-clad steel or solid copper on the job.

~~{~~2.2.3 Grounding Plates

Provide grounding plates made of ~~{~~copper-clad steel~~}~~~~[iron]~~~~[stainless steel]~~ ~~[solid copper]~~ conforming to UL 96.

~~}~~2.2.4 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation.

2.2.5 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that

conform to NFPA 780 and UL 96.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

Provide a lightning protection system that meets the requirements of NFPA 780~~[, including tie-ins to existing lightning protection systems]~~. Lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, ~~[and]~~ grounding electrodes~~[~~ and ground ring electrode conductor~~]~~. ~~[~~Expose conductors on the structures except where conductors are required to be in protective sleeves.~~]~~ Bond secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or below the level of the grounded metallic parts.

3.1.1 Roof-Mounted Components

Coordinate with the roofing manufacturer and provide certification that the roof manufacturer's warranty is not violated by the installation methods for air terminals and roof conductors.

3.1.1.1 Air Terminals

~~[~~Use adhesive shoes with adhesive approved by the roof manufacturer when installing air terminals on "rubber" (EPDM) type roofs.~~]~~ ~~[~~In areas of snow or constant wind, ensure that a section of roofing material (minimum dimensional area of 1 square foot) is first glued to the roof and then the air terminal is glued to it unless the roof manufacturer recommends another solution.~~]~~ ~~[~~Use a standing seam base for installation of air terminals on a standing seam metal roof that does not produce any roof penetrations.~~]~~

3.1.1.2 Roof Conductors

~~[~~Use adhesive shoes with adhesive approved by the roof manufacturer when installing roof conductors on "rubber" (EPDM) type roofs.~~]~~ ~~[~~Use a standing seam base for installation of roof conductors on a standing seam metal roof that does not produce any roof penetrations.~~]~~ ~~[Roof conductors are to be concealed within the ceiling cavities as much as practicable.]~~

3.1.2 Down Conductors

Protect exposed down conductors from physical damage as required by NFPA 780. Use Schedule 80 PVC to protect down conductors. Paint the Schedule 80 PVC to match the surrounding surface with paint that is approved for use on PVC. ~~[~~Down conductors are to be concealed within the wall cavities.~~]~~

3.1.3 Ground Connections

Attach each down conductor ~~[~~and ground ring electrode~~]~~ to ground rods by welding (including exothermic), brazing, or compression. All connections to ground rods below ground level must be by exothermic weld connection or with a high compression connection using a hydraulic or electric compression tool to provide the correct circumferential pressure. Accessible connections above ground level and in test wells can be accomplished by mechanical clamping.

3.1.4 Grounding Electrodes

Extend driven ground rods vertically into the existing undisturbed earth for a distance of not less 10 feet. Set ground rods not less than 3 feet nor more than 8 feet, from the structure foundation, and at least beyond the drip line for the facility. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum allowed resistance of a driven ground rod is [25] [_____] ohms, under normally dry conditions [when a ground ring electrode is not used]. Contact the Contracting Officer for direction on how to proceed when two of any three ground rods, driven not less than 10 feet into the ground, a minimum of 10 feet apart, and equally spaced around the perimeter, give a combined value exceeding 50 ohms immediately after having driven. [For ground ring electrode, provide continuous No. 1/0 bare stranded copper cable. Lay ground ring electrode around the perimeter of the structure in a trench not less than 3 feet nor more than 8 feet from the nearest point of the structure foundation, and at least beyond the drip line for the facility. Install ground ring electrode to a minimum depth of 30 inches. Install a ground ring electrode in earth undisturbed by excavation, not earth fill, and do not locate beneath roof overhang, or wholly under paved areas or roadways where rainfall cannot penetrate to keep soil moist in the vicinity of the cable.]

[_____]

[3.1.5 Grounding Plates

Provide a grounding plate for each down conductor. Set grounding plates not less than 3 feet nor more than 8 feet, from the structure foundation, and at least beyond the drip line for the facility. Grounding plate is to be buried as deeply in the existing dirt as local conditions allow, without exceeding 10 feet in depth.

]3.2 APPLICATIONS

3.2.1 Nonmetallic Exterior Walls with Metallic Roof

Bond metal roof sections together which are insulated from each other so that they are electrically continuous, having a surface contact of at least 3 square inches.

[3.2.2 Personnel Ramps and Covered Passageways

Place a down conductor and a driven ground at one of the corners where the ramp connects to each building or structure. Connect down conductor and driven ground to the ground ring electrode or nearest ground connection of the building or structure. Where buildings or structures and connecting ramps are clad with metal, separately bond the metal of the buildings and ramps to a down conductor as close to grade as possible.

]3.3 INTERFACE WITH OTHER STRUCTURES

[3.3.1 Fences

Bond metal fence and gate systems to the lightning protection system whenever the fence or gate is within 6 feet of any part of the lightning protection system in accordance with ANSI C2.

]][3.3.2 Exterior Overhead Systems

Bond to the nearest down conductor as close to grade as possible. This includes overhead pipes, conduits, cable trays, or any other metallic objects on the exterior of the building that enter a building. In addition, bond pipes, conduits, and cable trays to any metallic objects (such as steel structural support of air handling units or cooling towers) that are within 6 feet.

]3.4 RESTORATION

Where sod has been removed, place sod as soon as possible after completing the backfilling. Restore, to original condition, the areas disturbed by trenching, storing of dirt, cable laying, and other work. Overfill to accommodate for settling. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration. Maintain disturbed surfaces and replacements until final acceptance.

3.5 FIELD QUALITY CONTROL

3.5.1 Lightning Protection and Grounding System Test

Test the lightning protection and grounding system to ensure continuity is not in excess of 1 ohm and that resistance to ground is not in excess of [25] [_____] ohms. Provide documentation for the measured values at each test point. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

-- End of Section --

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SECTION 26 51 00

INTERIOR LIGHTING
05/20, CHG 2: 11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2021) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B633	(2019) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM D4674 REV A	(2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED

	Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2019) Technical Memorandum: Projecting Long-Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources
ANSI/IES TM-30	(2020) Technical Memorandum: IES Method for Evaluating Light Source Color Rendition
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 77	(2017) Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps– Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination

NEMA SSL 7A	(2015) Phase-Cut Dimming for Solid State Lighting: Basic Compatibility
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 7	(2011; R 2016) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 101	(2021) Life Safety Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 94	(2013; Reprint May 2021) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 916	(2015) Standard for Energy Management Equipment
UL 917	(2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches
UL 924	(2016; Reprint May 2020) UL Standard for Safety Emergency Lighting and Power Equipment
UL 1472	(2015) UL Standard for Safety Solid-State Dimming Controls
UL 1598	(2021; Reprint Jun 2021) Luminaires
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 8750	(2015; Reprint Jul 2021) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories that are mounted in exterior environments and not attached to the exterior of the building are specified in Section 26 56 00 EXTERIOR LIGHTING. ~~Cybersecurity requirements are specified in Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Commissioning requirements for Army and Air Force projects are specified in Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING. Commissioning requirements for Navy projects are specified in Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING. Emergency lighting requirements are specified in Section 26 52 00.00 40 EMERGENCY LIGHTING.~~

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings, must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G~~[, [_____]]~~

Occupancy/Vacancy Sensor Coverage Layout; G~~[, [_____]]~~; S

Lighting Control System One-Line Diagram; G~~[, [_____]]~~

Sequence of Operation for Lighting Control System; G~~[, [_____]]~~

SD-03 Product Data

Luminaires; G~~[, [_____]]~~

Light Sources; G[, [_____]]

LED Drivers; G[, [_____]]

Luminaire Warranty; G[, [_____]]

Lighting Controls Warranty; G[, [_____]]

Local Area Controller; G[, [_____]]

Lighting Relay Panel; G[, [_____]]

Lighting Control Panel; G[, [_____]]

Gateway; G[, [_____]]

Lighting Contactor; G[, [_____]]

Switches; G[, [_____]]

Digital Switch Timers; G[, [_____]]

Wall Box Dimmers; G[, [_____]]

Scene Wallstations; G[, [_____]]

Occupancy/Vacancy Sensors; G[, [_____]]

Photosensors; G[, [_____]]

Time Clocks; G[, [_____]]

Power Packs; G[, [_____]]

Power Hook Luminaire Hangers; G[, [_____]]

Mini Inverters; G[, [_____]]

Exit Signs; G[, [_____]]

Emergency Drivers; G[, [_____]]

Energy Star Label For Residential Luminaires; S

Linear LED Lamps; G[, [_____]]

[SD-04 Samples

Luminaire Samples; G[, [_____]]

] SD-05 Design Data

Luminaire Design Data; G[, [_____]]

Photometric Plan; G[, [_____]]

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G~~[, [_____]]~~

ANSI/IES LM-80 Test Report; G~~[, [_____]]~~

ANSI/IES TM-21 Test Report; G~~[, [_____]]~~

~~ANSI/IES TM-30 Test Report; G[, [_____]]~~

Occupancy/Vacancy Sensor Verification Test; G~~[, [_____]]~~

Photosensor Verification Test; G~~[, [_____]]~~

SD-07 Certificates

LED Driver and Dimming Switch Compatibility Certificate; G~~[, [_____]]~~

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G~~[, [_____]]~~

Lighting Control System, Data Package 5; G~~[, [_____]]~~

Maintenance Staff Training Plan; G~~[, [_____]]~~

End-User Training Plan; G~~[, [_____]]~~

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Luminaire Drawings

Include dimensions, accessories installation details, and construction details. Photometric data, including CRI, CCT, LED driver type,~~[aiming diagram,]~~ zonal lumen data, and candlepower distribution data must accompany shop drawings.

1.5.2 Luminaire Design Data

a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified in accordance with the NFPA 70. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

b. Provide long term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required

data in IES format as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

~~1.5.6 ANSI/IES TM-30 Test Report~~

~~Submit color vector graphic in accordance with ANSI/IES TM-30 on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Include spectral distribution of test LED light source.~~

1.5.6 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices without flickering and to specified dimming levels.

~~1.5.7 Photometric Plan~~

~~1.5.7.1 Computer-generated Photometric Plans~~

~~Computer-generated photometric plans for each space are required to verify proposed luminaires and locations meet the required performance criteria of the design using the applicable light loss factor (LLF).~~

~~Target illumination levels are provided for each Interior Application. Depending on the application and the recommendations provided by the IES, values are given as one of the following:~~

~~a. Minimum: No values anywhere on the calculation grid may be less than this value, within a 10 percent margin of error.~~

~~b. Minimum Average: An average, taken over the entire task area for the application, may not be less than this value, within a 10 percent margin of error.~~

~~c. Maximum: No values anywhere on the calculation grid may be greater than this value, within a 10 percent margin of error.~~

~~d. Maximum Average: An average, taken over the entire task area for the application, may not be greater than this value, within a 10 percent margin of error.~~

~~e. Uniformity: Unless otherwise noted, uniformity is calculated as a ratio of the average calculated illuminance over the minimum~~

~~calculated illuminance of the calculation grid.~~

~~1.5.7.2 Schematic Photometric Plan Calculations~~

~~Schematic photometric plan calculations must include:~~

~~a. Horizontal illuminance measurements at workplane or other designated height above finished floor, taken at a maximum of every one foot across the task area.~~

~~b. Average maintained illuminance level.~~

~~c. Minimum and maximum maintained illuminance levels.~~

~~d. Lighting power density (Watts per square foot).~~

~~e. LLF. Recommended LLF is 0.81 for LED luminaires but LLF varies based on environment and application.~~

~~1.5.7.3 Final Photometric Plan Calculations~~

~~Final photometric plan calculations must include:~~

~~a. Horizontal illuminance measurements at workplane or other designated height above finished floor, taken at a maximum of every one foot across the task area.~~

~~b. Where applicable, vertical illuminance measurements at designated surface, taken at a maximum of every one foot across task area.~~

~~c. Minimum and maximum maintained illuminance levels.~~

~~d. Average maintained illuminance level.~~

~~e. Average to minimum and maximum to minimum ratios for horizontal illuminance.~~

~~f. Lighting power density (Watts per square foot).~~

~~g. LLF. Recommended LLF is 0.81 for LED luminaires but LLF varies based on environment and application.~~

1.5.7 Occupancy/Vacancy Sensor Coverage Layout

Provide floor plans showing coverage layouts of all devices using manufacturer's product information.

1.5.8 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.

b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List for LM-79 testing.

c. One of the EPA-Recognized Laboratories listed for LM-80 testing.

1.5.9 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.10 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.10.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.10.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

(1) Finish warranty must include failure and substantial deterioration

such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All LED drivers and integral control equipment.

(b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

~~[(c) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) show a color shift greater than 0.003 delta u'v' from the zero hour measurement stated in the ANSI/IES LM-79 Test Report.~~

~~]~~ b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and assembly.

1.6.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

(1) Software: Failure of input/output to execute switching or dimming commands.

(2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to occupancy sensors, photosensors, and manual wall station control devices.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7 OPERATION AND MAINTENANCE MANUALS

1.7.1 Lighting System

Provide operation and maintenance manuals for the lighting system in

accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system for the building. Additional O&M Manual requirements for the Army are provided in Section 01 78 24.00 10 FACILITY DATA REQUIREMENTS. Additional requirements for the Navy are provided in Section 01 78 24.00 20 FACILITY ELECTRONIC OPERATION AND MAINTENANCE SUPPORT INFORMATION (eOMSI). Include the following:

a. Manufacturers' operating and maintenance manuals.

b. Luminaire shop drawings for modified and custom luminaires.

c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.7.2 Lighting Control System

Provide operation and maintenance manuals for the lighting control system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting control system for the building. Include the following:

a. Lighting control system layout and wiring plan.

b. Lighting control system one-line diagram.

c. Product data for all devices, including installation and programming instructions.

d. Occupancy/vacancy sensor coverage layout.

e. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the lighting control system. Training materials must include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

f. Sequence of operation descriptions for each typical room type, including final programming, schedules, and calibration settings.

~~[~~ g. "As-built" lighting control panel schedules.

~~]~~PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and NL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light source provided.

~~[Provide luminaire with Energy Star Label For Residential Luminaires in accordance with Energy Star.~~

~~][2.2.1 Luminaire Samples~~

~~Submit one sample of each luminaire type [_____], complete with light source, LED driver rated for 120 V operation, and 6 feet pigtail with 3-prong Edison plug. Sample will be returned to the Contractor for installation in the project work.~~

~~]~~2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housings constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Recessed 1 by 4, 2 by 4, and 2 by 2	100 LPW
Recessed Downlight (fixed, adjustable, wallwash)	80 LPW
Linear, Accent (undercabinet, cove)	45 LPW
Linear, Ambient (indirect wall mount, linear pendent)	100 LPW
High Bay, Low Bay, and Industrial Locations	100 LPW
Food Service and Hazardous Locations	60 LPW
Other (track, residential diffusers)	50 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	100 LPW

e. UL listed for dry or damp location typical of interior installations.~~[~~ Any luminaire mounted on the exterior of the building must be UL listed for wet location typical of exterior installations.~~]~~

f. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

g. Lenses constructed of heat tempered borosilicate glass, UV-resistant acrylic, or silicone.~~[Provide polycarbonate vandal-resistant lenses as indicated.]~~ Sandblasting, etching and polishing must be performed as indicated in the luminaire description.

~~[~~ h. ANSI/IES TM-15. Provide exterior building-mounted luminaires that do not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Exterior Wall Sconce	Above 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 4 feet AFF	B4-U0-G4
Steplight	Above 4 feet AFF	B1-U1-G2
Steplight	Below or at 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

~~]~~~~[~~i. For all recessed luminaires that are identified to be in contact with insulation, provide luminaires that are IC-rated.

~~][j. For all recessed luminaires that are to be installed in air plenums, require housings that are Chicago Plenum rated.~~

~~]2.2.1.1 Luminaire Conversion Kits~~

~~Provide luminaire conversion kits that meet UL 1598C Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits.~~

~~2.2.2 Luminaires for Hazardous Locations~~

~~In addition to requirements stated herein, provide LED luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.~~

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, delivered lumen output, and wattage as indicated in the luminaire schedule on project plans.

2.3.1 LED Light Sources

~~[CEC Title 20.]~~Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal CCT of ~~[3000][2700][3500][~~4000~~]~~ Kelvin.

b. Minimum Color Rendering Index (CRI) of ~~[~~80~~][90][95 with an R9 value of 95].[~~ Fidelity index greater than or equal to 80, gamut index between 97 and 110, determined in accordance with ANSI/IES TM-30.~~]~~

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 3-step McAdam ellipse.

[e. Color maintenance value of no greater than 0.003 (delta u'v') at 6000 hours as listed in ANSI/IES LM-79 Test Report.

][2.3.1.1 Linear LED Lamps

Provide linear LED Lamps that are compatible with existing instant-start or programmed-start ballasts, and meet the following additional requirements:

a. UL 1993 UL Type A linear LED lamp.

b. Power Factor greater than or equal to 0.90 at full input power and across specified dimming range.

c. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.

d. Lumen per watt efficacy no less than 120.

e. Minimum beam angle of [270][180] degrees.

f. Lamp datasheet complies with ANSI C78.54. Manufacturer must provide list of all ballasts that are compatible for use with lamp.

]2.4 LED DRIVERS

NEMA SSL 1, UL 8750. Provide LED drivers that are electronic, UL Class 1 or Class 2, constant-current type and that comply with the following requirements:

a. The combined driver and LED light source system does not exceed the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operates at a voltage of [120-277][120][277] volts at 50/60 hertz, with input voltage fluctuations of plus/minus 10 percent.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Withstands Category A surges of 2 kV without impairment of performance. Provide surge protection that is integral to the driver.

g. Integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. 47 CFR 15. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

k. Provide dimming capability as indicated in the luminaire schedule on project plans.[Dimmable drivers must dim down to [10][5][1] percent. Dimmable drivers must be controlled by a [Class 2 low voltage 0-10VDC controller] [Digital Addressable Lighting Interface (DALI)] dimming signal protocol unless otherwise specified. LED drivers of the same family/series must track evenly across multiple luminaires at all light levels.]

[2.4.1 Remote LED Drivers

Provide remote LED Drivers that are UL listed for dry locations typical of interior installations. Provide LED driver in junction box or housing with mounting plate. Housing must allow for field connections to occur inside the housing or must contain mechanical connections.

]2.5 LIGHTING CONTROLS

Provide network certification for all networked lighting control systems and devices in accordance with the requirements of Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Provide lighting control systems that do not switch off battery-operated or emergency backup luminaires or exit signs in path of egress. Provide system with override of lighting control devices controlling luminaires in path of egress with activation of fire alarm system.

2.5.1 System

Provide lighting control system that operates the lighting system as described in the lighting control strategies in the project plans. Submit Sequence of Operation for Lighting Control System describing the operation of the proposed lighting control system and devices. Sequence of Operation must provide the strategies identified in the lighting control strategies.

2.5.1.1 Localized Control Systems

Provide room or area-wide lighting control system capable of manual control, time-based control, and receiving input from photosensors and occupancy/vacancy sensors.

2.5.1.1.1 Local Area Controller

Provide controller designed for single area or room with the following requirements:

a. Operates at a voltage of [120-277][120][277] volts at 50/60 hertz.

b. [2][_____] zone, with [1][2][_____] relay[s] rated 20 amps[each] with one manual [switch][dimmer] per zone.

~~c~~b. Provide inputs for occupancy/vacancy sensors, photosensors, and low-voltage wall switches.

~~[~~ ~~d~~c. Provide daylight harvesting capability with full-range dimming control with input from photosensor.

~~][e. Provide capability for receptacle load control from occupancy sensors.~~

~~][f~~d. Provide full 'OFF' function with input from external time clock input.

~~][g~~e. Capable of 0-10V dimming.

~~][h~~f. AV interface via ~~[RS-232][RS-485][~~ethernet and CAT5~~]~~.

~~][i~~g. Provide override 'ON' function with input from Fire Alarm Control Panel for all emergency lighting. Controller must not turn off power to emergency batteries or exit signs.

~~]~~2.5.1.2 Centralized Control Systems

Provide a centralized lighting control system capable of manual control, time-based control, receiving input from photosensors and occupancy/vacancy sensors, with the capabilities of controlling, monitoring, and programming changes from one centralized on-site location, and integration with other building systems.

2.5.1.2.1 Lighting Relay Panel

UL 924. Enclose panel hardware in a ~~[~~surface~~][flush]~~-mounted, NEMA ~~[~~1 ~~][3R][4]~~, painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide Lighting Control Panels that meet the following criteria:

a. Input voltage of ~~[120][277][~~120-277~~]~~ at 50/60 Hz, with internal low voltage power supply as required.

b. ~~[8][~~16~~][32][_____]~~ single-pole latching relays rated at ~~[~~20~~][30]~~ amps, ~~[~~120-277~~][120][277]~~ volts. Provide provision for relays to close upon power failure. Provide relays designed for 10 years of use at full rated load.

c. Relay control module operates at 24 VDC and is rated to control a minimum of ~~[8][~~16~~][32][_____]~~ relays.

~~[~~ d. Capable of 0-10V dimming.

~~]~~2.5.1.2.2 Lighting Control Panel

UL 916, 47 CFR 15~~[, CEC Title 24]~~. Provide an electronic, programmable lighting control panel complete with microprocessor, capable of providing lighting control with input from internal programming, digital switches,~~[~~ time clocks,~~]~~ and other control devices.

Enclose panel hardware in a ~~[~~surface~~][flush]~~-mounted, NEMA ~~[~~1~~][3R][4]~~, painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from

line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide Lighting Control Panels that meet the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low-voltage VDC power supply as required.

b. Solid-state, microprocessor-based, internal astronomical time clock. Microprocessor must have nonvolatile memory and must reset automatically after power interruptions of up to 90 days.

c. Interface for providing local programming and control capability, with physical key-locked cover or programmed security access code to prevent unauthorized use.

d. Dimming modules capable of [0-10V][DALI] dimming.

e. Modules and control panels include multichannel output with [_____]16 channels, with multiple inputs for manual control, photosensors, and occupancy/vacancy sensors.

[f. Control processor is configured to interface with [BACnet in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][LONworks in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] compliant network via [native compatibility][gateway].

]g. Outputs that require line-voltage switching are provided by relays which are designed for 10 years of use at full rated load.

]h. Control processor indicates failure of normal power and which circuits are supplied by alternative power source if connected to emergency lighting units.

]i. Provide building automation system write access points to lighting control system for [manual override][building schedules][utility demand response events].

]j. Provide building automation read access points to lighting control system for [occupancy status per room or area][current lighting load in kilowatts][calculated energy use in kilowatt-hours][utility demand response priorities].

]2.5.1.2.3 Gateway

Provide gateway in accordance with Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports. Provide [BACnet][LONworks][_____] communication interface that enables remote control and monitoring of lighting from a workstation according to read access points and write access points listed in this section. Control features and monitoring points displayed locally at lighting panel must be available through the Gateway. Provide Gateway that meets the following requirements:

a. Microprocessor-based communications device that perform bi-directional protocol translation.

~~b. Support full bi-directional communication and translation.~~

~~c. Contain its own microprocessor, RAM, battery, communication ports, and power supply.~~

~~[d. Support an additional 5 percent points for future expansion.~~

~~]~~2.5.1.2.3 Lighting Contactor

NEMA ICS 2, NEMA ICS 6. Provide an electrically~~[mechanically]~~-held lighting contactor housed in a NEMA ~~[~~1~~][12][3R][4][4X][_____]~~ enclosure. Provide contactor with ~~one [~~16~~_____]~~ ~~[~~normally-open(NO)~~][normally-closed(NC)], single[double]~~ pole contacts, rated 600 volts, 30 amps. Provide coil operating voltage of ~~[24][120][~~277~~][480][_____]~~ volts.

2.5.2 Devices

2.5.2.1 Switches

Provide line-voltage toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. When used for non-digital loads, devices must be rated at 20 Amps inductive load, and be compatible with the lighting control systems.

~~2.5.2.2 Digital Switch Timers~~

~~Provide line-voltage toggle switches that allow manual control to ON and automatically switches lighting load to OFF. Device operates with the use of paddle, button, or toggle, and operates at [120-277][120][277] volts. Device allows for programming of auto off timer from [2][5][10] minutes to [1][6][12] hours.~~

2.5.2.2 Wall Box Dimmers

UL 1472, UL 20, IEEE C62.41, NEMA 77, NEMA SSL 7A. Dimmers must provide flicker-free, continuously variable light output throughout the dimming range of ~~[~~10~~][5][1]~~ percent to 100 percent. Devices must be capable of operating at their full rated capacity regardless of being single or ganged-mounted, and be compatible with three-way and four-way switching scenarios.

Provide wall-box dimmers that meet the following requirements:

a. Device operates as ~~[~~part of a lighting control system~~][an independent control device]~~.

b. Device operates with the use of a vertical slider, paddle, rotary, button, or toggle with adjacent vertical slider.

c. Finish of device matches switches and outlets in the same area.

d. Back box in wall has sufficient depth to accommodate body of switch and wiring.

e. Dimmer is capable of controlling ~~[~~0-10 volt~~][DALI]~~ LED drivers. Dimmers and the drivers they control must be provided from the same manufacturer or tested and certified as compatible for use together.

f. Radio frequency interference suppression is integral to device.

~~2.5.2.3 Scene Wallstations~~

~~Provide scene wallstations that are compatible with the other components of the lighting control system and capable of Class 1 or 2 wiring methods in accordance with the NEC and local codes. Provide devices that contain on/off group, preset scene functions, or dim up/dim down interface through front panel. Programming of new scenes or zone assignments must be accomplished by authorized personnel from the space being controlled. Provide labeling for each button, including laminated sheet with scene descriptions to be posted near each scene controller.~~

2.5.2.3 Occupancy/Vacancy Sensors

IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A, NEMA WD 7 ~~[, CEC Title 24, CEC Title 20]~~. Provide occupancy/vacancy sensors with coverage patterns as indicated on ~~[~~project plans~~][manufacturer shop drawings]~~.~~[~~ Provide no less quantity of sensors as shown on plans, but add additional sensors when required to fulfill coverage requirement for the specific model of sensor provided.~~][Provide sensor types as described in the sequence of operations. Sensor locations and quantities are shown in shop drawings provided by the lighting control system manufacturer.][Provide occupancy sensor operation that requires movement to activate luminaires controlled and turns luminaires off after a set time of inactivity.][Provide vacancy sensor operation that requires manual control to activate luminaires and turns luminaires off after a set time of inactivity.]~~ Provide ceiling or wall-mounted occupancy/vacancy sensors that meet the following requirements:

a. Operating voltage of ~~[12-24][~~120-277~~][120][277]~~ volts.

b. Time delay of 30 seconds to 30 minutes with at least four intermediate time delay settings.

c. Sensors are ~~[~~ceiling mounted~~][wall-box mounted][wall mounted][integral to luminaire]~~.

~~d.[Does not exceed a maximum load requirement of 20mA at 24VDC.][No minimum load requirement and be capable of switching from zero to 800 W at 120 VAC, 50/60 Hz and from zero to 1200 W at 277 VAC, 50/60 Hz.][Networked sensor with no minimum or maximum load. Sensor is programmed to control zones.]~~

~~e~~d. Shielded or controlled by internal logic to adjust sensitivity to avoid false triggering due to ambient temperature, air temperature variations or HVAC air movement.

~~f~~e. Sensor is equipped to automatically energize the connected load upon loss of normal power when located in a means of egress.

~~g~~f. Occupancy and vacancy operation is field-adjustable and ~~[~~programmable via lighting control system processor.~~][programmable with push-button or dip switch on the sensor device.]~~

~~h~~g. No leakage current to load when in the off mode.

~~i~~h. Utilize zero-crossing circuitry to prevent damage from high inrush current and to promote long life operation.

[j]i. Allow the adding or deleting of specific luminaires or zones to the assigned sensor without the use of ladders.[Provide sensors that allow for remote control adjustments of operational parameters (sensitivity, time delay), and that are be able to transmit, receive, and store system information through the lighting control system processor.]

]][kj. Provide an isolated relay for integrating control of HVAC or other automated systems.

]2.5.2.3.1 Passive Infrared Sensors

Provide Passive Infrared Sensors (PIR) sensors that detect occupancy by sensing heat and movement in the area of coverage. Provide sensors are constructed of a housing of high-impact, injection-molded thermoplastic. Provide PIR sensors that are temperature compensated, with a dual element sensor and a multi-element fresnel lens of POLY IR4 material.

2.5.2.3.2 Ultrasonic Sensors

Provide ultrasonic sensors that detect occupancy by sensing a change in pattern of reflected ultrasonic waves in the area of coverage. Provide sensors that are constructed of a housing of high-impact, injection-molded thermoplastic. Provide ultrasonic sensors that operate at 40 kHz.

2.5.2.3.1 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the PIR or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.2.3.2 High Bay Sensors

Provide occupancy/vacancy sensors specifically designed for high-bay mounting applications for all [ceiling-mounted sensors][sensors integral to luminaires] mounted above 35 feet using PIR technology. Provide high-bay sensors with interchangeable lenses for 360 degree open area coverage or narrow rectangular warehouse aisle coverage.[Provide sensors that are designed to mount directly to or adjacent to high- or low-bay luminaires.]

2.5.2.3.3 Integrated Sensors

Provide integrated occupancy/vacancy sensors that mount directly to the luminaires as indicated in project plans.[Sensor mounts to standard junction box or directly to luminaire using a [straight][drop] nipple mount.][Provide sensors that communicate to [lighting control panel][local area controller] via [RJ45][SPDT relay][_____].]

2.5.2.3.2 Power Packs

UL 2043[, CEC Title 24]. Provide power packs to provide power to lighting control sensors as required in accordance with the manufacturer's specifications. Provide power packs that meet the following requirements:

a. Operate at an input voltage of [120][277][120-277] VAC, with an output voltage [12-24][12][24] VDC at 225 mA.

b. Constructed of plenum-rated, high-impact thermoplastic enclosure.

c. Utilizes zero-crossing circuitry to prevent damage from inrush current.

d. Maximum load rating of 16 [_____] amps for electronic [_____] lighting loads.

e. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

2.5.2.4 Photosensors

[CEC Title 24, CEC Title 20.]Provide photosensors that meet the following requirements:

a. Detect changes in ambient lighting level and enable dimming as required by sequence of operation by operating in [an open-loop][a closed-loop] system.

b. Contain a detection cone, where the base of the cone may be circular or an elongated shape, and where the smallest angle between the edge and the axis of the cone is between 20 and 50 degrees. The cone axis may be tilted to the vertical when installed to give the sensor preferred directionality.

c. Sensors are [ceiling-mounted][wall-box-mounted][wall-mounted][mounted integral to luminaire] with sensitivity, filtering, range and viewing angle to meet requirements of sequence of operation, scope of work and construction documents.

d. Time delay that is adjustable from 1 to 30 seconds ON delay, and 1 to 30 minutes OFF delay to prevent cycling, with deadband adjustment of 25 percent to 100 percent above lower setpoint.

e. Output dimming signal is linear to light level with less than 1 percent variation. Cadmium sulfide photo-resistors are not acceptable.

f. Sensor is not combined in the same housing or location with occupancy or vacancy sensors if the proper location for one function compromises the successful operation of the other function, or in any way reduces the system's ability to meet the design intent.

2.5.2.5 Time Clocks

UL 917, NEMA ICS 6. House time clock in a surface-mounted, lockable, NEMA [1][3R][4] enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

a. [Astronomic][24 hour][7 day][365 day] programming function, providing a total of [56][96][2000][4000] on/off set points.

b. [24 hour][12 hour AM/PM] type digital clock display format.

c. Power outage back-up for time clock utilizing [a capacitor][alkaline batteries][lithium battery] which provides coverage for a minimum of [seven][four][_____] days.

d. Capable of controlling a minimum of [1][2][4][8][12][16][_____] channels or loads.

e. Contacts are rated for [30] [_____] amps at 120-277 VAC resistive load in a [SPST][DPST][SPDT][DPST] [normally open (NO)][normally closed (NC)] configuration.

f. Contains [function that allows automatic control to be skipped on certain selected days of the week][manual bypass or remote override control][daylight savings time automatic adjustment][EEPROM memory module][momentary function for output contacts][ability for photosensor input].

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

2.6.1 Exit Signs

UL 924, NFPA 101. Provide wattage as indicated in the luminaire schedule on project plans. Provide LED Exit Signs that meet the following criteria:

a. [Housing constructed of [UV-stable, thermo-plastic][clear polycarbonate housing][painted, die-cast aluminum][painted steel].][Edge-lit type with clear acrylic, edge-lit face and aluminum trim having [clear aluminum][white][chrome][brass][_____] finish.]

b. UL listed for [damp][wet] location.

c. Configured for [universal][ceiling][wall][end] mounting.

d. 6 inch high, 3/4 inch stroke [red][green] lettering on face of sign with chevrons on either side of lettering to indicate direction.

e. Single or double face as indicated in project plans and luminaire schedule.

2.6.1.1 Exit Signs with Battery Backup

Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1-1/2 hours. LEDs must have a minimum rated life of 10 years.[Provide self-diagnostic circuitry integral to emergency LED driver.] In lieu of battery, can use a nonradioactive photoluminescent plate.

2.6.1.2 Remote-Powered Exit Signs

Provide exit sign that contains provision for [120-277 VAC][120 VAC][277 VAC][6-48 VDC] input from remote source.

2.6.2 Emergency Lighting Unit (ELU)

UL 924, NFPA 101. Provide emergency lighting units (ELUs) completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Provide in [UV-stable, thermo-plastic] [painted, die-cast aluminum] [painted steel] housing with [UL damp label] [UL wet label] as indicated. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted light sources and having no more than two unit-mounted light sources may be rated six volts. Equip units with brown-out sensitive circuit to activate battery when input voltage

~~falls to 75 percent of normal. Equip with [two] [_____] LED light sources, automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free [lead-calcium] [nickel-cadmium] [_____] type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 90 minutes. LEDs must have a minimum rated life of 10 years.[Provide self-diagnostic circuitry integral to emergency LED driver.]~~

2.6.2 LED Emergency Drivers

UL 924, NFPA 101. Provide LED emergency driver with automatic power failure detection, test switch and LED indicator (or combination switch/indicator) located on luminaire exterior, and fully-automatic solid-state charger, battery and inverter integral to a self-contained housing.~~[~~ Provide self-diagnostic function integral to emergency driver.~~]~~ Integral nickel-cadmium~~[lead-calcium][_____]~~ battery is required to supply a minimum of 90 minutes of emergency power at ~~[5][7][~~10~~]~~~~[_____]~~ watts, ~~[~~10-50~~]~~~~[_____]~~ VDC~~[~~ compatible with LED forward voltage requirements ~~]~~, constant output. Driver must be RoHS compliant, rated for installation in plenum-rated spaces and damp locations, and be warranted for a minimum of five years.

2.6.3 Self-Diagnostic Circuitry for LED Drivers

UL 924, NFPA 101. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

~~2.6.4 Mini Inverters~~

~~UL 924, NFPA 101. Provide mini inverters that are designed to provide power to emergency luminaires. Provide mini inverters that are suitable for [dry] [damp] [wet] installations, operate at a voltage of [120-277] [120] [277] volts at 50/60 hertz, and are capable of operating 0-10V dimming override. Provide mini inverters that supply a minimum of 90 minutes of emergency power.~~

~~2.6.5 Central Emergency Lighting System~~

~~UL 924, NFPA 101, NFPA 110 level 1, NFPA 70.. Provide a central power system providing emergency power at [277] [120] volts, 60 hertz, for a minimum period of [90] [_____] minutes. Design the system to handle surges during loss and recovery of the voltage, and to deliver its full rated output to the designated lamp load. Provide [batteries] [backup ac source] for power.~~

~~2.6.5.1 Operation~~

~~Provide system such that when the lighting system loses normal supply voltage, it automatically disengages itself from the normal input line, and switches to a self-contained inverter with built-in protection when the output is shorted or overloaded. Ensure that, when normal line voltage resumes, the emergency system automatically switches back to normal operation. Size the transfer switch for this function to handle~~

~~[125] [_____] percent of full load. Provide the battery system with self-contained inverters with overload protection.~~

~~2.6.5.2 Charger~~

~~Provide a completely automatic battery charger that maintains the batteries in a fully charged condition and recharges the batteries to full capacity within [24] [_____] hours after full discharge in accordance with UL 924.~~

~~2.6.5.3 Batteries~~

~~Provide sealed [lead-acid] [nickel-cadmium] batteries, maintenance-free for a period of not less than [10] [_____] years under normal operating conditions.~~

~~2.6.5.4 Accessories~~

~~Provide visual indicators to indicate normal power, inverter power, and battery-charger operation. Provide a low-voltage test switch to simulate power failure by interrupting the input line, voltage meter, electrolyte level detector to automatically disable the charging circuit in the event of a fault, and low-voltage cutoff to prevent extreme battery power dissipation.~~

~~2.6.5.5 Enclosure~~

~~Provide a free-standing cabinet with floor stand and constructed of [2.7] [_____] millimeter [12] [_____]-gage sheet steel with baked-on enamel finish and a locking latch.~~

2.7 LUMINAIRE MOUNTING ACCESSORIES

2.7.1 Suspended Luminaires

a. Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers.

b. Hangers must allow luminaires to swing within an angle of 45 degrees. Brace pendents 4 feet or longer to limit swinging.~~[Provide with swivel hangers to ensure a plumb installation for rigid stem pendents. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.]~~

c. Single-unit suspended luminaires must have ~~[~~cable~~]~~~~[twin-stem]~~ hangers. Multiple-unit or continuous row luminaires with a separate power supply cord must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

d. Provide all linear pendent and surface mounted luminaires with two supports per four-foot section or three per eight-foot section unless otherwise recommended by manufacturer.

~~[e. Provide rods in minimum 0.18 inch diameter.~~

~~]~~2.7.2 Recess and Surface Mounted Luminaires

Provide access to light source and LED driver from bottom of luminaire.

Provide trim ~~[~~and lenses ~~]~~for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications. Luminaires recessed in ceilings which have a fire resistive rating of one hour or more must be enclosed in a box which has a fire resistive rating equal to that of the ceiling. For surface mounted luminaires with brackets, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the luminaire rigidly in design position. Flanged part of luminaire stud must be of broad base type, secured to outlet box at not fewer than three points.

2.7.3 Luminaire Support Hardware

2.7.3.1 Wire

ASTM A641/A641M. Galvanized, soft tempered steel, minimum 0.11 inches in diameter, or galvanized, braided steel, minimum 0.08 inches in diameter.

2.7.3.2 Wire for Humid Spaces

ASTM A580/A580M. Composition 302 or 304, annealed stainless steel, minimum 0.11 inches in diameter.

ASTM B164. UNS NO4400, annealed nickel-copper alloy, minimum 0.11 inches in diameter.

2.7.3.3 Threaded Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.7.3.4 Straps

Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

~~2.7.4 Power Hook Luminaire Hangers~~

~~UL 1598. Provide an assembly consisting of through-wired power hook housing, interlocking plug and receptacle, power cord, and luminaire support loop. Power hook housing must be cast aluminum having two 3/4 inch threaded hubs. Support hook must have safety screw. Luminaire support loop must be cast aluminum with provisions for accepting 3/4 inch threaded stems. Power cord must include 16 inches of 3 conductor No. 16 Type SO cord. Assembly must be rated 120 volts or 277 volts, 15 amperes.~~

2.8 EQUIPMENT IDENTIFICATION

2.8.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.8.2 Labels

UL 1598. All luminaires must be clearly marked for operation of specific light sources and LED drivers. The labels must be easy to read when standing next to the equipment, and durable to match the life of the

equipment to which they are attached. Note the following light source characteristics in the format "Use Only _____":

a. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) for all luminaires.

b. Driver and dimming protocol.

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

IEEE C2, NFPA 70.

3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature (CCT), color rendering index (CRI), and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

3.1.2 Luminaires

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed. Provide wires, straps, or rods for luminaire support in this section. Install luminaires with vent holes free of air blocking obstacles.

3.1.2.1 Suspended Luminaires

Measure mounting heights from the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain architect approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Support suspended luminaires from structural framework of ceiling or from inserts cast into slab.

a. Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level.

b. Locate so that there are no obstructions within the 45 degree range in

all directions.

c. The stem, canopy and luminaire must be capable of 45 degree swing.

d. Rigid pendent stem, aircraft cable, rods, or chains 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation.

e. Suspended luminaires in continuous rows must have internal wireway systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces.

f. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints.

g. Support steel luminaires to prevent "oil-canning" effects.

h. Match supporting pendents with supported luminaire. Aircraft cable must be stainless steel.

i. Match finish of canopies to match the ceiling, and provide low profile canopies unless otherwise shown.

j. Maximum distance between suspension points must be 10 feet or as recommended by the manufacturer, whichever is less.

3.1.2.2 Recessed and Semi-Recessed Luminaires

a. Support recessed and semi-recessed luminaires independently from the building structure by a minimum of two wires, straps or rods per luminaire and located near opposite corners of the luminaire. Secure horizontal movement with clips provided by manufacturer. Ceiling grid clips are not allowed as an alternative to independently supported luminaires.

b. Support round luminaires or luminaires smaller in size than the ceiling grid independently from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around.

c. Do not support luminaires by acoustical tile ceiling panels.

d. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire.

~~e. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.~~

~~f~~e. Adjust aperture rings on all applicable ceiling recessed luminaires to accommodate various ceiling material thickness. Coordinate cut-out size in ceiling to ensure aperture covers cut-out entirely. Install aperture rings such that the bottom of the ring is flush with finished ceiling or not more than 1/16 inch above. Do not install luminaires such that the aperture ring extends below the finished ceiling surface.

~~[g. For luminaire recessed in plaster ceilings, provide plaster frames for setting. Install setting such that the bottom of the frame is flush with finished ceiling. Support luminaires with plaster frames utilizing yokes or leveling lugs. Do not mount luminaires or support elements to ducts or pipes. Yokes must support a luminaire by no fewer than two bolts each.~~

~~]3.1.2.3 Field Applied Painting~~

~~Provide field applied painting for luminaire type [_____]. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.~~

3.1.3 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

~~[3.1.3.1 Remote LED Drivers~~

~~Locate Remote LED Drivers within the maximum distance allowed to minimize voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, above accessible ceilings or behind a removable wall or ceiling panel. Mount housing or junction box so that it is rigidly and securely fastened in place. Install LED drivers such that components are not in contact with combustible materials unless listed for such condition. Remote LED drivers must be grounded in accordance with NFPA 70.~~

~~Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector.~~

~~]~~3.1.4 Exit Signs

NFPA 101. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

~~[Connect exit signs on separate circuits and serve from [an emergency panel][a separate circuit breaker][a fused disconnect switch]. Provide only one source of control, which would be [the circuit breaker in the emergency panel][the separate circuit breaker][the fused disconnect switch]. Paint source of control red and provide lockout capability.~~

~~]~~3.1.5 Lighting Controls

~~Refer to Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for additional lighting control installation requirements.~~

~~3.1.5.1 Scene Wallstations~~

~~Submit labeling templates for all scene wallstations, ganged faceplates and other manual control cover plates. Label each scene control button with approved scene description.~~

3.1.5.1 Occupancy/Vacancy Sensors

a. Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage must provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways.

b. Locate ceiling-mounted sensors no closer than 6 feet from the nearest HVAC supply or return diffuser.

c. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations.

3.1.5.2 Photosensors

Locate and aim sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor set-point in accordance with the manufacturer's recommendations and for the indicated light level of the area of coverage, measured at the work plane.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Lighting Control Verification Tests

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

a. Verify occupancy/vacancy sensors operate as described in sequence of operations. Provide testing of sensor coverage, sensitivity, and time-out settings in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit occupancy/vacancy sensor verification test.

b. Verify photosensors operate as described in sequence of operations. Provide testing of sensor coverage, aiming, and calibration in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit photosensor verification test.

c. Verify wall box dimmers and scene wallstations operate as described in sequence of operations.

3.2.1.2 Emergency Lighting Test

Interrupt power supply to demonstrate proper operation of emergency lighting. If adjustments are made to the lighting system, re-test system to show compliance with standards.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Commissioning

NFPA 101. Commission all components of the lighting system and lighting control system in accordance with Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING. Commission all components of the lighting system and

lighting control system in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING. Factory Trained Field Service Technician is responsible for calibration and programming sequences for input devices and systems in accordance with the requirements described in the sequence of operation.

3.3.2 Training

3.3.2.1 Maintenance Staff Training

Submit a Maintenance Staff Training Plan at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrates full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.2.2 End-User Training

Submit an End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide users with a list of control devices located within user-occupied spaces, such as photosensors and occupancy and vacancy sensors, including information on the proper operation and schedule for each device. Provide demonstration for each type of interface. Provide users with the building schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

Provide laminated instructions to the user at each scene wallstation. Provide only instructions relevant to the functionality of the specific scene wallstation. Provide a description of each labeled scene control button. If the room utilizes occupancy/vacancy sensors or photosensors, include a description of this functionality on the instruction sheet.

-- End of Section --

SECTION 26 55 80

SURGICAL, PROCEDURE AND EXAM LIGHTING FIXTURES
11/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 99	(2021; TIA 20-1) Health Care Facilities Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Support; G~~[, [_____]]~~

~~[~~ Structural Shop Drawings; G~~[, [_____]]~~

~~]~~ SD-03 Product Data

Light Fixtures; G~~[, [_____]]~~

Fixture Arm Supports; G~~[, [_____]]~~

Wall Controls; G~~[, [_____]]~~

SD-09 Manufacturer's Field Reports

Installation Report; G~~[, [_____]]~~

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G~~[, [_____]]~~

1.3 OPERATION AND MAINTENANCE MANUAL

Include the following information for each light fixture in the operation and maintenance manual:

a. Vendor/manufacturer product data

b. Assembly information

c. Mounting details: structural support, wiring, transformers, all accessories and co-ordination with architectural features and finishes

d. Wiring diagram(s)

e. Recommended maintenance

f. Infection control measures~~, [sterile removable fixture covers][or][removable sterilizable handles]~~

g. Replacement parts list

~~[~~ h. Structural support shop drawings and supporting calculations

~~]~~1.4 QUALITY CONTROL

1.4.1 Structural Support~~[~~ and Structural Shop Drawings~~]~~

Coordinate structural support with vendor/manufacturer, building structural system and other MEP services.~~[Use[prefabricated] supporting frames with welded joints to the greatest extent possible.]~~ Comply with 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. Include the following information for the structural support submittal for each light fixture:

a. Vendor/manufacturer's structural design data.

b. Structural shop drawings indicating the construction method, materials, arrangement and attachment to the building structure and the light fixture arm~~[signed and sealed by a registered engineer]~~.

~~[~~ c. Structural calculations signed and sealed by a registered engineer.

~~]~~1.5 DELIVERY, STORAGE, AND HANDLING

Deliver equipment, components, and materials in original packaging, labeled with the manufacturer/vendor, brand name and part number(s) as appropriate. Inspect equipment, components, and materials upon receipt. Remove and replace damaged items. Comply with manufacturers/vendors instructions and recommendations for storage and handling of all equipment, components, and materials. Protect materials and components from deleterious environments including weather, direct sunlight, temperature, moisture, contamination, corrosion, and construction traffic.

PART 2 PRODUCTS

2.1 LIGHT FIXTURES

Submit the following for each light fixture:

a. Vendor/manufacturer product data.

b. Assembly information, including wiring, transformers, all accessories and coordination with architectural features and finishes.

c. Mounting details including structural support.

d. Wiring diagrams for power and communication.

e. Infection control measures.

2.1.1 Design Requirements

~~Provide surgical lighting fixtures for use in surgical operating rooms, with the following characteristics:~~

~~a. Comply with IEC 60601-2-41 and ANSI/AAMI ES60601-1.~~

~~b. Electrical service: [120][120-240] volts, [60][50/60] Hz, single-phase, three-wire grounded circuits.~~

~~c. Maximum allowable fixture current leakage 0.1 milliampere, measured between metal parts and ground.~~

~~d. Restricted frequency ranges for ballasts, drivers, and controls: 20KHz to 25KHz, 32KHz to 39KHz, and above 60KHz. Avoid interference with medical devices.~~

~~e. Infection control: [sterile removable fixture covers][or][removable sterilizable handles].~~

~~[2.1.2 Surgical Light Fixtures[- JSN [_____]]~~

~~Ceiling mounted with [one][two][three] light head[s][and [one][two] flat screen displays on radial arm(s)]. Radial arms to provide [minimum of 330][360][_____] degree rotation[with limit stop]. [LED][_____] light source with illumination level of [160,000][_____] lux at working distance of [32-47][39.37][_____] inches with a[n adjustable] pattern size between [6.5-9.5][_____] inches, and shadow reduction capability. Provide color temperature [between][of][3500-5000][4000][4500][5000][, adjustable] with a color rendering index (Ra) of [96][_____] (minimum) and (R9) of [90][_____] (minimum). Minimum service life [40,000][_____] hours. Provide [recessed][surface mount] wall controller[with _____].[Configure [each][_____] light head for camera installation.]~~

~~][~~2.1.2 Surgical Light Fixtures - Minor Surgery and Procedure Room~~[~~ - JSN ~~[_____]~~M7470 - Light, Surgical, Ceiling, Single, Small~~]~~

~~[~~Ceiling mounted~~][_____]~~ with ~~[~~one~~][two]~~ light head~~[s][and flat screen display on radial arm]~~. Radial arm~~(s)~~ to provide ~~[~~minimum 330~~][_____]~~ degree rotation~~[with limit stop]~~. ~~[~~LED~~][_____]~~ light source with illumination level of ~~[50,000][80,000][~~125,000~~][_____]~~ lux at working distance of ~~[at least 12][~~39.37~~][_____]~~ inches, with a~~[n adjustable]~~ pattern size ~~[~~of at least 6~~][_____]~~ inches~~[and shadow reduction capability]~~. Provide color temperature ~~[~~between ~~][of][~~3500-5000 ~~][4500][5500][, adjustable]~~ with a color rendering index (Ra) of ~~[~~at least 95~~][96][_____]~~ and (R9) of ~~[~~90~~][_____]~~ (minimum). Minimum service life ~~[~~ 40,000~~][_____]~~ hours. Provide ~~[recessed][~~surface mount~~]~~ wall controller~~[~~ ~~with [on/off control with dimming][_____]].[Configure[each] light head for camera installation.]~~.

~~][2.1.3 Exam Light Fixtures[- JSN [_____]]~~

~~[Wall Mounted][Ceiling mounted][_____] with one light head. Radial arm to~~

provide [minimum 330][_____] degree rotation[with limit stop]. [LED][_____] light source with illumination level of [20,000][50,000][_____] lux at working distance of [at least 12][_____] inches, with a[n adjustable] pattern size [of at least 4][_____] inches[and shadow reduction capability]. Provide color temperature [between 3600-5500][of ___][with a color rendering index (Ra) of [at least 95][_____]] and (R9) of [90][_____] (minimum). Minimum service life [40,000][_____] hours. Provide [switch mounted on light head][touchless on/off][wall controller][_____].

][2.1.4 Labor and Delivery Light Fixtures[- JSN M7440]

Recessed, ceiling mounted fixture with [one][two] light head[s][, with each light head in a recessed enclosure]. [LED][_____] light source with an illumination level of [43,000][_____] lux with[remote] rotation adjustment of [25][30][_____] degrees. Provide color temperature [between 3600-5500][4400][with a color rendering index (Ra) of [at least 95][_____]] and (R9) of [90][_____]. Minimum service life [40,000][_____] hours. Provide wall controller to control light intensity and light head position.

]2.2 FIXTURE ARM SUPPORTS

Mount lighthead[s][and flat screen display(s)] on an arm assembly. Configure the lighthead[s][and flat screen display(s)] to rotate within a clearance circle of [15 1/2][_____] feet. Provide vertical height adjustment to allow positioning of fixture[s][and displays] between [3 feet 11 inches][_____] and [7 feet 6 inches][_____] above the floor. Provide control for fixture within[and outside of] sterile field. Enable free, smooth, and silent movement of each arm assembly throughout its range of maneuverability without drifting, regardless of its position.[Provide fully independent repositioning throughout the full range of movement for each arm on a single multi-fixture mount, bypassing other components.]

2.3 WALL CONTROLS

[Recessed][or][Surfaced] mounted. Include[overcurrent protection,] on/off switch located outside the sterile field and indicator light.

PART 3 EXECUTION

3.1 INSTALLATION

Reference section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT, NFPA 99 and NFPA 70. Install [surgical][,][exam][,][and][labor and delivery] light assembly and fixture arm supports in accordance with the approved installation drawings and manufacturer's instructions and recommendations for each assembly.

3.1.1 Wiring Methods

Provide conduit, wiring, and rough in for each light assembly[and any future add-on option(s)] in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 FIELD QUALITY CONTROL

3.2.1 Installation Report

For each assembly submit a ~~[~~vendor/manufacturer~~][factory-authorized installer]~~ installation report confirming each light fixture and associated equipment has been properly installed, adjusted and tested, and meets the manufacturer's installation requirements.

-- End of Section --

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SECTION 26 56 00

EXTERIOR LIGHTING
08/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1089	(2013) Standard Specification for Spun Cast Prestressed Concrete Poles

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES RP-8	(2018; Addenda 1 2020; Errata 1-2 2021) Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires

ANSI/IES TM-21	(2019) Technical Memorandum: Projecting Long-Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C136.3	(2020) Roadway and Area Lighting Equipment - Luminaire Attachments
ANSI C136.13	(2020) Roadway and Area Lighting Equipment - Metal Brackets for Wood Poles
ANSI C136.21	(2014) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps– Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA C136.10	(2017) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles--Physical and Electrical Interchangeability and Testing
NEMA C136.31	(2018) Roadway and Area Lighting Equipment - Luminaire Vibration
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA WD 7	(2011; R 2016) Occupancy Motion Sensors

Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 773	(2016; Reprint Jul 2020) UL Standard for Safety Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2016; Reprint Jun 2020) UL Standard for Safety Nonindustrial Photoelectric Switches for Lighting Control
UL 916	(2015) Standard for Energy Management Equipment
UL 924	(2016; Reprint May 2020) UL Standard for Safety Emergency Lighting and Power Equipment
UL 1310	(2018) UL Standard for Safety Class 2 Power Units
UL 1598	(2021; Reprint Jun 2021) Luminaires
UL 8750	(2015; Reprint Jul 2021) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section(s) ~~[~~33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION~~]~~ ~~[33 71 01.00 40 OVERHEAD TRANSMISSION AND DISTRIBUTION] [~~33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION~~]~~. Luminaires and accessories installed in interior of buildings or attached to the exterior of a building are specified in Section 26 51 00 INTERIOR LIGHTING. ~~Cybersecurity requirements are specified in Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.[Commissioning requirements for Army and Air Force projects are specified in Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING.] Commissioning requirements for Navy projects are specified in Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.~~

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total Harmonic Distortion (THD) is the Root Mean Square (RMS) of all the harmonic components divided by the total fundamental current.

e. The "Groundline Section" of wood poles is that portion of the pole between one foot above, and 2 feet below the groundline.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G~~[, [_____]]~~

Pole Drawings; G~~[, [_____]]~~

Control System One-Line Diagram; G~~[, [_____]]~~

Sequence of Operation for Exterior Lighting Control System; G~~[, [_____]]~~

SD-03 Product Data

Luminaires; G~~[, [_____]]~~

Light Sources; G~~[, [_____]]~~

LED Drivers; G~~[, [_____]]~~

Luminaire Warranty; G~~[, [_____]]~~

Lighting Controls Warranty; G~~[, [_____]]~~

Pole Warranty; G~~[, [_____]]~~

Dimming Panel; G~~[, [_____]]~~

Motion Sensors; G~~[, [_____]]~~

Photosensors; G~~[, [_____]]~~

Time Clock; G[, [_____]]

Lighting Contactor; G[, [_____]]

Poles; G[, [_____]]

Brackets

Obstruction Marker Luminaires; G[, [_____]]

[SD-04 Samples

Luminaire Samples; G[, [_____]]

] SD-05 Design Data

Luminaire Design Data; G[, [_____]]

Photometric Plan; G[, [_____]]

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G[, [_____]]

ANSI/IES LM-80 Test Report; G[, [_____]]

ANSI/IES TM-21 Test Report; G[, [_____]]

Pressure Treated Wood Pole Quality; G[, [_____]]

Tests for Fiberglass Poles; G[, [_____]]

SD-08 Manufacturer's Instructions

Poles

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G[, [_____]]

Exterior Lighting Control System, Data Package 5; G[, [_____]]

Maintenance Staff Training Plan; G[, [_____]]

End-User Training Plan; G[, [_____]]

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Drawing Requirements

1.5.1.1 Luminaire Drawings

Include dimensions,[effective projected area (EPA), weight,] accessories, and installation and construction details. Photometric data, including CRI, CCT, TM-15-11 BUG rating, LED driver type,[aiming diagram,] zonal

lumen data, and candlepower distribution data per LM-79 must accompany shop drawings.

1.5.1.2 Pole Drawings

Include dimensions, wind load determined in accordance with ~~[AASHTO LTS][~~ ASCE 7-16~~]~~, pole deflection, pole class, and other applicable information.~~[~~ For concrete poles, include: section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes; initial prestressing steel tension; and concrete strengths at release and at 28 days.~~]~~

1.5.2 Luminaire Design Data

a. Provide distribution data according to IES classification type as defined in IES Lighting Library and ANSI/IES RP-8.

b. B.U.G. rating for the installed position as defined by ANSI/IES TM-15 and shielding as defined by ANSI/IES RP-8.

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification in accordance with NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

d. Provide long term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

e. Provide wind loading calculations for luminaires mounted on poles. Weight and effective projected area (EPA) of luminaires and mounting brackets must not exceed maximum rating of pole as installed in particular wind zone area.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

~~1.5.6 Tests for Fiberglass Poles~~

~~a. Ultraviolet resistance tests: Perform according to ASTM G154 using a UV-B light source having a 313 nanometer wavelength, operated at 130 degrees F, cycling the light source on for 4 hours and off for 4 hours for a total test period of 1500 hours minimum with the following results:~~

~~Fiber exposure:~~	~~None~~
~~Crazing:~~	~~None~~
~~Checking:~~	~~None~~
~~Chalking:~~	~~None~~
~~Color:~~	~~May dull slightly~~

~~b. Flexural strength and deflection test: Test loading must be as a cantilever beam with pole butt as fixed end and a force simulating wind load at the free end.~~

~~1.5.7 Pressure Treated Wood Pole Quality~~

~~Ensure the quality of pressure treated wood poles. Furnish an inspection report (for wood poles) of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with AWPA U1 and RUS Bull 1728F-700 standards. The RUS approved Quality Mark "WQC" on each pole will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.~~

~~[~~1.5.6 Photometric Plan

For ~~[~~roadways~~]~~ ~~[~~parking lots~~][intersections][_____]~~ include computer-generated photometric analysis of the "designed to" values in accordance with ~~[~~ANSI/IES RP-8~~][ANSI/IES LP-11]~~ for the "end of useful life" of the luminaire installation using a light loss factor of 0.81. Provide photometric plans that meet criteria in the Basis of Design in the project plans. Include the following in the submittal:

a. Horizontal illuminance measurements at finished grade, taken at a maximum grid size of 10 feet by 10 feet.

b. Vertical illuminance measurements at 5 feet above finished grade at all sidewalks and crosswalks, taken at a maximum of 10 feet.

c. Minimum and maximum footcandle levels.

d. Average maintained footcandle level.

e. Maximum to minimum ratio for horizontal illuminance only.

~~[~~ f. Average maintained luminance in candela per square meter.

~~]]~~1.5.7 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports

must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.

c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.5.8 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory provisions of NFPA 70 unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.9 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.9.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.9.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

1.6.1 Aluminum Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6.2 Steel Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

~~1.6.3 Wood Poles~~

~~Do not store poles on ground. Stack poles stored for more than 2 weeks on decay-resisting skids arranged to support the poles without producing noticeable distortion. Store poles to permit free circulation of air; the bottom poles in the stack must be at least one foot above ground level and growing vegetation. Do not permit decayed or decaying wood to remain underneath stored poles. Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentation more than one inch in depth in handling the poles. Do not apply tools to the groundline section of any pole.~~

~~1.6.4 Fiberglass Poles~~

~~Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.~~

1.6.3 Concrete Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation.

1.7 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

   (1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

   (2) Material warranty must include:

      (a) All LED drivers and integral control equipment.

      (b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the

using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and installation.

1.7.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

(1) Software: Failure of input/output to execute switching or dimming commands.

(2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to photosensors and motion sensors.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7.3 Pole Warranty

Provide and transfer to the government the original pole manufacturers standard commercial warranty for each different pole manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Provide a written ~~[three] [~~one~~]~~ year minimum replacement warranty for material, luminaire finish, and workmanship. Warranty service must be performed by a factory-trained engineer or technician.

1.8 OPERATION AND MAINTENANCE MANUALS

1.8.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system. Additional O&M Manual requirements for the Army are provided in Section 01 78 24.00 10 FACILITY DATA REQUIREMENTS. Additional requirements for the Navy are provided in Section 01 78 24.00 20 FACILITY ELECTRONIC OPERATION AND MAINTENANCE SUPPORT INFORMATION (eOMSI). Include the following:

a. Manufacturers' operating and maintenance manuals.

b. Luminaire shop drawings for modified and custom luminaires.

c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.8.2 Exterior Lighting Control System

Provide operation and maintenance manuals for the exterior lighting control system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the exterior lighting control system. Include the following:

a. Control System One-Line Diagram

b. Product data for all devices, including installation and programming instructions.

c. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the control system. Training materials must include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

~~[d. Motion sensor coverage layout.~~

~~]~~PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and XL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the LED driver and light source provided.

~~[2.2.1 Luminaire Samples~~

~~Submit one sample of each luminaire type [_____], complete with light source and LED driver rated for 120 V operation, and 6 feet pigtail with 3-prong Edison plug. Sample will be returned to the Contractor for installation in the project work.~~

~~]~~2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housing constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value

of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Area and Roadway (pole mounted, arm mounted)	119 LPW
Pedestrian Post-Top (pole mounted, arm mounted)	97 LPW
Bollard	45 LPW
Accent (adjustable landscape, sign lighting)	35 LPW
Linear Accent (facade, wallwash)	80 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	113 LPW

e. Product rated for operation within an ambient temperature range of minus 22 degrees F to~~[104 degrees F][~~ 122 degrees F~~]~~.

f. UL listed for wet locations.~~[Optical compartment for LED luminaires must be sealed and rated a minimum of IP65 per NEMA IEC 60529.]~~

g. IES Lighting Library. Light distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans.

h. Housing finish that is baked-on enamel, anodized, or baked-on powder coat paint. Finish must be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

i. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

j. ANSI/IES TM-15. Does not exceed the BUG ratings as listed in the luminaire schedule.~~.~~ If BUG ratings are not listed in the luminaire schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Area and Roadway	All	B3-U0-G3
Pedestrian Post-Top	All	B2-U1-G1

Lighting Application	Mounting Conditions	BUG Rating
Exterior Wall Sconce	Above 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 4 feet AFF	B4-U0-G4
Steplight	Above 4 feet AFF	B1-U1-G2
Steplight	Below or at 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

k. Fully assembled and electrically tested prior to shipment from factory.

l. Finish color is as indicated in the luminaire schedule or detail on the project plans.

m. Lenses constructed of ~~[~~clear~~]~~~~[frosted]~~ tempered glass or UV-resistant acrylic.~~[Provide polycarbonate vandal-resistant lenses.]~~

n. All factory electrical connections are made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

o. NEMA C136.31. Comply with 3G vibration testing.

~~[p. Luminaire arm bolts constructed from 304 stainless steel or zinc-plated steel.~~

~~]~~~~[q~~p. Wiring compartment on pole-mounted, street and area luminaires is accessible without the use of hand tools to manipulate small screws, bolts, or hardware.

~~]~~~~[q~~r. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, LED drivers, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

~~]~~~~[s. ANSI C136.3. For all roadway and area luminaires, provide products with an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled.~~

~~]~~~~[2.2.2 Obstruction Marker Luminaires~~

~~Provide obstruction marker luminaires for facilities as required by the FAA and in accordance with Section 26 56 20 AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS.~~

~~]~~2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, lumen rating, and wattage as indicated in luminaire schedule on project plans.

2.3.1 LED Light Sources

Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal Correlated

Color Temperature (CCT) of ~~[3000][2700][3500][~~4000~~]~~ Kelvin.

b. Minimum Color Rendering Index (CRI) of ~~[~~80~~][70]~~.

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 4-step McAdam ellipse.

2.4 LED DRIVERS

NEMA SSL 1, UL 1310. Provide LED Drivers that are electronic, UL Class 1 or Class 2, constant-current type and meet the following requirements:

a. The combined LED driver and LED light source system is greater than or equal to the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operate at a voltage of ~~[~~120-277~~][120][277]~~ volts at 50/60 hertz, with input voltage fluctuations of plus or minus 10 percent.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Meets the "Elevated" (10kV/10kA) requirements per IEEE C62.41.2 -2002. Manufacturer must indicate whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire. Provide surge protection that is integral to the LED driver.

g. Contains integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating for all drivers mounted under a covered structure, such as a canopy, or where otherwise appropriate.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

k. UL listed for wet locations typical of exterior installations.

l. ~~[~~Dimmable, and compatible with a standard dimming control circuit of 0 - 10V~~][Non-dimmable]~~.

m. Rated to operate between ambient temperatures of minus 22 degrees F and ~~104 degrees F[~~ 122 degrees F~~]~~.

2.4.1 Remote LED Drivers

Provide remote LED Drivers that are [UL listed for wet locations typical of exterior installations][located in an IP68 direct burial enclosure listed for wet location].

2.5 LIGHTING CONTROLS

[Provide a control system interface within each luminaire that is compatible with the energy management or control system used by the utility department in charge of the project area for control of site lighting.]Provide network certification for all networked lighting control systems and devices in accordance with the requirements of Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.5.1 System

Provide exterior lighting control system that operates the exterior lighting system as described in the exterior lighting control strategies in the project plans. Submit Sequence of Operation for Exterior Lighting Control System describing the operation of the proposed exterior lighting control system and devices. Sequence of Operation must provide the strategies identified in the exterior lighting control strategies.

2.5.1.1 Relay Panel

Enclose panel hardware in a [surface][flush]-mounted, NEMA [1][3R][4], painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide relay panel that meets the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low voltage power supply as required.

b. UL 924. [8][16][32][_____] single-pole latching relays rated at [20][30] amps, [120-277][120][277] volts. Provide provision for relays to close upon power failure. Provide relays designed for 10 years of use at full rated load.

c. Relay control module operates at 24 VDC and is rated to control a minimum of [8][16][32][_____] relays.

2.5.1.2 Dimming Panel

UL 916, 47 CFR 15[, CEC Title 24]. Provide dimming panel that is designed as a [a standalone][an automated control system interface] type. Provide panel that meets the following criteria:

a. Consists of a single NEMA [1][3R][4] [flush][surface]-mounted enclosure with two separate interior sections; one for Class 1 (branch circuit) and one for Class 2 (low voltage) wiring.

b. Panel enclosure is constructed of [16][14] gauge cold-rolled steel with baked-on enamel finish.

c. Class 1 section contains the load side of all relays and the incoming branch circuit wiring.

d. Class 2 section contains a 24 VDC control power transformer, relays, relay control modules, and control wiring~~[, and [BACnet compatibility in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [LONworks compatibility in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] field-programmable application controller for panels connected to the facility automated control system]~~.

e. Contains inputs for signals from photosensors, time clocks, and motion sensors.

f. Capable of 0-10V dimming.

2.5.1.3 Networked Lighting Control System

Provide a networked exterior lighting control system that meets the following requirements:

a. ~~[~~Wired network~~][Wireless mesh network][Powerline carrier]~~ system.

~~b. ANSI C136.41. [Communicates via gateway with [_____] nodes per gateway and a maximum of [_____] feet between gateways.] [Gateway-less system with wireless node compatible with 7-pin dimming receptacle. Wireless node must have a communication frequency of [_____][kHz][MHz][GHz] and must be located no greater than [_____] feet apart.]~~

~~c~~b. Capable of ~~[~~0-10V~~][DALI]~~ dimming.

~~d~~c. Capable of astronomic time clock functions, programmable luminaire grouping, ~~[motion detection][programmable motion detection grouping],~~ light source monitoring, LED driver monitoring, energy monitoring in kilowatt-hours, ~~[remote monitoring with read-only access][~~remote control and programming with read and write access~~]~~.

~~2.5.1.4 Gateway~~

~~Provide gateway in accordance with Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports. Provide [BACnet communication interface in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][LONworks communication interface in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][_____] that enables remote control and monitoring of lighting from a workstation according to read access points and write access points listed in the paragraph NETWORKED LIGHTING CONTROL SYSTEM. Control features and monitoring points displayed locally at lighting panel must be available through the Gateway. Provide Gateway that meets the following requirements:~~

~~a. Microprocessor-based communications device that perform bi-directional protocol translation.~~

~~b. Support full bi-directional communication and translation.~~

c. Contain its own microprocessor, RAM, battery, communication ports, and power supply.

[d. Support an additional 5 percent points for future expansion.

]2.5.2 Devices

2.5.2.1 Time Clock

NEMA ICS 6. House time clock in a surface-mounted, lockable NEMA [1][3R] enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

a. [24 hour][7 day][astronomic] programming function, providing a total of 56 [_____] on/off set points.

b. [12 hour AM/PM][24 hour] type digital clock display format.

c. Power outage back-up for switch utilizing [a capacitor][alkaline batteries][lithium battery] which provides coverage for a minimum of [seven days][three years][eight years].

d. Capable of controlling a minimum of [1][2][4][16_____] channels or loads.

e. Contacts are rated for [30] [_____] amps at 120-277 VAC resistive load in a [SPST][DPST][SPDT][DPST] [normally open (NO)][normally closed (NC)] configuration.

f. Contains [function that allows automatic control to be skipped on certain selected days of the week][manual bypass or remote override control][daylight savings time automatic adjustment][EEPROM memory module][momentary function for output contacts][ability for photosensor input].

2.5.2.2 Photosensors

UL 773, UL 773A. Provide Photosensors that meet the following requirements:

a. Hermetically sealed, [cadmium sulfide][silicon diode] light sensor type, rated at [_____600] watts, [277_____] volts, 50/60 Hz with single-pole, [single][double]-throw contacts.

b. Turns ON at 1 to 3 footcandles and turns OFF at 3 to 15 footcandles.

c. Designed to fail to the ON position.

d. Housing is constructed of [polycarbonate][die cast aluminum][UV stabilized polypropylene], rated to operate within a temperature range of minus 40 to 158 degrees F.

e. Time delay that prevents accidental switching from transient light sources.

[f. Directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.

~~]~~ ~~g~~f. Designed for 20-year service to match life expectancy of long-life LED fixtures and exceed 15,000 operations at full load. Provide photosensors with zero-cross technology to withstand severe in-rush current and extend relay life.

~~[~~ ~~h~~g. ~~[~~Fixed~~]~~~~[Swivel]~~ base type housing with 1/2 in threaded base for mounting to a junction box or conduit.

~~]~~~~[i~~h. NEMA C136.10. Twist-lock receptacle type. Provide with solid brass prongs and voltage markings and color coding on exterior of housing.

~~]~~~~[i~~j~~~. Provide photosensors with metal oxide varistor (MOV) type surge protection.

~~]~~2.5.2.3 Motion Sensors

NEMA WD 7, UL 773A. Provide sensors that meet the following requirements:

a. Operating voltage of ~~[12-24]~~[120-277~~]~~~~[120]~~~~[277]~~ volts.

b. ~~[Passive infrared]~~~~[Microwave]~~[Dual technology passive infrared/microwave~~]~~ type sensors with ~~[~~270~~]~~~~[_____]~~ degree coverage.

c. Time delay that can be adjusted from 15 seconds to 15 minutes.

d. Default state is "Fail to ON position."

e. Sensors installed integral to the luminaire must be provided by the luminaire manufacturer.

f. Sensor contains an integral light level sensor that does not allow luminaires to operate during daylight hours

~~g. [Equipped with a threaded base for mounting to a weatherproof junction box][Mounted directly to luminaire].~~

~~[~~ ~~h~~g. Operates in conjunction with bi-level controllers that reduce the connected lighting power by 50 percent.

~~]2.5.2.4 Lighting Contactor~~

~~NEMA ICS 2. Provide a [mechanically][electrically]-held lighting contactor [housed in a NEMA [1][3R][4][_____] enclosure conforming to NEMA ICS 6]. Contactor must have [2][4][6][_____] poles, configured as [normally open (NO)][normally closed (NC)]. Contacts must be rated [600][_____] volts, [30][_____] amperes for a resistive load. Coil operating voltage must be [24][120][277][_____] volts. Contactor must have silver cadmium oxide double-break contacts [and coil clearing contacts for mechanically held contactors] and must require no arcing contacts.[Provide contactor with hand-off-automatic [on-off] selector switch.][Provide contactor as specified above along with [disconnect switch][circuit breaker] in integral NEMA [1][3R][_____] enclosure with flange-mounted handle to satisfy requirement for a "combination lighting contactor" when specified.]~~

2.6 POLES

~~[AASHTO LTS]~~[ASCE 7-16~~]~~. Provide round ~~[straight]~~[tapered~~]~~ poles designed

for wind loading of [100][_____] miles per hour while supporting luminaires and all other appurtenances indicated. The effective projected areas (EPA) of luminaires and appurtenances used in calculations must be specific for the actual products provided on each pole. Provide poles that are[embedded][anchor]-base type designed for use with[underground][overhead] supply conductors.[Poles[, other than wood poles,] must have oval-shaped hand hole having a minimum clear opening of 3 by 5 inches. Secure hand hole covers by stainless steel captive screws.][Provide metal poles with an internal grounding connection accessible from the hand hole near the bottom of each pole. Install a means of wire disconnection accessible from the hand hole.] Do not install square poles. Provide poles from a Manufacturer with a standard provision for protecting the finish during shipment and installation. Do not install scratched, stained, chipped, or dented poles.

2.6.1 Aluminum Poles

Provide aluminum poles with [uniform satin][anodized][_____] finish unless otherwise noted in luminaire schedule on project plans. Do not paint aluminum poles. Provide poles that meet the following requirements:

a. AASHTO LTS. Manufactured of corrosion resistant aluminum alloys for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys.

b. Seamless extruded or spun seamless-type with minimum 0.188 inch wall thickness.

c. Top of shaft is fitted with a round or tapered cover.

d. ASTM B108/B108M. Pole base is mounted by anchor bolts, made of cast 356-T6 aluminum alloy. Base must be machined to receive the lower end of shaft.

e. Joint between shaft and base is welded.

f. ASTM B108/B108M. Base cover is cast 356-T6 aluminum alloy.

g. All hardware other than anchor bolts are either 2024-T4 anodized aluminum alloy or stainless steel.

h. Grounding connection is designed to prevent electrolysis when used with copper ground wire.

2.6.2 Steel Poles

Provide steel poles with[hot-dipped galvanized in accordance with ASTM A123/A123M][iron-oxide primed] factory finish. Provide poles that meet the following requirements:

a. Minimum 11-gage steel with minimum yield/strength of 48,000 psi

b. Pole is [mounted by anchor bolts][direct set].

c. Consists of tapered tubular members, either round in cross section or polygonal.

d. Pole shaft is one piece and is of welded construction with no bolts, rivets, or other means of fastening except as specifically approved.

~~e. Base covers are of structural quality hot-rolled carbon steel plate, with a minimum yield of 36,000 psi.~~

~~f. Markings are approximately 3 to 4 feet above grade and includes manufacturer, year of manufacture, top and bottom diameters, and length.~~

~~g. Grounding connection is designed to prevent electrolysis when used with copper ground wire.~~

~~2.6.3 Wood Poles~~

~~ATIS ANSI O5.1, RUS Bull 1728F-700. Provide wood poles of[Southern Yellow Pine][Douglas Fir][_____]. Provide poles that meet the following requirements:~~

~~a. AWPA U1. RUS Bull 1728F-700. Treated full length with chromated copper arsenate (CCA) or ammoniacal copper arsenate (ACA). Poles must be gained, bored, and roofed before treatment.~~

~~b. Branded by manufacturer with manufacturer's mark and date of treatment, height and class of pole, wood species, preservation code, and retention. Place the brand so that the bottom of the brand or disc is 10 feet from the pole butt for poles up to 50 feet long[and 14 feet from the butt for poles over 50 feet long].~~

~~2.6.4 Fiberglass Poles~~

~~NEMA C136.20. Provide fiberglass poles with resin color of [dark bronze][_____] with uniform pigment coloration throughout entire wall thickness. Provide poles that meet the following additional requirements:~~

~~a. Poles are designed specifically for supporting luminaires and have factory-formed cable entrance and hand hole.~~

~~b. Finish surface is pigmented polyurethane having a minimum dry film thickness of 1.5 mils. Polyurethane may be omitted if the surface layer of the pole is inherently ultraviolet inhibited.~~

~~c. Minimum fiberglass content is 65 percent with resin and pigment comprising the other 35 percent material content.~~

2.6.1 Concrete Poles

ASTM C1089. Cross-sectional shape must be round.

2.6.1.1 Steel Reinforcing

Provide prestressed concrete pole shafts that are reinforced with steel prestressing members. Provide internal longitudinal loading by either pre-tensioning or post-tensioning longitudinal reinforcing members.

2.6.1.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft must be tensioned between 60 to 70 percent of its ultimate strength. The amount of reinforcement must be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force

does not exceed the minimum section compressive strength of the concrete.

2.6.1.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core opening, such as hand holes and wiring inlet, protect reinforcing with a vapor proof noncorrosive sleeve over the length without the 1/2 inch concrete coverage. Apply a nonmigrating slipper coating to each steel reinforcing member which is to be post-tensioned prior to the application of concrete to ensure uniformity of stress throughout the length of each member.

2.6.1.4 Strength Requirement

As an exception to the requirements of ASTM C1089, provide poles that are naturally cured to achieve a 28-day compressive strength of 7000 psi. Poles must not be subjected to severe temperature changes during the curing period.

2.6.1.5 Shaft Preparation

Provide completed prestressed concrete pole shaft with a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and must be clean, smooth, and free of surface voids and internal honeycombing. Do not install poles within 15 days of manufacture.

2.6.2 Brackets and Supports

ANSI C136.3, ANSI C136.13, and ANSI C136.21. Provide pole brackets that are not less than 1 1/4 inch~~[~~ galvanized steel pipe~~][aluminum]~~ secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets must be coordinated to luminaires provided, and brackets for use with one type of luminaire must be identical. Brackets for pole-mounted street lights must correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Provide special mountings or brackets as indicated and of metal which will not promote galvanic reaction with luminaire head.

2.6.3 Pole Foundations

Provide anchor bolts consisting of a steel rod with a minimum yield strength of 50,000 psi; the top 12 inches of the rod must be galvanized in accordance with ASTM A153/A153M. Concrete must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.7.2 Labels

UL 1598. Luminaires must be clearly marked for operation of specific

light sources and drivers according to proper light source type. Note the following luminaire characteristics in the format "Use Only _____":

a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

b. Driver and dimming protocol.

Markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Luminaires

Install all luminaires in accordance with the luminaire manufacturer's written instructions. Install all luminaires at locations and heights as indicated on the project plans. Level all luminaires in accordance to manufacturer's written instructions.~~[Aim all luminaires in accordance with aiming diagram.]~~

~~[~~3.1.2 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

~~[3.1.2.1 Remote LED Drivers~~

~~Locate Remote LED Drivers within the maximum distance allowed to reduce voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, or in accessible IP68-rated enclosure. Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector suitable for wet-location. Remote LED drivers must be electronically grounded in accordance with NFPA 70.~~

~~]]3.1.3 Field-Applied Painting~~

~~Provide field applied painting for luminaire type [_____]. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.~~

~~3.1.4 Wood Poles~~

~~Pole holes must be at least as large at the top as at the bottom and must be large enough to provide 4 inches of clearance between the pole and the side of the hole.~~

~~a. Setting depth: Provide pole setting depths as follows:~~

~~Length of Pole (feet)~~	~~Setting in Soil (feet)~~
~~20~~	~~5.0~~
~~25~~	~~5.5~~
~~30~~	~~5.5~~
~~35~~	~~6.0~~
~~40~~	~~6.0~~
~~45~~	~~6.5~~
~~50~~	~~7.0~~
~~55~~	~~7.5~~
~~60~~	~~8.0~~

~~b. Soil setting: "Setting in Soil" depths must apply where pole holes are in soil, sand, or gravel or any combination of these.[At corners, dead ends and other points of extra strain, poles 40 feet long or more must be set 6 inches deeper.]~~

~~c. Setting on sloping ground: On sloping ground, measure the depth of the hole from the low side of the hole.~~

~~d. Backfill: Tamp pole backfill for the full depth of the hole and mound the excess fill around the pole.~~

3.1.3 Concrete Poles

Install according to pole manufacturer's instructions.

~~3.1.4 Fiberglass Poles~~

~~Install according to pole manufacturer's instructions.~~

~~3.1.5 Aluminum and Steel Poles~~

~~Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit bells, and ground rods must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust~~

poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.[After installation, paint exposed surfaces of steel poles with two finish coats of[exterior oil paint of a color as indicated][aluminum paint]. Install according to pole manufacturer's instructions. Alterations to poles after fabrication will void manufacturer's warranty and is not allowed.]

3.1.4 Pole Setting

[Set pole to depth as indicated.][Poles in straight runs must be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.]

3.1.5 Lighting Controls

Refer to Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for additional lighting control installation requirements.

3.1.5.1 Photosensors

Aim photosensor according to manufacturer's recommendations.[Mount sensor on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.][Set adjustable window slide for [_____] footcandles photosensor turn-on.]

3.1.5.2 Motion Sensors

Locate sensors in accordance with the manufacturer's recommendation. Locate sensors to achieve coverage of areas as indicated on project plans. Coverage patterns must be derated as recommended by manufacturer based on mounting height of sensor and any obstructions such as trees. Do not use gross rated coverage in manufacturer's product literature.

3.1.6 Grounding

Ground noncurrent-carrying parts of equipment including[metal poles,] luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Perform initial operational test, consisting of the entire system energized for 72 consecutive hours without any failures of any kind occurring in the system. All circuits must test clear of faults, grounds, and open circuits.

3.2.1.1 Lighting Control Verification Test

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

Provide on-site training to the Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide training that includes calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

3.3.1.1 Maintenance Staff Training

Submit a Maintenance Staff Training Plan at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrate full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.1.2 End-User Training

Submit a End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide demonstration for each type of user interface. Provide users with the curfew schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

-- End of Section --

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SECTION 27 05 13.43

TELEVISION DISTRIBUTION SYSTEM
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code

NATIONAL CABLE AND TELECOMMUNICATIONS ASSOCIATION (NCTA)

NCTA RP	(1989) NCTA Recommended Practices for Measurements on Cable Television Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 76.605	Technical Standards

UNDERWRITERS LABORATORIES (UL)

UL 969	(2017; Reprint Mar 2018) UL Standard for Safety Marking and Labeling Systems
UL 1581	(2001; Reprint Jun 2021) UL Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 1666	(2007; Reprint Jun 2012) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.2 DEFINITIONS

1.2.1 Television Distribution System

The television distribution system ~~system~~, commonly referred to as cable television, is a network of cables, headend, electronic and passive components that process and amplify television (TV) signals for distribution of adequate signals to each receiver from the headend equipment to the individual television outlets and provides distortion-free signal to TV sets by isolating each receiver from the system and providing the proper amount of signal to each set.

1.2.2 Headend

The connection point between television distribution system equipment and equipment provided by the local television service provider.

1.2.3 Distribution System

Distribution system transports and delivers adequate signals to each receiver. Provides distortion-free signal to TV sets by isolating each receiver from the system and by providing proper amount of signal to each set.

1.2.4 Cable

~~{~~Trunk and feeder cables are low-loss cables used to transport the desired signal from the headend equipment to the telecommunications room in the area to be served. These cables are used to transport signal from the ~~{~~ telecommunications room~~]~~~~[~~headend equipment~~]~~ into close proximity to a number of user locations in excess of 200 feet from the ~~{~~ telecommunications room~~]~~~~[~~headend equipment~~]~~. ~~]~~Drop cables are used to transport the desired signal used from the ~~{~~telecommunications closet room ~~]~~~~[~~headend equipment~~]~~ to the wall outlet.

1.3 SYSTEM DESCRIPTION

1.3.1 Headend

Contractor shall provide interior equipment up to headend ~~{~~and including the main amplifier~~]~~ located at the interior television distribution system ~~{~~backboard~~]~~~~[~~cabinet~~]~~~~[~~rack~~]~~.

1.3.2 Distribution System

~~{~~ ~~{~~For P4639: Distribution system shall be star topology with each outlet connected to a telecommunications room with a feeder cable or a drop cable and each telecommunications room connected to the headend equipment with a ~~{~~coaxial~~]~~~~[~~fiber optic~~]~~ trunk cable.

~~]~~~~[~~For P4638: Distribution system shall be star topology with each outlet connected to headend equipment with the drop cable~~]~~.

~~]~~~~[~~Distribution system shall be a star topology utilizing a coaxial trunk cable and category [6] UTP drop cables with the exception of low voltage patient television outlets. Low voltage patient television outlets shall be connected with coaxial drop cables.~~]~~

1.3.3 Cable

~~{~~Provide trunk cables to transport the desired signal from the headend equipment to the telecommunications room in the area to be served. ~~]~~~~[~~ Provide ~~{~~trunk~~]~~ ~~[~~feeder~~]~~ cables to transport signal from the ~~{~~headend equipment~~]~~~~[~~telecommunications room~~]~~ to user locations for cable lengths in excess of 200 feet from the ~~{~~headend equipment~~]~~~~[~~telecommunications room~~]~~. ~~]~~Provide drop cables to transport the desired signal from the ~~{~~ telecommunications room~~]~~~~[~~headend equipment~~]~~ to the outlet.

1.3.4 System Components

System shall provide high quality TV signals to all outlets[with a return path for interactive television and cable modem access]. Provide any combination of items specified herein to achieve required performance, subject to approvals, limitations, acceptance test, and other requirements specified herein. System shall include amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators and all other parts, components, and equipment necessary to provide a complete and usable system.

1.3.4.1 System Bandwidth

a. Downstream: 50-1000 MHz minimum.

b. Upstream 5-40 MHz minimum.

1.3.5 System Performance

System shall be in compliance with 47 CFR 76.605.

1.3.5.1 Receiver Termination Signal Level

Each termination for a TV receiver must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) at 55 MHz and of 0 dBmV (1000 microvolts) at 1000 MHz and a maximum signal of 15 dBmV or a level not to overload the receiver for the entire system bandwidth.

1.3.5.2 Distribution System

a. Modulation distortion at power frequencies: 4 percent or less hum distortion;

b. Composite third order distortion for:

(1) CW carriers: 53 dB.

(2) Modulated carriers: 59 dB.

c. Subscriber terminal isolation: 18 dB or greater.

d. Carrier to second order beat ratio: 60 dB.

e. Amplitude characteristic:within a range of plus or minus 2 decibels from 0.75 MHz to 5.0 MHz above the lower boundary frequency of the cable television channel, referenced to the average of the highest and lowest amplitudes within these frequency boundaries.

f. Visual, aural carrier level, 24-hour variation: 47 CFR 76.605, subpart (a), rules (4), (5), and (6).

g. Frequency determination: 47 CFR 76.605, subpart (a), rules (1),(2), and (3).

1.3.5.3 System Tolerance

The system must not show a serious loss of carrier to noise when the system levels are lowered 3 dB below normal or a significant distortion when the levels are increased 3 dB above normal, as observed on a TV set

located at the far end extremities of the system.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Television Distribution System Wiring Diagrams And Installation Details; G[, [_____]]

Television Distribution System Components; G[, [_____]]

SD-03 Product Data

Attenuators; G[, [_____]]

[Amplifiers, including [Headend,]Trunk, Bridging, and Distribution; G[, [_____]]

]

Cables, including [Trunk, Feeder, and]Drop; G[, [_____]]

Terminators; G[, [_____]]

Splitters/Combiners; G[, [_____]]

[Fiber Optic Couplers; G[, [_____]]

] Line Taps; G[, [_____]]

Coaxial Outlets; G[, [_____]]

Coaxial Connectors; G[, [_____]]

Tilt Compensator; G[, [_____]]

[Distribution Hubs; G[, [_____]]

][Baluns; G[, [_____]]

][Grounding Block; G[, [_____]]

] Submittals for each manufactured item must be the current manufacturer's descriptive literature of catalog products, equipment drawings, diagrams, performance and characteristics curves, and catalog cuts.

SD-05 Design Data

Television Distribution System Loss Calculations; G[, [_____]]

SD-06 Test Reports

Operational Test Plan; G~~[, [_____]]~~

Operational Test Procedures; G~~[, [_____]]~~

System Pretest; G~~[, [_____]]~~

Acceptance Tests; G~~[, [_____]]~~

SD-08 Manufacturer's Instructions

Connector Installation; G~~[, [_____]]~~

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G~~[, [_____]]~~

Submit Data Package 5 for each component in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Wiring Diagrams and Installation Details

Illustrate how each item of equipment functions in the system and include an overall system schematic indicating the relationship of television distribution system units on one diagram. Drawings must include wiring diagrams and installation details of equipment indicating proposed locations, layout and arrangements, and other items that must be shown to ensure coordinated installation.

1.5.2 Television Distribution System Loss Calculations

Calculations must verify that the system does not exceed the loss values specified in dBmV at the ~~[receiver terminations]~~[input of all active devices and the receiver terminations~~]~~. Provide a drawing displaying all distribution network calculations. The drawing should accurately show taps, splitters, outlets, and the type and length of all ~~[~~trunk, feeder, and ~~]~~drop cables. The drawing must show how many taps, splitters, or outlets are served by each tap or splitter.

1.5.3 Operational Test Plan

Test plan must define tests required to ensure that the system meets technical, operational, and performance specifications. Test plan must be based on NCTA RP and be in accordance with FCC proof of performance requirements. Test plan must include plan for testing for signal leakage. Provide test requirements and guidelines.

1.5.4 Operational Test Procedures

Use test plan and design documents to develop test procedures. Procedures must consist of detailed instructions for a test setup, execution, and evaluation of test results.

1.5.5 Connector Installation

Provide manufacturer's instructions for installing connectors.

PART 2 PRODUCTS

2.1 ELECTRONIC EQUIPMENT

Electronic components of similar type must be produced and designed by the same manufacturer as major components of the equipment and must have the manufacturer's name and model permanently attached. Equipment must function properly as a complete integrated system. Equipment must be shielded. The system must be designed to operate within 5 to 1000 MHz bandwidth using 1000 MHz passive devices and a minimum of 1000 MHz active devices.

~~2.2 HEADEND EQUIPMENT~~

~~2.2.1 Headend Amplifiers~~

~~Provide broadband distribution amplifiers. Amplifiers must amplify broadband signals from 40 to 1000 MHz[and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance]. Amplifiers must be bidirectional with variable slope and gain control.~~

~~2.2.2 Attenuators~~

~~Provide attenuators to equalize signal levels, when required. Variable attenuators are not permitted.~~

~~2.2.3 Power Supplies~~

~~Power supplies must contain a current limiter circuit to protect against short circuits on the radio frequency (RF) line. Provide overvoltage protection to protect solid state equipment from line surges and induced voltages, in accordance with IEEE C62.41.1 and IEEE C62.41.2.~~

2.2 DISTRIBUTION EQUIPMENT

~~[~~2.2.1 Distribution Amplifiers

Distribution amplifiers shall be equipped for 75 ohms input and output impedance. Electronic equipment exposed to weather shall be equipped with weatherproof housings. Amplifiers shall be bidirectional with variable slope and gain control and shall amplify broadband signals from 50 to 1000 MHz~~[and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance]~~.

2.2.1.1 Trunk Amplifiers

Trunk amplifiers shall have automatic level and slope control features.

2.2.1.2 Bridging Amplifiers

Bridging amplifiers shall be used to connect feeder cables to trunk cables.

~~[2.2.1.3 Fiber Optic Amplifiers~~

~~Provide fiber optic amplifiers in fiber optic backbone distribution systems as required to provide required optical power to fiber optic receivers.~~

~~][2.2.1.4 Fiber Optic Receiver Distribution Amplifier~~

~~Provide fiber optic receiver with integrated broadband distribution amplifier to receive the fiber optic video signal and distribute it to the coaxial cable sub-distribution system.~~

~~]]~~2.2.2 Cables and Associated Hardware

Cabling shall be UL listed for the application and shall comply with NFPA 70. Provide a labeling system for cabling as required by UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.2.2.1 Trunk Cable

~~[~~ UL 1666. Provide trunk cable with an NFPA 70 rating of CATVR.

a. Provide RG-11 coaxial cable with the following characteristics:

(1) 14 AWG copper-clad steel center conductor.

(2) Gas injected foam polyethylene dielectric with nominal 0.28 inches outer diameter.

(3) Bonded foil inner-shield and 60 percent aluminum braid~~[~~ or quad shield~~]~~.

(4) 75 ohms impedance.

(5) 82 to 85 percent nominal velocity of propagation.

(6) Black PVC jacket

(7) Maximum attenuation characteristics:

MHz	DB/100 ft
5	0.38
55	0.96
300	2.25
350	2.42
450	2.86
500	2.90
600	3.18
750	3.65
1000	4.35

b. Provide 625 Series cable with an NFPA 70 rating of CATVR and the following characteristics:

(1) Copper-clad aluminum center conductor

(2) Seamless aluminum tubing shield

(3) Expanded polyethylene dielectric

(4) 75 ohms impedance

(5) Nominal diameter over outer conductor: 0.625 inches.

(6) Maximum attenuation at 20 degrees C and 1000 MHz: 2.07 dB/100 feet

(7) Black medium density polyethylene jacket

(8) Nominal 87 percent velocity of propagation

~~][Provide fiber optic trunk cable as indicated and in accordance with ICEA S-83-596, TIA-568.3, UL 1666 and NFPA 70. Provide the number of strands indicated, (but not less than 6 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode, tight buffered fiber optic cable as recommended by the television distribution system manufacturer.~~

~~][~~2.2.2.2 Feeder Cable

UL 1581, provide RG-11 coaxial trunk cable with an NFPA 70 rating of ~~[CATV][~~CATVP~~]~~ and the following characteristics:

a. 14 AWG copper-clad steel center conductor.

b. ~~[~~Gas injected foam polyethylene~~][Foam FEP]~~ dielectric with .28 inches nominal outer diameter.

c. Bonded foil inner-shield and a minimum of 60 percent aluminum braid~~[~~ or quad shield~~]~~.

d. 75 ohms impedance.

e. 81 to 84 percent nominal velocity of propagation.

f. ~~[~~Black PVC~~][PVC low smoke polymer or FEP]~~ jacket.

g. Maximum attenuation characteristics:

~~[~~

~~CATV~~	
~~MHz~~	~~DB/100 ft~~
~~50~~	~~.95~~
~~100~~	~~1.3~~
~~200~~	~~1.9~~
~~400~~	~~2.7~~

CATV	
MHz	DB/100 ft
700	3.9
1000	4.8

]|

CATVP	
MHz	DB/100 ft
50	1.2
100	1.7
200	2.5
400	3.5
700	4.6
900	5.3
1000	5.6

]]|2.2.2.3 Drop Cable

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of |[CATV]|CATVP] and with the following characteristics:

a. No. 18 AWG copper-clad steel center conductor.

b. Bonded foil inner-shield and 90 percent aluminum braid.

c. Characteristic impedance of 75 ohms.

d. |Gas injected foam polyethylene]|[Foam FEP] dielectric

e. Nominal capacitance, conductor to shield, of 16.2 pf per 100 ft .

f. Maximum operating voltage of 350 V RMS.

g. Maximum attenuation:

|

CATV	
MHz	DB/100 ft
10	0.81
50	1.46

CATV	
MHz	DB/100 ft
100	2.05
200	2.83
400	4.0
500	4.53
700	6.0
1000	7.3

][

CATVP	
MHz	DB/100 ft
10	0.7
50	1.5
100	2.1
200	3.1
400	4.5
500	6.0
700	6.9
1000	7.3

] h. [Black polyvinyl chloride (PVC)][PVC low smoke polymer or FEP] jacket.

i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

][2.2.2.4 Low Voltage Patient Television Drop Cable

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of [CATV][CATVP] and with the following characteristics:

a. No. 18 AWG solid copper center conductor.

b. Aluminum/Polyesetr/Aluminum tape 100 percent coverage inner-shield and tinned copper outer braid with 60 percent coverage.

c. Characteristic impedance of 75 ohms.

d. [Gas injected foam polyethylene][Foam FEP] dielectric

e. Nominal capacitance, conductor to shield, of 16.2 pf per ft.

f. Maximum operating voltage of 300 V RMS.

g. Maximum attenuation:

[

CATV	
MHz	DB/100 ft
10	0.70
50	1.5
100	2.0
200	2.8
400	4.0
700	5.3
900	6.1
1000	6.5
1500	8.3

][

CATVP	
MHz	DB/100 ft
10	0.70
50	1.5
100	2.0
200	2.8
400	4.0
700	5.3
1000	6.5
1500	8.3

] h. [Black polyvinyl chloride (PVC)][PVC low smoke polymer or FEP] jacket.

i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

]2.2.3 Category 6A Drop Cable

Provide as indicated on the drawings and 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.2.4 Category 6A Patch Cords

Provide patch cords, as complete assemblies, with matching connectors as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Patch cords shall meet minimum performance requirements specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM for cables, cable length and hardware specified.

2.2.5 Terminators

Coaxial terminators shall be rated for 75 ohms and 1/4 watt.~~[~~ Category 6A port terminators shalww l be plug-in hub type and shall have integral 8-pin modular connector.~~]~~

2.2.6 Splitters/Combiners

Use splitters/combiners with characteristics equal to or exceeding the characteristics listed in this paragraph over the entire operating band. All unused outlets must be terminated with 75-ohm terminators.

a. Peak to Valley: Not to exceed 1 dB across bandwidth of device.

b. Return loss: 18 dB minimum.

c. Bandwidth: 5-1000 Mh

~~[2.2.7 Fiber Optic Couplers~~

~~Use fiber optic couplers to split fiber optic light sources equal to or exceeding the characteristics listed in this paragraph.~~

~~a. Number of inputs: 1~~

~~b. Wavelength: 1310 and 1550 nm~~

~~c. Number of Outputs: [2 with insertion loss of 3.3 dB, uniformity of greater than 0.7 dB, and directivitiy of greater than 50 dB][4 with insertion loss of 6.3 dB, uniformity of greater than 1.4 dB, and directivitiy of greater than 50 dB][8 with insertion loss of 9.5 dB, uniformity of greater than 2.1 dB, and directivitiy of greater than 50 dB][16 with insertion loss of 12.6 dB, uniformity of greater than 2.8 dB, and directivitiy of greater than 50 dB]~~

~~]~~2.2.7 Line Taps

Line taps shall have 18 dB minimum isolation from each tap to the thru-line.Pressure tapoffs are not permitted. Taps shall be rated from 5 to 1000 MHz and shall have a peak to valley not to exceed 1 dB to 1 GHz.

2.2.8 Coaxial Outlets

Provide flush mounted, 75-ohm, F-type connector outlets rated from 5 to 1000 MHz in standard electrical outlet boxes~~[with isolation barrier]~~.

2.2.9 Coaxial Connectors

Provide one piece connectors. ~~[~~Trunk and feeder cable connectors shall be pin type. ~~]~~Drop cable connectors shall be feed thru type.

2.2.10 Tilt Compensator

Provide tilt compensators as required.

~~[2.2.11 Distribution Hubs~~

~~Rack-mountable passive distribution hubs with 16 front mounted modular 8-pin jacks for connection to UTP 4-pair category 6 cabling, and "F" fitting on rear panel for connection to coaxial trunk cable. Hubs shall be tested compliant with FCC Part 15 requirements. Bandwidth: 5 – 860 MHz. Hubs shall be supplied with quantities of plug-in terminators to terminate all unused ports. Provide quantities of hubs as indicated.~~

~~][2.2.12 Baluns~~

~~Provide single-port converters (for use at TV outlet locations). Converter shall convert balanced line signal to coaxial unbalanced signal for connection to coaxial inputs of television receiver/monitors. Converter shall be equipped with integral 8-pin modular jack on one end and male "F" fitting on the opposite end. Provide quantities as indicated~~

~~]~~2.3 GROUNDING AND BONDING

Provide ground rods and connections in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

~~[2.3.1 Grounding Block~~

~~Provide [corrosion-resistant] grounding block suitable for [outdoor][indoor] installation.~~

~~][2.4 BACKBOARDS~~

~~Provide void-free, fire rated interior grade plywood, 3/4 inch thick,[4 by 8 feet][as indicated]. Backboards shall be painted with a gray, nonconductive fire-resistant overcoat. Do not cover the fire stamp on the backboard.~~

~~]~~PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Distribution System

Distribution system shall conform to requirements specified herein. Installation shall be in accordance with IEEE C2 and NFPA 70.

3.1.1.1 Raceway

Provide cable installed in raceways such as conduit and cable trays in compliance with NFPA 70. Raceway shall comply with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.~~[~~ Provide ~~3~~2 inch, minimum, PVC from interior headend location to exterior television service provider connection location. Coordinate location and requirements with the local cable television service provider.~~]~~

~~[3.1.1.2 Grounding System~~

~~Provide the grounding block [at the main television distribution~~

~~backboard][_____]. Ground this device according to the requirements of IEEE C2 and NFPA 70.~~

~~]~~3.1.1.2 Trunk, Feeder, and Drop Cable

Provide cable to grounding blocks, to line taps, and to outlets.

3.1.1.3 Splitters, Directional Couplers, Attenuators, Amplifiers

Install in accordance with manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

3.2.1 System Pretest

Upon completing installation of the television distribution system, the Contractor ~~[~~shall align and balance the system and ~~]~~shall perform complete pretesting. During the system pretest, Contractor, utilizing the approved spectrum analyzer or signal level meter, shall verify that the system is fully operational and meets all the system performance requirements of the specification. Contractor shall test the signal loss in dBmV at 55~~[~~, 151, 547,~~]~~ and 1000 MHz. The signal levels shall be 0 dBmV (1000 microvolts), minimum. The signal shall not exceed 15 dBmV over the entire system bandwidth. Any deficiencies found shall be corrected and revalidated by follow up testing. Contractor shall measure and record the video and audio carrier levels at each of the frequency levels specified at each of the following points in the system:

a. Furthest outlet from ~~[~~each communications room~~]~~~~[service entrance point of connection]~~.

b. A random sampling of 25 percent of the ~~[~~outlets~~[~~ from each communications room~~]]~~~~[housing units]~~.

~~[~~ c. At each outlet.

~~][d. [Headend and]Distribution amplifier inputs and outputs.~~

~~]~~3.2.2 Acceptance Tests

Contractor shall notify the Contracting Officer of system readiness 10 days prior to the date of acceptance testing. Contractor shall also coordinate with the local television service provider and allow them to attend witness tests. The television distribution system shall be tested in accordance with the approved test plan in the presence of the Contracting Officer's representative to certify acceptable performance. System test shall verify that the total system meets all the requirements of the specification and complies with the specified standards. Contractor shall verify that no signal leakage exists in conformance with NCTA RP and 47 CFR 76.605. System leakage shall also be tested at the headend location with signal applied to system. Deficiencies revealed by the testing shall be corrected on the ~~[housing units]~~[outlets~~]~~ sampled as well as on the ~~[units]~~[outlets~~]~~ not sampled and revalidated by follow-up testing. Contractor shall conduct testing at each of the following points in the system:

a. Furthest outlet from ~~[~~each communications room~~]~~~~[service entrance point of connection]~~.

b. A random sampling of 25 percent of the ~~[~~outlets ~~[~~from each telecommunications room~~]][housing units]~~ as designated by the Contracting Officer.

~~[~~ c. At each outlet.

~~][d. [Headend and]Distribution amplifier inputs and outputs.~~

~~]~~3.3 OPERATION AND MAINTENANCE MANUALS

Submit commercial, off-the-shelf manuals for operation, installation, configuration, and maintenance of products provided as a part of the cable television premises distribution system.

-- End of Section --

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SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM
08/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596	(2016) Indoor Optical Fiber Cables
ICEA S-90-661	(2012) Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables for Use in General Purpose and LAN Communications Wiring Systems Technical Requirements

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568	(2006) Standard for Installing Building Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66	(2019) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-21	(1988a; R 2012) FOTP-21 - Mating

	Durability of Fiber Optic Interconnecting Devices
TIA-526-7	(2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-526-14	(2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2016d; Add 1 2019) Optical Fiber Cabling Components Standard
TIA-569	(2019e) Telecommunications Pathways and Spaces
TIA-606	(2017c) Administration Standard for the Telecommunications Cabling Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-1152	(2016; R 2021) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding
TIA/EIA-604-10	(2002a) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

UNDERWRITERS LABORATORIES (UL)

UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 444	(2017; Reprint Jun 2021) UL Standard for Safety Communications Cables
UL 467	(2013; Reprint Jun 2017) UL Standard for

	Safety Grounding and Bonding Equipment
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 969	(2017; Reprint Mar 2018) UL Standard for Safety Marking and Labeling Systems
UL 1286	(2008; Reprint Apr 2021) UL Standard for Safety Office Furnishings
UL 1666	(2007; Reprint Jun 2012) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 1863	(2004; Reprint Oct 2019) UL Standard for Safety Communication Circuit Accessories

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP), apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-606 and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star.~~{~~ The interbuilding backbone system provides connectivity between the campus distributors and is specified in Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).~~}~~ Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.~~{~~ The telecommunications contractor must coordinate with the NMCI/COSC/NGEN contractor concerning access to and configuration of telecommunications spaces. The telecommunications contractor may be required to coordinate work effort within the telecommunications spaces with the NMCI/COSC/NGEN contractor.~~}~~

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Drawings; G~~[, [_____]]~~

Telecommunications Space Drawings; G~~[, [_____]]~~

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Telecommunications Cabling (backbone and horizontal); G~~[, [_____]]~~

Patch Panels; G~~[, [_____]]~~

Telecommunications Outlet/Connector Assemblies; G~~[, [_____]]~~

Equipment Support Frame; G~~[, [_____]]~~

~~[~~ Connector Blocks; G~~[, [_____]]~~

~~]~~

~~[~~ ~~Spare Parts; G[, [_____]]~~

~~]~~ Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications Cabling Testing; G~~[, [_____]]~~

SD-07 Certificates

Telecommunications Contractor Qualifications; G~~[, [_____]]~~

Key Personnel Qualifications; G~~[, [_____]]~~

Manufacturer Qualifications; G~~[, [_____]]~~

Test Plan; G~~[, [_____]]~~

SD-09 Manufacturer's Field Reports

Factory Reel Tests; G[, [_____]]

SD-10 Operation and Maintenance Data

Telecommunications Cabling and Pathway System Data Package 5; G[, [_____]]

SD-11 Closeout Submittals

Record Documentation; G[, [_____]]

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot[, except as specified otherwise]. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

Provide[registered communications distribution designer (RCDD) approved,] drawings in accordance with TIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications, CD's[, BD's], and FD's to the telecommunications work area outlets.[Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer.] The following drawings shall be provided as a minimum:

a. T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and {cabinet}{, rack}{, backboard}{ and} wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the

installation of this system or any of its components shall have a minimum of [3][_____] years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using [optical fiber and] copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of [3] [_____] years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568.1, TIA-568.2 and TIA-568.3.

1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, [60][_____] days prior to the proposed test date. Include procedures for certification, validation, and testing.

1.6.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials,

installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 MAINTENANCE

1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later

than [2] [_____] months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided[in hard copy format][on electronic media using Windows based computer cable management software.]] A licensed copy of the cable management software including documentation, shall be provided.] Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA-606. The cable records shall [include only the required data fields][include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility] in accordance with TIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA-606. Documentation shall include the required data fields[as a minimum][only] in accordance with TIA-606.

[1.10.3 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

]PART 2 PRODUCTS

2.1 COMPONENTS

Components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide system furniture pathways in accordance with UL 1286.

2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3 and NFPA 70. Provide a labeling system for cabling as required by TIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661~~{~~ and optical fiber cables in accordance with ICEA S-83-596~~}~~ for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

~~{~~2.3.1 Backbone Cabling

~~{~~2.3.1.1 Backbone Copper

Copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, ~~{~~100~~}~~ ~~{_____}~~-pair, Category 3, UTP, in accordance with ICEA S-90-661, TIA-568.1, TIA-568.2 and UL 444, formed into 25 pair binder groups covered with a~~{~~ gray~~}{~~ ~~_____}~~ thermoplastic jacket~~{ and overall metallic shield}~~. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular length marking intervals in accordance with ICEA S-90-661 . Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG)communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.

~~}{~~2.3.1.2 Backbone Optical Fiber

Provide in accordance with ICEA S-83-596, TIA-568.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches.

Provide the number of strands indicated, (but not less than 12 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode(OS1), tight buffered fiber optic cable.

~~{~~ Provide tight buffered fiber optic multimode, ~~{~~50/125-um diameter laser optimized(OM3)~~} {50/125-um diameter(OM2)} {62.5/125-um diameter(OM1)}~~ cable as indicated.

~~}~~ Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

Provide plenum (OFNP) riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be

in accordance with TIA/EIA-598.

]]2.3.2 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568.1.

2.3.2.1 Horizontal Copper

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661 . Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6A, with a [blue] [green] thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.[Provide residential Category 6 cabling in accordance with TIA-570.]

[2.3.2.2 Horizontal Optical Fiber

Provide optical fiber horizontal cable in accordance with ICEA S-83-596and TIA-568.3. Cable shall be tight buffered, [multimode, 50/125-um diameter laser optimized, OM3]][,][multimode, 50/125-um diameter, OM2][multimode, 62.5.125-um diameter, OM1]or [single-mode, 8/125-um diameter, OS1]. Cable shall be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 40 inches.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.Cables installed in conduit within and under slabs be UL listed and labeled for wet locations in accordance with NFPA 70. The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598.

]][2.3.3 Work Area Cabling

2.3.3.1 Work Area Copper

Provide work area copper cable in accordance with TIA-568.2, with a [blue,] [green] thermoplastic jacket.

[2.3.3.2 Work Area Optical Fiber

Provide optical work area cable in accordance with TIA-568.3.

]]2.4 TELECOMMUNICATIONS SPACES

Provide connecting hardware and termination equipment in the telecommunications entrance facility[and telecommunication equipment room[s]] to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA-606.

2.4.1 Backboards

Provide void-free, interior grade A-C plywood 3/4 inch thick ~~{~~4 by 8 feet~~}~~ ~~[as indicated]~~. Backboards shall be fire rated by manufacturing process. Fire stamp shall be clearly visible.~~{~~ Paint applied over fire retardant backboard shall be UL 723 fire retardant paint. Provide label including paint manufacturer, date painted, UL listing and name of Installer. When painted, paint label and fire stamp shall be clearly visible.~~}~~ Backboards shall be provided on a minimum of two adjacent walls in the telecommunication spaces.

~~{~~2.4.2 Equipment Support Frame

Provide in accordance with ECIA EIA/ECA 310-E and UL 50.

~~{~~ a. Bracket, wall mounted, 8 gauge aluminum. Provide hinged bracket compatible with ~~{~~19 inches~~}~~ ~~[23 inches]~~ panel mounting.

~~}{~~b. Racks, floor mounted modular type, ~~{~~16 gauge steel~~}{~~ or ~~}{~~11 gauge aluminum~~}~~ construction, minimum, treated to resist corrosion. Provide rack with vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug~~{~~ and a surge protected power strip with 6 duplex 20 amp receptacles~~}~~. Rack shall be compatible with ~~{~~19 inches~~}~~ ~~[23 inches]~~ panel mounting.

~~}[~~c. Cabinets, freestanding modular type, [16 gauge steel][or][11 gauge aluminum] construction , minimum, treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with [19 inches] [23 inches] panel mounting. Provide cabinet with grounding bar[,][[rack][roof] mounted 550 CFM fan with filter][and][a surge protected power strip with 6 duplex 20 amp receptacles].[All cabinets shall be keyed alike.]

~~}[~~d. Cabinets, wall-mounted modular type, [16 gauge steel][or][11 gauge aluminum] construction , minimum, treated to resist corrosion. Cabinet shall have have lockable front[and rear] door[s], louvered side panels,[250 CFM [roof][rack] mounted fan,] ground lug, and top and bottom cable access. Cabinet shall be compatible with [19 inches] [23 inches] panel mounting.[All cabinets shall be keyed alike.][A [duplex AC outlet][surge protected power strip with 6 duplex 20 amp receptacles] shall be provided within the cabinet.]

~~}}{~~2.4.3 Connector Blocks

Provide insulation displacement connector (IDC) Type 110 for Category 6A systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

~~}{~~2.4.4 Cable Guides

Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on~~{~~ ~~{~~19~~}[~~23~~}~~ inches equipment~~{~~ racks~~}[~~ cabinets~~]}{~~ and ~~}[~~ telecommunications backboards~~}~~. Cable guides of ring or bracket type devices~~{~~ mounted on ~~{~~ rack~~}[~~cabinet~~]~~ panels~~}~~ and ~~{~~backboard~~}~~ for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws,~~{~~

and]| or]nuts and lockwashers.

]|2.4.5 Patch Panels

Provide ports for the number of horizontal and backbone cables terminated on the panel plus [25]|[_____] percent spare. Provide pre-connectorized [optical fiber]| and]|copper] patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified.[Provide fiber optic patch cables with crossover orientation in accordance with TIA-568.3]. Patch cords shall meet minimum performance requirements specified in TIA-568.1, TIA-568.2 [and TIA-568.3] for cables, cable length and hardware specified.

2.4.5.1 Modular to 110 Block Patch Panel

Provide in accordance with TIA-568.1 and TIA-568.2. Panels shall be third party verified[and shall comply with EIA/TIA Category 6A requirements]. Panel shall be constructed of 0.09 inches minimum aluminum and shall be [cabinet]|rack]|[wall] mounted and compatible with an ECIA EIA/ECA 310-E [19 inches] [23 inches] equipment[cabinet]| rack]. Panel shall provide [48]|[_____] non-keyed, 8-pin modular ports, wired to [T568A]|[T568B]. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

[2.4.5.2 Fiber Optic Patch Panel

Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of[[16]|[or 18] gauge steel]|[or]|[11 gauge aluminum] minimum and shall be [cabinet]|rack]|[wall] mounted and compatible with a ECIA EIA/ECA 310-E [19 inches] [23 inches] equipment rack. Each panel shall provide [12]|[_____] [multimode]|[single-mode] adapters as [duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,] [duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic][MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic][ST in accordance with TIA/EIA-604-2 with metallic] alignment sleeves. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 8 inches deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.

]]|2.4.6 Optical Fiber Distribution Panel

[Cabinet]|Rack]|[Wall] mounted optical fiber distribution panel (OFDP) shall be constructed in accordance with ECIA EIA/ECA 310-E utilizing[[16] or [18] gauge steel]| or]| 11 gauge aluminum] minimum. Panel shall be divided into two sections, distribution and user. Distribution section shall have strain relief, routing guides, splice tray and shall be lockable, user section shall have a cover for patch cord protection. Each panel shall provide[[12]|[_____] multimode]| and]| [12]|[_____] single-mode] pigtails and adapters. Provide adapters as [duplex LC with zirconia ceramic] [duplex SC with zirconia ceramic][MT-RJ with thermoplastic][ST with metallic] alignment sleeves. Provide dust covers for adapters. Provide patch cords as specified in the paragraph PATCH PANELS.

]2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

2.5.1 Outlet/Connector Copper

Outlet/connectors shall comply with FCC Part 68, TIA-568.1, and TIA-568.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified[and shall comply with TIA-568.2 Category 6A requirements]. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired [T568A][or][T568B][as indicated]. UTP outlet/connectors shall comply with TIA-568.2 for [200] [_____] mating cycles.[UTP outlet/connectors installed in outdoor or marine environments shall be jell-filled type containing an anti-corrosive, memory retaining compound.]

2.5.2 Optical Fiber Adapters(Couplers)

Provide optical fiber adapters suitable for[duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,][duplex SC in Accordance with TIA/EIA-604-3 with zirconia ceramic alignment sleeves,] [MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic alignment sleeves,][and][ST in accordance with TIA/EIA-604-2 with metallic alignment sleeves] as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for [500][_____] mating cycles.

2.5.3 Optical Fiber Connectors

Provide in accordance with TIA-455-21.[Optical fiber connectors shall be[duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,] [duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic][MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic][ST in accordance with TIA/EIA-604-2 with metallic] ferrule, epoxyless[crimp style] compatible with[[62.5/125][50/125] multimode] and [8/125 single-mode] fiber. The connectors shall provide a maximum attenuation of 0.3 dB at[850][/1300 and][1310][/1550] nm with less than a 0.2 dB change after 500 mating cycles.]

2.5.4 Cover Plates

Telecommunications cover plates shall comply with UL 514C, and TIA-568.1, [TIA-568.2], [TIA-568.3]; [flush][or][oversized] design constructed of [high impact thermoplastic material [[ivory][white][brown] in color][to match color of receptacle/switch cover plates specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]][302 stainless material][or][brass material]. Provide labeling in accordance with the paragraph LABELING in this section.

[2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

Provide MUTOA(s) in accordance with TIA-568.1.

][2.7 TERMINAL CABINETS

Construct of zinc-coated sheet steel,[36 by 24 by 6 inches deep][as indicated]. Trim shall be fitted with hinged door and locking latch. Doors shall be maximum size openings to box interiors. Boxes shall be

~~provided with 5/8 inch backboard with two-coat varnish finish. Match trim, hardware, doors, and finishes with panelboards. Provide label and identification systems for telecommunications wiring and components consistent with TIA-606.~~

~~]~~2.6 GROUNDING AND BONDING PRODUCTS

Provide in accordance with UL 467, TIA-607, and NFPA 70. Components shall be identified as required by TIA-606. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.7 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.8 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.9 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inches thick, white with ~~[~~black~~]~~ ~~[_____]~~ center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style.

2.10 TESTS, INSPECTIONS, AND VERIFICATIONS

2.10.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568.1, TIA-568.2, TIA-568.3~~[~~, TIA-526-7 for single mode optical fiber ~~]~~[, and TIA-526-14 for multimode optical fiber~~]~~ cables.

PART 3 EXECUTION

3.1 INSTALLATION

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with NECA/BICSI 568, TIA-568.1, TIA-568.2, ~~[~~TIA-568.3, ~~]~~TIA-569, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network.~~[~~ ~~Provide residential cabling in a star wiring architecture from the distribution device as required by TIA-570.]~~ Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The

interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.{ Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.}

3.1.1 Cabling

Install {UTP,}{ and}{ optical fiber} telecommunications cabling system as detailed in TIA-568.1, {TIA-568.2, and } {TIA-568.3}{ and TIA-570} for residential cabling}. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

{3.1.1.1 Open Cable

Use only where specifically indicated on plans for use in cable trays, or below raised floors. Install in accordance with TIA-568.1, TIA-568.2{ { and }TIA-568.3}. Do not exceed cable pull tensions recommended by the manufacturer.{ Copper cable not in a wireway or pathway shall be suspended a minimum of {8}{_____} inches above ceilings by cable supports no greater than {60}{_____} inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.}

Plenum cable shall be used where open cables are routed through plenum areas. Cable routed exposed under raised floors shall be plenum rated. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Install cabling after the flooring system has been installed in raised floor areas.{ Cable {6}{_____} feet long shall be neatly coiled not less than {12}{_____} inches in diameter below each feed point in raised floor areas.}

}3.1.1.2 Backbone Cable

a. Copper Backbone Cable. Install intrabuilding backbone copper cable, in indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.

b. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

3.1.1.3 Horizontal Cabling

Install horizontal cabling as indicated on drawings Do not untwist Category 6A UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, 10 feet in the telecommunications room, and 12 inches in the work area outlet.

3.1.2 Pathway Installations

Provide in accordance with TIA-569 and NFPA 70. Provide building pathway as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

~~[3.1.3 Service Entrance Conduit, Overhead~~

~~Provide service entrance overhead as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS.~~

~~]][~~3.1.3 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

~~]~~3.1.4 Cable Tray Installation

Install cable tray as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Only ~~[~~CMP~~]][~~ and ~~][~~OFNP~~]~~ type cable shall be installed in a plenum.

3.1.5 Work Area Outlets

3.1.5.1 Terminations

Terminate UTP cable in accordance with TIA-568.1, TIA-568.2 and wiring configuration as specified.~~[~~ Terminate fiber optic cables in accordance with TIA-568.3.~~]~~

3.1.5.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.5.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.5.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

~~[3.1.5.5 Multi-User Telecommunications Outlet Assembly (MUTOA)~~

~~Run horizontal cable in the ceiling or underneath the floor and terminate each cable on a MUTOA in each individual zone. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be~~

~~installed in furniture unless that unit of furniture is permanently secured to the building structure. MUTOAs shall be located in an open work area so that each furniture cluster is served by at least one MUTOA. The MUTOA shall be limited to serving a maximum of twelve work areas. Maximum work area cable length requirements shall also be taken into account. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in TIA-606, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.~~

~~]~~3.1.6 Telecommunications Space Termination

Install termination hardware required for ~~[~~Category 6A~~]][~~ and ~~]][~~optical fiber~~]~~ system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

~~[~~3.1.6.1 Connector Blocks

Connector blocks shall be ~~[cabinet]][~~rack~~]][wall]~~ mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569.

~~]~~3.1.6.2 Patch Panels

Patch panels shall be mounted ~~[~~in equipment ~~[cabinets]][~~racks~~]][on the plywood backboard]~~ with sufficient ports to accommodate the installed cable plant plus ~~[~~25~~]][_____]~~ percent spares.

~~[~~ a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel ~~[with cable ties]][~~as recommended by the manufacturer~~]~~ to prevent movement of the cable.

~~]][~~b. Fiber Optic Patch Panel. Fiber optic cable loop shall be ~~[[~~3~~]][_____]~~ feet in length~~]][provided as recommended by the manufacturer]~~. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

~~]][~~3.1.6.3 Equipment Support Frames

Install in accordance with TIA-569:

~~[~~ a. Bracket, wall mounted. Mount bracket to plywood backboard in accordance with manufacturer's recommendations. Mount rack so height of highest panel does not exceed 78 inches above floor.

~~]][~~b. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer's recommendations.

~~]][c. Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets.[Mount rack mounted fan in [roof][base] of cabinet.]~~

~~]][d. Cabinets, wall-mounted modular type. Mount cabinet to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 78 inches above floor.~~

~~]]~~3.1.7 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

3.1.8 Grounding and Bonding

Provide in accordance with TIA-607, NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using~~[~~ thermal ink transfer process~~][laser printer] [_____]~~.

3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA-606.

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA-606.

3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 TESTING

3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568.1, ~~[~~TIA-568.2~~]~~, ~~[~~TIA-568.3~~]~~. Test equipment shall conform to TIA-1152. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests.

Remove failed cable reels from project site upon attenuation test failure.

3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568.1, TIA-568.2, {and TIA-568.3}, [and][TIA-570 for residential cabling]. Visually confirm { Category 6A,} marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

{ {For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-14 using {Method A, Optical Power Meter and Light Source} [Method B, OTDR] for multimode optical fiber.]{For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-7 using {Method A, Optical Power Meter and Light Source]{Method B, OTDR] for single-mode optical fiber. }Perform verification acceptance tests.

}3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

{ a. Perform Category 6A link tests in accordance with TIA-568.1 and TIA-568.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

]{b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568.3.

}3.5.1.4 Final Verification Tests

Perform verification tests for UTP{ and optical fiber} systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

{ a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

]{b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

}

-- End of Section --

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SECTION 27 51 16

PUBLIC ADDRESS SYSTEMS
05/20

PART 1 GENERAL

1.1 RELATED SECTIONS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

~~[~~ Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.~~]~~
~~[~~ Section 07 84 00 FIRESTOPPING for additional work related to firestopping.~~]~~

~~[~~1.2 SUMMARY

1.2.1 Scope

~~a. This work includes design and providing a new, complete, public address system as [required and as]described herein for the [building name]. Provide a turnkey system capable of receiving, processing, and transmitting indicated input signals including the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, amplifiers, microphones, speakers, mounting hardware and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation. See paragraph titled SYSTEM DESCRIPTION for additional requirements.~~

~~[~~ ~~b~~a. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing all component locations, cable routing, junction boxes, other related equipment, conduit routing, and wire counts for all floors.~~]~~

~~]~~1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 800-82	(2015; Rev 2) Guide to Industrial Control Systems (ICS) Security

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2020; Change 1-2020) Risk Management Framework (RMF) for DoD Information Technology (IT)
UFC 4-010-06	(2016; with Change 1, 2017) Cybersecurity of Facility-Related Control Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1778	(2014; Reprint Sep 2017) UL Standard for Safety Uninterruptible Power Systems

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G~~[, [_____]]~~

SD-02 Shop Drawings

Detail Drawings; G~~[, [_____]]~~

System Layout; G[, [_____]]

[System Design; G[, [_____]]]

SD-03 Product Data

Spare Parts

[SD-05 Design Data

Design Analysis and Calculations; G[, [_____]]

]

SD-06 Test Reports

Approved Test Procedures; G[, [_____]]

Acceptance Tests

Accreditation; G[, [_____]]

SD-07 Certificates

Components

SD-10 Operation and Maintenance Data

Public Address System; G[, [_____]]

Submit Data Package 5 for each component in accordance with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

[1.5 SYSTEM DESCRIPTION

1.5.1 Design Requirements

Provide a Public Address System, capable of distributing the indicated audio signals from equipment including LAN controllers, communication links, cabling, battery backup, power line surge protection and all other necessary components to make a complete and operational system. Complete coverage will be provided for all interior public spaces and other spaces as indicated on the drawings.

Provide a zoned system capable of evenly distributing live [and pre-recorded] paging and music program sources. Provide balanced and highly intelligible distributed sound free of noise and distortion. Provide capability of both individual and simultaneous paging all separate paging zones. Intelligibility must meet the requirements of Modified Rhyme Test (MRT) of ASA S3.2

Provide all headend interface, amplification components, conditioners and any other equipment necessary. Provide system capable of interfacing with the GFGI telephone system for zone paging.

Provide all materials and labor needed for a complete and operational system for the services in this specification plus the additional system capabilities as indicated. This includes but not limited to all necessary equipment, interfaces, jumpers, terminations, cabling, amplifiers,

conditioners, power supplies, battery backup, software and all components required for system operation.

1.5.2 System Application Design

Provide the system application design required to provide a public address system that complies with and satisfies all of the requirements specified in this Section [and indicated on the Telecommunications Drawings] for this application and project.

1.5.3 Standard Products

Provide an application design that utilizes standard system components that are the product of a Manufacturer regularly engaged in the manufacture of networked public address system, and that have been in satisfactory use for at least six months. Provide all major components from the same manufacturer. The System must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the facility. Do not deliver material to the project site more than six months prior to the scheduled date of installation.

Provide hardware, software, and installation of a complete and engineered system. Provide a submitted design that is properly engineered for the operational requirements. Include all components required to meet this specification section in the design, other than a change in, or in addition to the operational frequencies identified herein.

1.5.4 Local Products

Incorporate local materials to the greatest extent possible. All proposed local products must meet all applicable hardware and software requirements set forth in these specifications.

1.5.5 Minimum Requirements

Specifications are minimum requirements. If the provided system requires enhanced specifications that exceed those specified herein in order to satisfy the specified design, configuration, capability, and performance requirements, then a provide a system with the enhanced specifications.

1.5.6 Current State-of-the-Art Technology

Provide application design and products that utilize current state-of-the-art products that provide the enhanced capability and performance specified herein. Provide design and products representing the latest manufacturer make and model.

1.5.7 Design Analysis and Calculations

Include in the design analysis and calculations, at a minimum, the following:

a. Power supply requirements for each component and each separate speaker zone of the system in accordance with the manufacturer's instructions. Provide power consumption and dissipation data under normal and maximum operating conditions.

b. Cable types and sizes.

c. Interfaces with all other systems such as the fire alarm and mass notification system for muting of public address system upon fire alarm or mass notification announcement.

1.5.8 Environmental Requirements

Provide equipment to be used indoors rated for continuous duty operation under ambient environmental conditions of 35 to 120 degrees F dry bulb and 10 to 95 percent reflective humidity, noncondensing. Provide all other equipment rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

1.5.9 Electrical Requirements

105 VAC to 130 VAC at 60 Hz operating voltage range, plus or minus 2 percent.

1.5.10 Power supplies

Provide power supplies that provide sufficient power for worst-case conditions of system operation that could occur without signal loss or perceptible degradation.

1.5.11 Power Line Surge Protection

Provide power line surge protection for all equipment connected to AC power. Provide surge protection integral to the equipment or installed as an accessory item in accordance to manufacturer's recommendations. Do not use fuses for surge protection.

1.5.12 Shielding and Grounding

Provide shielding and grounded as required by the system design, Manufacturer's instructions, FCC Part 15 listing, and regulatory requirements.

1.5.13 System Capability and Configuration

1.5.13.1 System Capability

Provide a public address system with capabilities to support ~~{~~zone paging, ~~}{~~ background music,~~}{~~ all-call,~~}{~~ priority paging,~~}{~~ messaging processors, ~~}{~~ software,~~}{~~ input modules,~~}{~~ controllers,~~}{~~ and interface modules~~,}~~ ~~[and] [_____]~~.

1.5.14 Performance Requirements

1.5.14.1 System Initiation and Operation

No user controlled features are permitted on this system. System is to be active on power up and perform as specified without any form of manual control.

1.5.14.2 Priority
Provide paging priorities as indicated.

1.6 CYBERSECURITY

a. The Risk Management Framework (RMF) is the process by which information systems are accredited for operation by a designated official from the Using Military Department. It is the standard process under which all DoD information systems must achieve and maintain their Authority To Operate. The Cyber Security process is documented in DOD 8510.01 and NIST SP 800-82. Refer to UFC 4-010-06 for additional requirements.

b. All systems that are IP addressable or interface with the Assured Network must be certified to operate. Coordinate with the Government to initiate and complete the accreditation process.

c. Cybersecurity requires input from the system vendor or provider and support from the local IMD. The local IMD-IA office is the point of contact for all Cybersecurity requirements. The local CMIO is the point of contact for all clinical and functional system requirements.

1.7 QUALIFICATIONS

1.7.1 General Qualification Requirements

a. The System Contractor, Installer and Manufacturer must each have the minimum qualifications specified, related to the type of system specified for this project.

b. The Government reserves the right to accept or reject the System Contractor, Installer or Manufacturer based upon qualifications and ability to conform to specified technical or licensing requirements of this Section. System Contractors, Installers and Manufacturers that do not have the specified qualifications will not be acceptable and will not be allowed to perform the work of this section.

c. The Government will determine the acceptability of any proposed System Contractor, Installer and Manufacturer based on submitted and verified documentation that substantiates that the proposed System Contractor, Installer and Manufacturer have the qualifications specified in this Section.

d. Submit documented verification of the specified qualifications as part of the Data Qualifications submittal. The Government maintains the right to request, inspect and verify references and resumes of all technical and managerial personnel assigned to the project.

e. Include qualification documentation, but not limited to the information outlined below:

(1) A list of projects performed by the System Contractor and Installer during the last five years explicitly involving the type of system specified in this section, including:

(a) Name of facility where work was completed.

(b) Name, title, address and telephone number of a point of contact for the listed facility.

(c) The make and model of the system provided and total scope of work for the facility.

(d) Restrict list to the facilities where the same type of system was installed for the same purpose provided.

1.7.2 System Contractor Qualifications

a. Contractor qualifications must include the following:

(1) The Contractor is regularly engaged in the system application design, documentation, installation, testing, training, and maintenance of the type of system specified in this section.

(2) The Contractor has a minimum of five years experience providing these services for systems having the same level of features and functions as the system being provided.

(3) The Contractor has a minimum of five years as the manufacturer or an authorized distributor and service organization for the manufacturer of the system provided.

b. Contactor personnel qualifications must:

(1) Be factory trained or certified for the make and model of the system provided.

(2) Have a minimum of five years experience performing the services specified in this specification section.

(3) Maintain a full compliment of spare parts for the provided system with the ability to furnish on-call maintenance 24 hours per day, 365 days per year.

1.7.3 Installer Qualifications

a. The installer personnel must be regularly engaged in the installation of the type of system in this specification section.

b. The installation supervisor must be factory trained or certified for the make and model of the system provided.

c. The installation supervisor must have a minimum of five years experience providing services having the same level of features and functions for the system included in this specification section.

d. The installation personnel must have a minimum of three years experience providing services having the same level of features and functions for the system included in this specification section.

1.7.4 Manufacturer Qualifications

The system manufacturer must:

a. Have a minimum of five years experience in producing the products and type of system included in this specification section.

b. Produce a system that satisfies all specified features, functions and product requirements.

c. Guarantee the availability of the replacement parts for the designed

system for a minimum of seven years from the date of final acceptance of the system by the Contracting Officer.

1.8 DELIVERY, STORAGE, AND HANDLING

Equipment placed in storage until installation shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.9 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than ~~{~~2~~}~~ ~~{_____}~~ months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The public address system shall consist of an audio distribution network to include amplifiers, mixers, microphones, speakers, cabling, and ancillary components required to meet the required system configuration and operation. Submit Data Package 3 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

2.1.1 Multi-Channel System with Paging

The system shall include microphones, microphone outlet receptacles, microphone inputs with preamplifiers, inputs for ~~{~~digital music,~~}~~ and ~~{~~ telephone,~~}~~ ~~{~~and~~}~~ ~~{_____}~~ program sources, ~~{~~single~~}~~ and ~~{~~all~~}~~ channel paging, control for each input, power amplifying equipment, and accessories required to output the public address and paging audio signals through selected portions of the audio distribution network as indicated. The paging signal shall be replaced ~~{~~by zones~~}~~ ~~{channel {_____}}~~and ~~{~~all ~~channels}~~ of the system output, when the paging function is activated.

2.1.2 Single-Channel System

The system shall control and amplify an audio program for distribution within the areas indicated. Components of the system shall include a ~~{~~ mixer-preamplifier,~~}~~ ~~{~~mixer-amplifier,~~}~~ ~~{~~mike input expander,~~}~~ ~~{~~power amplifier,~~}~~ ~~{~~microphone,~~}~~ ~~{~~speaker system,~~}~~ cabling and other associated hardware.

2.1.3 System Performance

The system shall provide even sound distribution throughout the designated area, plus or minus 3 dB for the 1/1 octave band centered at 4000 Hz. The system shall provide uniform frequency response throughout the designated area, plus or minus 3 dB as measured with 1/3-octave bands of pink noise at locations across the designated area selected by the Contracting Officer. The system shall be capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) in the area at an acoustic distortion level below 5 percent total harmonic distortion (THD). Unless otherwise specified the sound pressure reference level is 20 micro Pascal (0.00002 Newtons per square meter).

2.1.4 Detail Drawings

Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers. Check the layout based on the actual speakers to be installed and make necessary revisions in the detail drawings. Detail drawings shall also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

~~[2.1.5 Network IP System Design~~

~~Submit system design consisting of a design analysis, calculations, and drawings as described in paragraph titled Detail Drawings. In the design analysis, describe all components, equipment, and appurtenances required for a fully functional system. Also include a detailed description of system operation to include paging priorities, interfaces with other systems, telephone interface for paging, all system inputs, and paging zones.~~

~~]~~2.2 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products, and that essentially duplicate material and equipment that have been in satisfactory use at least 2 years. All components used in the system shall be commercial designs that comply with the requirements specified. Submit copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components. Equipment shall be supported by a service organization that is within ~~[~~20~~_____]~~ miles of the site.

2.2.1 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.2.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, model and catalog number, and serial number on a plate secured to the equipment.

~~[~~2.3 IP NETWORKED PUBLIC ADDRESS SYSTEM

Provide complete digital IP based audio network as required to deliver high quality audio signals to paging speakers as indicated on the drawings. Provide amplifiers of sufficient power to drive speakers indicated based on the defined paging zones. Provide additional amplifiers or modules as required for indicated paging zones.

2.3.1 System Components

Provide all system components as required for a complete and operational

system to include the following minimum components.

2.3.1.1 Headend Equipment

Provide floor mounted equipment rack to house all headend equipment.

2.3.1.2 Auxiliary Inputs

Provide rack space and input modules for a minimum of two auxiliary inputs. ~~Input sources are [_____].~~

2.3.2 Distribution Equipment

Provide all distribution equipment necessary to process and distribute paging and music to zones as indicated on the drawings.

2.3.2.1 Monitor Panel

Provide system monitor panel with speaker and zone selection capability to check each output, voice input, and zone selection.

2.3.2.2 Loudspeaker System

Provide low power loudspeakers for uniform sound distribution at low volume levels. Space speakers ~~[~~as indicated on the drawings~~][_____]~~. Provide separate volume control for individual rooms as indicated on the drawings. ~~[~~In rooms designated on the drawings, provide volume control with bypass feature to allow for all-call paging to bypass the local volume control and be audible at normal system volume.~~]~~

Provide speakers that are designed to provide even sound dispersion over the 20 Hz to 20 kHZ frequency range within the entire area the speaker covers.

2.3.2.3 Indoor Loudspeaker Assemblies

Provide cone type speakers with wall or ceiling enclosures and baffles as indicated on the drawings.

2.3.2.4 Outdoor Loudspeaker Assemblies

Provide weather resistant cone speakers with enclosures and baffles for outdoor ceiling locations. Provide horn type loudspeakers for outdoor wall mounted locations.

~~[~~2.3.2.5 IP Addressable PoE Loudspeakers

Provide PoE speakers with integral amplifiers to provide a maximum of 8 Watts of power from the PoE connection. Provide all networking components, PoE switches, cabling, and termination equipment to be an integral part of the public address system.

~~]~~2.3.2.6 Microphones

Provide types and quantities of microphones as indicated on the drawings.

2.3.3 System Configuration

2.3.3.1 All Call

Provide all call paging capability. All call paging will have priority over all other paging zones. Provide access to all call paging via a microphone, telephone, or both. Microphone access will have priority over telephone access for all paging zone types.

2.3.3.2 Zone Paging

Provide local paging zones as indicated on the drawings. Provide access to local zones using the telephone system[, microphones,]][or both]. All call paging will have priority over all local paging zones. Provide zone volume control at a controlled access location as indicated on the drawings.

[2.3.3.3 Medical and Dental Clinic Zoning

Provide separate wide area zone for the medical clinic areas and separate wide area zone for dental clinic areas as indicated on the drawings. These wide area zones are in addition to all call for the entire facility. All call will have priority over wide area zones.
]
[2.3.3.4 Auditorium Zone

Provide all call paging in the auditorium only. Do not include auditorium within a local or wide area paging zone.

]2.3.4 System Performance

Provide system that evenly distributes sound throughout loudspeaker zones at plus or minus 3 dB for the 1/1 octave band centered at 4,000 Hz. Provide system that has uniform frequency response throughput loudspeaker zones of plus or minus 3 DB as measured with 1/3 octave bands of pink noise at locations as selected by the Contracting Officer. Provide system capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level without causing the associated amplifier to exceed normal operating specifications for power or distortion. Reference sound pressure level is 20 micropascal, unless otherwise indicated. Minimum audio sound pressure level must be at least +15 dB in all areas. System must not produce audible hum, noise, buzz, or rattles at any loudspeaker. Electoral/acoustic signal-to-noise ratio for the entire system must be at least 66 dB.

[2.3.5 Electrical Power

Provide uninterruptable power supply (UPS) units that will support AC powered equipment for a minimum of 15 minutes of full power during an AC power failure. Provide UPS units that comply with UL 1778 and FCC Part 15

]][2.4 ANALOG AUDIO SYSTEM

2.4.1 MIXER-PREAMPLIFIER

Mixer-preamplifier shall as a minimum conform to the following specifications:

Rated Output	18 dB
Frequency Response	Plus or Minus 1 dB, 20 - 20,000 Hz
Distortion	Less than 0.5 percent, 20 - 20,000 Hz
Signal to noise	Microphone - 60 dB
	Aux - 70 dB
Inputs	5 independent balanced low-impedance transformer-isolated
Input Sensitivity	Microphone - 0.003 volts
	Aux - 0.125 volts
	Magnetic Cartridge - 0.0005 volts
Input Channel Isolation	80 dB minimum
Tone Controls	Plus or Minus 10 dB range at 50 and 15,000 Hz
Power Requirement	110-125 Vac 60 Hz

2.4.2 POWER AMPLIFIERS

Power amplifiers as a minimum conform to the following specifications:

Rated power output	[60] [125] [250] [_____] watts RMS
Frequency Response	Plus or Minus 3 dB, 20-20,000 Hz
Distortion	Less than 2 percent at RPO, 600-13,000 Hz
Input Impedance	50 k ohm unbalanced
Output Impedance	Balanced 4 and 8 ohms
Output voltage	25 and 70.7 volts
Power Requirement	110-125 Vac 60 Hz

2.4.3 MIXER AMPLIFIER

Mixer amplifier shall as a minimum conform to the following specifications:

Rated Power Output (RPO)	[35] [60] [125] [_____] watts RMS
Frequency Response	Plus or Minus 3 dB, 20-20,000 Hz

Distortion	Less than 1 percent at RPO, 60 - 13,000 Hz
Inputs	2 microphones (high impedance or low-impedance unbalanced 2 Aux. (high impedance)
Output Impedance	Balanced 4 and 8 ohms
Output Voltage	25 and 70.7 volts
Power Requirement	110-125 Vac 60 Hz

2.4.4 MICROPHONE INPUT MODULES

Microphone input modules shall as a minimum conform to the following specifications:

Rated Outputs	0.25 volts into 10,000 ohms
	1.0 volts into 10,000 ohms
Frequency Response	Plus or Minus 2 dB, 20 - 20,000 Hz
Distortion	Less than 0.5 percent 20 - 20,000 Hz
Inputs	4 transformer - coupled balanced 150 ohm
Input Sensitivity	0.003 volts
Input Channel Isolation	70 dB minimum

2.4.5 MICROPHONES

2.4.5.1 Desk Microphone

Microphones shall as a minimum conform to the following specifications:

Element	Dynamic
Pattern	Cardioid
Frequency Response	50 - 12,000 Hz
Impedance	Low impedance mic (150-400 ohms)
Front-to-back Ratio	20 dB
Selector switches	Selector switches for zone shall be be [integral microphone] or [Separate console adjacent to microphone]

~~2.4.5.2 Gooseneck Microphone~~

~~Gooseneck microphone shall meet the minimum requirements of the desk microphone. Microphone shall have push to talk button. Gooseneck tube length shall be [12] [16] [_____] inch.~~

~~2.4.5.3 Microphone Jack~~

~~Each outlet for microphones shall consist of a standard outlet box, flush-mounted, and fitted with a three-pole, polarized, locking-type, female microphone jack and a corrosion resistant-steel device plate.~~

~~]~~2.4 LOUDSPEAKERS

2.4.1 Cone Speaker

The cone speaker shall as a minimum conform to the following specifications:

Application	~~[Wall baffle] [~~Ceiling
Frequency range	60 to 12,000 Hz
Power Rating	Normal - ~~[~~7~~] [_____]~~ watts
	Peak - ~~[~~10~~] [_____]~~ watts
Voice Coil Impedance	8 ohms
Line Matching Transformer Type	25/ 70.7 volt line
Capacity	4 watts
Magnet	10 ounces or greater
Primary Taps	0.5, 1, 2 and 4 watts
Primary Impedance	25 volts - 1250, 625, and 312 ohms
	70.7 volts - 10k, 5k, and 2.5k ohms
Frequency Response	30 - 20,000 Hz
Insertion Loss	Less than 1 dB

~~2.4.2 Horn Speaker~~

~~The horn speaker shall as a minimum conform to the following specifications:~~

~~Application~~	~~[Indoor] [Outdoor] [Weatherproof]~~

Frequency Response	400 - 14,000 Hz
Power Taps	70 volt line - .9, 1.8, 3.8, 7.5, and 15 watts
Impedance	5000, 2500, 1300, 670, 330, 90, and 45 ohms
	Normal - [7] [_____] watts
	Peak - [15] [_____] watts
Dispersion	110 degrees

2.4.3 Dual Horn Speaker

The dual horn speaker shall meet the minimum requirements of horn speaker except the dispersion shall be 100 degrees.

2.4.4 High Output Speaker Enclosures

High Output speaker enclosures shall be of the tuned-port design for precise balancing and tuning of the speaker. The enclosures shall be constructed throughout of 3/4 inch high density board, with screwed and glued joints, durably braced, and padded with fiberglass where acoustically required. Speaker enclosures shall have a [25] [45] degree [_____] vertical dispersion and [90] [120] degrees [_____] horizontal dispersion. The effective length of throw shall be a minimum of[50] [130] [200] [_____] feet.

2.4.5 Wall Baffle Speaker Enclosures

The wall baffle speaker shall be of [particle board construction covered with [walnut laminate]][full steel construction painted [off-white][_____] [_____] and complete with [black] [_____] cloth grille]. Baffle shall feature 9.5 [12.5] degree slope to provide directional sound dispersion offset in the direction of radiation. Wall baffle enclosure shall come equipped with a wall mounting bracket designed to assure a rigid mounting to any flat surfaces.

2.4.2 Ceiling Speaker Enclosures

Ceiling speaker enclosure shall be constructed of heavy gauge cold steel with interior undercoating and 1-1/2 inch thick high density fiberglass 1-1/2 lbs/cu. ft. The unit shall be [round] [square] and designed for [recessed] [surface] installations which will be accomplished via [standard screw] [torsion spring] [flange mount] mounting. Recessed models shall have a rust-preventive, [textured black coating] [_____] and the surface mount unit finished in textured [white] [_____]. Enclosure shall include four triple compound conduit knockouts.

2.5 SPEAKER SWITCHING PANEL

2.5.1 Selector Switches

Zone control shall be provided for the paging function. The speaker switching panel shall contain at least [_____] double-pole, [[4-] [3-] position] [push button] selector switches and shall be [rack-mounted]

[desk mounted] [selector switches built in microphone]to activate priority relays. Selector switches labeling shall be provided to identify the zones.

2.5.2 System Power supply

Power supply shall be provided for priority relays and controls, rack-mounted and sized for a capacity equal to 200 percent of the as-built control system, and shall operate at 24 Vdc. Input and output shall be protected to permit Class 2 wiring in accordance with NFPA 70.

2.6 PRIORITY RELAYS AND CONTROLS

Provide priority relays and controls required to accomplish operations specified. Relays shall be completely enclosed with a plastic dust cover for maximum protection against foreign matter, and shall be plug-in type. Relays shall be provided with a diode wired across the relay coil for transient suppression and shall be installed utilizing factory-prewired, rack-mounted receptacle strips. Coil shall be maximum 24 volts dc.

2.7 SWITCHES AND CONTROLS

2.7.1 Remote Loudspeaker ON/OFF Switches

Remote switches shall be [key-operated] [toggle switch] 2-pole, wall-mounted, single gang type with engraved switch plates finished to match the approved finish of electrical wall switches. Low-voltage priority override relays shall be provided as part of the switches with all wiring to the racks to allow override of the ON/OFF switches for priority announcements.

2.7.2 Remote Loudspeaker Volume Controls

Remote volume controls shall be an auto transformer type with detented 3 dB steps and an OFF position. The controls shall be wall-mounted in single-gang outlet boxes and furnished with engraved switching plates finished to match approved finish of electrical wall switches. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be [10] [35] [75] [_____] watts. Low-voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

2.8 EQUIPMENT RACKS AND CABINETS

Equipment shall be mounted on~~[~~ 19 inch racks~~] [swing wall mounted cabinets with hinged front removable and reversible door and [right hand] [left hand] hinged rear section that provides access to equipment with 19 inch mounting rails] [and] [floor mounted cabinets with 19 inch mounting rails]~~ as indicated on the drawings UL listed andin accordance with ECIA EIA/ECA 310-E and located as shown on drawings. Ventilated rear panels, solid side panels, and solid top panels shall be provided for cabinets. Equipment cabinets shall be provided with lockable front panels that limit access to equipment. The lockable front shall not cover items that require operator access. Cabinet cooling shall be through ~~[~~ perforations or louvers in front panels to ensure adequate ventilation of equipment~~] [top cabinet mounted fan]~~. The racks and cabinets shall be factory finished with a uniform baked enamel over rust inhibiting primer.

2.9 CABLES

2.9.1 Speaker Cable

Cables shall be of the gauge required depending upon the cable run length. In no case shall cable be used which is smaller than 18 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.009 inch. Cables shall be jacketed with a ~~[~~PVC~~] [Fluoropolymer]~~ compound. The jacket thickness shall be 0.02 inch minimum.

2.9.2 Microphone Cable

Cable conductor shall be stranded copper 20 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.009 inch. Cable shall be shielded 100 percent of aluminum polyester foil with a bare 22 gauge stranded soft copper drain conductor. Cables shall be jacketed with a ~~[~~PVC~~]~~ ~~[Fluoropolymer]~~ compound. The jacket thickness shall be 0.02 inch minimum.

2.10 TERMINALS

Terminals shall be ~~[~~solderless, tool-crimped pressure~~] [or] [_____]~~ type.

2.11 SURGE PROTECTION

2.11.1 Power Line Surge Protection

Major components of the system such as power amplifiers, mixer-preamplifiers, and tuners, shall have a device, whether internal or external, which provides protection against voltage spikes and current surges originating from commercial power sources in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground). Surge protection device shall be UL listed and labeled as having been tested in accordance with UL 1449.

2.11.2 SIGNAL SURGE PROTECTION

Major components of the system shall have internal protection circuits which protects the component from mismatched loads, direct current, and shorted output lines. Communication cables/conductors shall have surge protection installed at each point where it exits or enters a building.

2.12 TELEPHONE INTERFACE MODULE

~~[2.12.1 Analog Interface Module~~

~~Telephone Interface module shall provide one way all call paging access from telephone to PA system. Paging shall be accomplished by the building telephone system instruments interconnected to the PA system via an interface module to allow telephone dial up access to the paging amplifier. Telephone interface module shall as a minimum conform to the following specifications:~~

~~Impedance~~	~~600 ohms~~
~~Frequency response~~	~~100Hz to 10Khz~~
~~70V Input Impedance~~	~~200K ohms~~
~~Output level~~	~~400mV rms~~
~~Input Power Requirement~~	~~12-24Vdc (from power supply)~~
~~Access requirement~~	~~Electronic (analog) or IA2 line key (line card required) PABX loop or ground start trunk port, or dedicated single line phone~~

~~]~~[2.12.1 VoIP Interface Module

Provide paging interface module suitable for use with VoIP telephone systems.

~~]~~PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work and working conditions, verify dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 INSTALLATION

Install equipment as indicated and specified, and in accordance with the manufacturer's recommendations except where otherwise indicated. Equipment mounted out-of-doors or subject to inclement conditions shall be weatherproofed.

3.2.1 Equipment Racks

Mount racks side-by-side and bolt together. Group items of the same function together, either vertically or side-by-side. Arrange controls symmetrically at a height as indicated. Make audio input and interconnections with approved shielded cable and plug connectors; output connections may be screw terminal type. All connections to power supplies shall utilize standard male plug and female receptacle connectors with the female receptacle being the source side of the connection. Inputs, outputs, interconnections, test points, and relays shall be accessible at the rear of the equipment rack for maintenance and testing. Each item shall be removable from the rack without disturbing other items or connections. Empty space in equipment racks shall be covered by blank panels so that the entire front of the rack is occupied by panels.

3.2.2 Wiring

Install wiring in rigid steel conduit, intermediate metal conduit, cable trays, or electric metallic tubing as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wiring for microphone, grounding, line level, speaker and power cables shall be isolated from each other by physical isolation and metallic shielding. Shielding shall be terminated

at only one end.

3.3 GROUNDING

All grounding practices shall comply with NFPA 70. Equipment shall be grounded to the serving panelboard ground bus through a green grounding conductor. Metallic conduits serving the equipment shall be isolated on the equipment end with an insulating bushing to prevent noise from being transferred to the circuit. Equipment racks shall be grounded to the panelboard ground bus utilizing a 8 AWG conductor. Grounding conductor shall be terminated to the rack using connector suitable for that purpose.

3.4 TRAINING

Conduct a training course for [_____] members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of [_____] hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to the start of the training course.

3.5 ACCEPTANCE TESTS

Submit test reports in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports shall include the manufacturer, model number, and serial number of test equipment used in each test. Each report shall indicate the final position of controls and operating mode of the system. After installation has been completed, conduct acceptance tests, utilizing the approved test procedures, to demonstrate that equipment operates in accordance with specification requirements. Submit test plan and test procedures for the acceptance tests. The test plan and test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedure shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance. Notify the Contracting Officer ~~[~~14~~]~~ ~~[_____]~~ days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified.

3.5.1 Testing Requirements

Include the following minimum testing:

a. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

b. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

   (1) Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors

with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

(2) Repeat test for each separately controlled zone of loudspeakers.

(3) Minimum acceptance ratio is 50 dB

c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

d. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

e. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

~~[f. Power Outage Test: Turn off AC power at the circuit breaker for AC powered components connected to a UPS unit to ensure components continue to operate for a minimum of 15 minutes.]~~

~~g~~f. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

Public address system will be considered defective if it does not pass any of the required individual tests and inspections listed above.

-- End of Section --

SECTION 27 52 24

NURSE CALL SYSTEM
11/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 99	(2021; TIA 20-1) Health Care Facilities Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-569	(2019e) Telecommunications Pathways and Spaces

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-06	(2016; with Change 1, 2017) Cybersecurity of Facility-Related Control Systems
UFC 4-510-01	(2019; with Change 2, 2019) Design Medical Military Facilities

UNDERWRITERS LABORATORIES (UL)

UL 1069	(2007; Reprint Apr 2020) UL Standard for Safety Hospital Signaling and Nurse Call Equipment

1.2 DEFINITIONS

Use UL 1069, NFPA 99, UFC 4-510-01, and TIA-569 for definitions, abbreviations and acronyms unless noted otherwise. In the case of discrepancies UL 1069 takes preference. UFC 4-510-01 takes preference over TIA-569.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wiring Diagrams; G[, [_____]]

System Riser Diagrams; G[, [_____]]

SD-03 Product Data

Master Station - Tone-Visual; G[, [_____]]

Master Station - Audio-Visual; G[, [_____]]

Nurse Call Control Cabinet; G[, [_____]]

Battery Backup or Uninterruptible Power Supply; G[, [_____]]

Nurse Call Controller; G[, [_____]]

Pull Cord; G[, [_____]]

Pull Cord - with Audio; G[, [_____]]

Patient Station; G[, [_____]]

Patient Station - Audio; G[, [_____]]

Patient Station - Behavioral Health; G[, [_____]]

Staff Emergency Station; G[, [_____]]

Staff Station; G[, [_____]]

Staff Station - Audio; G[, [_____]]

Staff Station - Behavioral Health; G[, [_____]]

Central Code Annunciation Station; G[, [_____]]

Cord Sets; G[, [_____]]

Bed Interface Outlet Station; G[, [_____]]

Cancel Station; G[, [_____]]

Code Blue Station; G[, [_____]]

[Infant Distress Code Station; G[, [_____]]

] Dome Light; G[, [_____]]

Zone Light; G[, [_____]]

Corridor Light; G[, [_____]]

Duty Station; G[, [_____]]

Equipment Alarm Station; G[, [_____]]

Nurse Call - Lighting Interface; G[, [_____]]

Nurse Call - TV Interface; G[, [_____]]

Call Logging Workstation; G[, [_____]]

Maintenance Workstation; G[, [_____]]

SD-06 Test Reports

Acceptance Test Plan; G[, [_____]]

Acceptance Test Report; G[, [_____]]

Operational Test Report; G[, [_____]]

Corrective Action Results; G[, [_____]]

Warranty Period Inspection And Testing Plan; G[, [_____]]

Warranty Period Inspection And Test Report; G[, [_____]]

SD-07 Certificates

System Contractor Qualifications; G[, [_____]]

Lead Installer Qualifications; G[, [_____]]

Manufacturer Qualifications; G[, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Data; G[, [_____]]

Software Service Agreement; G[, [_____]]

SD-11 Closeout Submittals

As-Built System Drawings; G[, [_____]]

Equipment Spare Parts List; G[, [_____]]

1.4 MAINTENANCE MATERIAL SUBMITTALS

1.4.1 Extra Materials

Furnish the spare parts to the facility as itemized below, after the successful completion of system acceptance testing.

Quantity	Items
[_____]	Each type of Station
[_____]	Patient Station
[_____]	[Dome Light]
[_____]	[Push Button Cord Sets]

Quantity	Items
[_____]	[Zone Light]
[_____]	[Corridor Light]
[_____]	[Pneumatic Cord Sets]
[_____]	[Pillow Speaker Cord Sets]
[_____]	[Sets of Main Terminal/Equipment Panel plug-in modules]
[_____]	[_____]
[_____]	[_____]

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Conform to UL 1069, UFC 4-510-01, and NFPA 99. Nurse call system components listed by UL or a nationally recognized testing laboratory (NRTL).

1.4.1.1 Cybersecurity

Comply with the cybersecurity requirements identified in UFC 4-010-06, Section 25 05 11, and NFPA 99 while maintaining compliance with UL 1069. Document compliance of cybersecurity requirements for the fundamental nurse call system(s) and all proposed integrations of supplemental systems.

1.4.2 Product Standardization

Provide standard product[s] for the nurse call system from a single manufacturer/vendor, designed to integrate together and operate as a complete system.

1.4.3 Service Organization

Support from a factory-authorized service organization within a [4][_____] -hour window, from notification to arrival at site.

1.4.4 Qualifications

1.4.4.1 System Contractor Qualifications

Authorized vendor/contractor and service organization for the manufacturer of the nurse call system, with a minimum of five years regularly engaged in performing services for projects with similar level of complexity, features and functions including system application, design, integration, installation, testing, training, and maintenance.

Ensure system contractor personnel are factory trained or certified for the make and model of the system(s) provided.

1.4.4.2 Lead Installer Qualifications

Factory trained or certified on the type of system(s) provided. Minimum of five years regularly engaged in the installation of systems for projects with similar level of complexity, features, and functions.

1.4.4.3 Manufacturer Qualifications

Minimum of five years regularly engaged in the manufacture of UL 1069 -listed nurse call systems and equipment, of the same level of complexity, features and functions.

1.5 STORAGE AND PROTECTION

Deliver equipment, components, and materials in original packaging, labeled with the manufacturer/vendor name, part name and part number as appropriate. Inspect equipment, components, and materials upon receipt. Replace damaged items.

Comply with manufacturer's instructions and recommendations for storage and handling of all equipment, components, and materials. Protect materials and components from deleterious environments including weather, direct sunlight, moisture, contamination, corrosion, and construction traffic.

~~[1.6 SOFTWARE SERVICE AGREEMENT~~

~~Submit a proposal for maintenance, licensing, and any other running costs associated with the nurse call system for the next [5][_____] years, divided into annual costs. Coordinate proposal with the Using Services and DHA.~~

~~]~~PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION AND REQUIREMENTS

2.1.1 General Requirements

Provide a complete and fully functional nurse call system in compliance with UL 1069, UFC 4-510-01, and NFPA 99. Compliance to include all aspects of the nurse call system and subsystems including components and cabling, and the selection, arrangement, and connection of materials and circuits.

Supply and install all necessary equipment required, whether or not enumerated, to provide a complete and operating nurse call system. Include the following capabilities:

a. Simultaneously process and signal all calls regardless of the priority level within the nurse call system. When several different priority level calls are present on the system at one time, precedence is given to the highest priority level for call tones and visual indicators.

b. Electronically supervise all call initiation and notification devices, and associated wiring in accordance with UL 1069. Report station failure to designated console~~[, PC]~~, e-mail, and wireless device.~~[Provide integral diagnostics able to quickly locate the source of the problem.][Provide network monitoring tool to ensure network reliability.]~~

c. Support the routing of patient calls to any annunciator[, wireless/telephone network/hands-free/personally assignable communications devices][, pager,] or other annunciating device anywhere in the facility, or to any combination of the above regardless of the location of the calling station. Process calls based on location, room assignment, priority or combination thereof.

d. Perform resetting or canceling of a call with a priority of level #3 or higher only at the initiating station or device within the originating room.

e. Accomplish all programming and firmware changes on a working system without interruption to the normal operation of the system. In the event of an error or failure in the update process, revert to the previous firmware. Test and approve for installation all security patches prior to implementation to prevent interruption in service.

f. Minimum [99][_____] different event types may be defined in the nurse call network to facilitate work flow within and outside of normal nurse call activity (i.e. environmental services, facilities, transportation, lab, pharmacy, etc.).

g. Provide separate, dedicated nurse call network to accomplish all fundamental nurse call operations.[Provide gateways to enable nurse call system integration(s) via the facility network(s).]

h. Provide battery backup or uninterruptible power supply capable of operating the nurse call system(s) at full power for 15 minutes upon AC power failure.

i. Provide the nurse call network to support at least [990][_____] call processes to facilitate work flow and call escalations to various staff or groups.

[2.1.1.1 Integration/Coordination

Integrate the nurse call system with the following[existing] systems, by use of agnostic and non-proprietary software. Provide middleware that allows for system integration and provides for interoperability of other systems. Where facility has both tone-visual and audio-visual systems, integrate all subsystems into a combined, fully-functioning nurse call system. Obtain cybersecurity approval for integrations and middleware, while maintaining UL 1069 listing.

[a. Wireless/networked-telephone, hands-free, personally-assignable communication device

][b. Closed circuit television (CCTV)

][c. Hospital-grade televisions

][d. Admit, discharge and transfer system

][e. Patient entertainment system

][f. Infant protection system

][g. Electronic medical records / Electronic health records systems

~~][h. Patient education system~~

~~][i. Access control system~~

~~][j. Patient room lighting control~~

~~][k. Shade control~~

~~][l. Bed exit system~~

~~][m. Equipment monitoring[, including [_____]]~~

~~][n. Real time location services~~

~~][o. Staff assignment~~

~~][p. Radio paging~~

~~][q. Network time synchronization~~

~~][r. Call logging workstation~~

~~][s. [_____]~~

~~][t. [_____]~~

~~][Coordinate patient's control units (headwall[,][and][pillow speaker][, and][bed side-rails]) to provide remote control of devices such as lighting and television, which are not part of the nurse call system.~~

~~]][2.1.1.2 Expansion Capability~~

~~Provide nurse call system with capability for future expansion. Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and main trunk cable conductor quantities adequate to increase the number of stations in the future by [25][_____] percent above those indicated without adding internal or external components or main trunk cable conductors.~~

~~Provide ability to change any individual room without reprogramming by the manufacturer.~~

~~][2.1.1.3 Existing System Compatibility~~

~~Maintain UL 1069[and cybersecurity approval] through additions or modifications to the existing nurse call system.~~

~~]~~2.1.1.1 Call Annunciation Priorities

Sequence the annunciation of all call types in a four level priority matrix, with the highest priority of Level 1 and the lowest priority of Level 4. Coordinate the call type names, meanings and priority levels with facility.

Priority Level	Call Type	Lamp Color
#1 Code	Code Blue Code Call	[Blue][Purple][Color coordinated with facility]
#2 Emergency	Emergency Bed Exit Alarm Staff Assist Failure Alarm [Medical Device Emergency Alarm]	[Red][Color coordinated with facility]
#3 Priority	Patient Priority Call Cord Disconnected Bed Cable Disconnected	[Yellow][White][Color coordinated with facility]
#4 Routine	Patient Routine [Medical Device Routine Alarm] [Voice Intercom - Staff and Duty Stations (Audio Only)]	[Green][Color coordinated with facility]

2.1.2 System Shop Drawings

2.1.2.1 System Riser Diagrams

Submit system riser diagram for the overall system, including any integration, and for each subsystem. Identify systems integrated with the nurse call system, and provide description and details for the integration of each system. Identify the level of responsibility of the nurse call system provider for each integration, including provision of interface or gateway modules.

2.1.2.2 Wiring Diagrams

Submit wiring diagrams for the overall system and each subsystem. Indicate wiring type and size, as well as conduit or raceway size for each section of the nurse call system. Ensure system wiring reflects the required expansion capability.

2.1.3 Nurse Call Tone-Visual (NCTV) System

2.1.3.1 Operational Requirements

Provide NCTV system with capability to meet UL 1069 fundamental nurse call functions utilizing alert tones, visual indicators, selectable voice annunciation, and alphanumeric text displays.

2.1.3.2 Master Station - Tone-Visual

LED or monitor display meeting UL 1069. Provide tone-visual annunciation of calls, service requests, staff registration, with ability to display events from any device in the nurse call system network. Call-in priorities are differentiated through unique tone signals and call-in LED flash patterns. Tone may be muted at annunciator, but automatically re-engage if another call is received.

2.1.3.3 Nurse Call Control Cabinet

Wall or rack mounted cabinet for nurse call system head-end equipment including power supplies, battery backup or uninterruptible power supply, ~~[Ethernet switch,]~~ and other ancillary equipment.

~~2.1.4 Nurse Call Audio-Visual (NCAV) System~~

~~2.1.4.1 Operational Requirements~~

~~Provide NCAV system with capability to meet UL 1069 fundamental nurse call functions utilizing alert tones, visual indicators, selectable voice annunciation, alphanumeric text displays, and full duplex voice intercom. Full duplex audio communications capability on all handsets and all loud-speaking devices including patient, staff, duty, and master stations.~~

~~2.1.4.2 Master Station - Audio Visual~~

~~a. Provide a master station console display that meets the system manufacturer's minimum specifications, utilizing [touch screen][or][keypad][or][standard mouse] control.[Provide an automated service reminder when selecting a call or log item.][While in audio contact with the patient, display all user defined information, such as caregiver assigned[, and pertinent patient information] in an enriched display.][When a PC is "associated" with a VoIP console, provide user with easy to follow on-screen functions, such as display of call priority, room and patient information.]~~

~~b. Display calls on the master station in order of their priority level, and then in the order of call placement.~~

~~c. Provide the following additional functions at each one of these users' screens:~~

~~(1) Full display of all calls, including corridor light color sequence.~~

~~(2) Text message to multiple devices such as pagers, wireless phone displays, handsfree devices, and personally assignable communication devices.~~

~~[(3) Display calls in a centralized display format (i.e. Centralized Code Blue display).~~

~~] (4) Display and route calls in a de-centralized workflow environment.~~

~~[(5) Display all staff information, staff status, wireless extension and their location.~~

~~]2.1.4.3 Nurse Call Controller~~

~~a. Provide a nurse call network controller in each nursing unit or service with an audio-visual system, capable of non-blocking, duplex communications between consoles and rooms, duty stations, staff stations, sub stations, and master stations.~~

~~b. Provide controller as life safety grade meaning that it does not require regular rebooting for continued basic functions of system. Maintain fundamental nurse call operations upon loss of facility's communication network. A PC may not be used as a nurse call~~

~~controller.~~

2.2 MATERIAL AND EQUIPMENT

2.2.1 Pull Cord

An emergency call device activated by pulling cord. Provide pendant attached to the end of the cord, within patient reach. Provide with call assurance LED~~[, second, unique call-in priority button,]~~ and cancel button. Provide water-resistant device where installed in wet area.

~~2.2.2 Pull Cord - with Audio~~

~~An emergency call device activated by pulling cord. Provide pendant attached to the end of the cord, within patient reach. Provide with call assurance LED,[second unique call-in priority button,] cancel button, and speaker/microphone. Provide water-resistant device where installed in wet area.~~

~~2.2.3 Patient Station~~

~~Call placed lamp, reset pushbutton, and polarized receptacle matching cord set plug, mounted in a single faceplate. Provide each patient bed with a cord set plug, call placed lamp and unique system address where patient station serves two adjacent patient beds.~~

~~2.2.4 Patient Station - Audio~~

~~a. Call placed lamp, reset pushbutton, speaker/microphone, and polarized receptacle matching cord set plug, mounted in a single faceplate. Provide each patient bed with a cord set plug, call placed lamp and unique system address where patient station serves two adjacent patient beds.~~

~~[b. Where the patient station functions as a system hub, provide support of up to [13][_____] call in stations, [3][_____] of which can have audio capability. Provides annunciation at associated console and visible annunciation at device, for calls originating from connected call stations.~~

~~]2.2.5 Patient Station - Behavioral Health~~

~~Provide tamper-proof pushbutton call device. Pull cords are prohibited. Provide water-resistant device where installed in wet area. Provide each patient bed with a pushbutton and unique system address where patient station serves two adjacent patient beds.~~

2.2.2 Staff Emergency Station

Call station with the ability to place a staff emergency call. Provide station with a call assurance LED and a cancel button, mounted in a single faceplate.

~~2.2.3 Staff Station~~

~~Provide with call button, call assurance LED, and cancel button mounted in a single faceplate.~~

~~2.2.4 Staff Station - Audio~~

~~Provides two-way intercom capability. Provide with call button, call assurance LED, cancel button, and speaker/microphone mounted in a single faceplate.~~

~~2.2.5 Staff Station - Behavioral Health~~

~~Provide two-way intercom capability via ceiling-mounted speakers and microphone. Include call-assurance LED.~~

2.2.3 Central Code Annunciation Station

Provides central annunciation of code calls from any code station.

~~2.2.4 Cord Sets~~

~~Listed by UL or a NRTL and compatible with the nurse call system listing. Provide a cord set wall bracket with each cord set to hold device when not in use.~~

~~2.2.4.1 Cord Set - Push-Button~~

~~Sufficient length of cord for patient reach; compatible with medical gas environment; equipped with momentary-action, call button switch; sterilizable; washable cord.~~

~~2.2.4.2 Cord Set - Geriatric Call-Button~~

~~Sufficient length of cord for patient reach; compatible with medical gas environment; equipped with momentary-action, light-pressure switch in soft outer jacket; sterilizable; washable cord.~~

~~2.2.4.3 Cord Set - Squeeze-Bulb Switch~~

~~Sufficient length of cord for patient reach; compatible with medical gas environment; equipped with neoprene squeeze bulb activator and plug-mounted momentary contact switch; sterilizable; washable cord.~~

~~2.2.4.4 Cord Set - Breath Call Cord~~

~~Flexible PVC jacketed cable; momentary contact air-pressure sensitive switch; sufficient length of cord for patient reach; adjustable arm included for clamping; suitable for use in oxygen-enriched atmosphere; include 12 replacement straws; sterilizable; washable cord.~~

~~2.2.4.5 Cord Set - Pillow Speaker~~

~~Eight-conductor, DIN, flexible PVC jacketed cable. Contains nurse-call button, volume control, separate lighting control for room and reading lights, speaker, and channel control in molded flame-retardant ABS housing. Sufficient length of cord for patient reach with sheet clip; washable cord.~~

~~2.2.5 Bed Interface Outlet Station~~

~~37-pin receptacle, with dummy plug or dust cap and stainless steel wall plate, supervise and annunciate calls originating from the bed rails on the nurse call system and enable auxiliary functions.~~

~~2.2.6 Cancel Station~~

~~Cancel button, with flexible programming for cancellation of some or all call priorities, located in the same room as the originating call devices, mounted in a single faceplate.~~

2.2.4 Code Blue Station

Call station with the singular function to place a code call. Provide station with call assurance LED and cancel button.

~~[2.2.5 Infant Distress Code Station~~

~~Call station with the singular function to place a infant distress code call. Provide station with a call assurance LED and a cancel button.~~

~~]~~2.2.5 Dome Light

a. [Four][_____] segment light with integral tone device, with each segment capable of indicating a call in [white, blue, purple, red, yellow, green, orange, and pink][white, blue, red, yellow, and green][_____]. Fully programmable LED lights for the following criteria: colors, patterns, and flash rates.

2.2.6 Zone Light

Provide visual indication with integral tone device of calls by mimicking associated dome light tone, patterns, and flash rates. Provide device capable of producing the same colors as the dome light.

2.2.7 Corridor Light

Provide visual indication with integral tone device of calls by mimicking associated dome light tone, patterns, and flash rates. Provide device capable of producing the same colors as the dome light.

2.2.8 Duty Station

Provides visual and audible notification of calls. Contains [4][_____] LEDs to provide visual indication by mimicking dome light display. Provide device capable of producing the same colors as the dome light. Contains call-in button and speaker/microphone.

2.2.9 Equipment Alarm Station

~~[~~Two~~][_____]~~ isolated inputs for auxiliary alarms with call assurance LEDs and cancel button, compatible with 1/4 inch jack medical instruments. Supervise inputs to initiate a call if a cord is removed.

~~2.2.10 Nurse Call - Lighting Interface~~

~~Provide [on-off control][full range dimming] for [1][2][_____] zone(s) of lighting from the pillow speaker or bed rail. Lighting interface listed by UL or a NRTL.~~

~~2.2.11 Nurse Call - TV Interface~~

~~Provides control of hospital grade TV, including power, channel selection,~~

~~channel up/down, volume up/down, closed caption, and mute from the pillow speaker or bed rail. TV interface listed by UL or a NRTL.~~

~~[2.2.12 Call Logging Workstation~~

~~Provide workstation to monitor, collect, process, store and archive call logs, and prepare analytical reports on the nurse call system and applicable integrations. Coordinate reports required with the Using Services.~~

~~][2.2.13 Maintenance Workstation~~

~~Provide workstation for remote monitoring, diagnostics, testing, and troubleshooting of nurse call system failures.~~

~~]~~PART 3 EXECUTION

3.1 INSTALLATION

Provide a complete and operational nurse call system, with subsystems, in compliance with NFPA 70, NFPA 99, UL 1069, UFC 4-510-01, and TIA-569. Install equipment and accessory items to suit manufacturer's instructions and recommendations, plans and specifications. Provide insulated conductors in electrical metallic tubing and cable tray as the wiring method.

3.1.1 System Installation

a. Use water-resistant devices in wet areas, such as toilet rooms and showers.

b. ~~[Surface mount main terminal/equipment panels][~~Rack~~][Cabinet]~~-mount the system LAN, server, and battery back-up equipment in the ~~[~~server room~~][room approved by DHA to house servers]~~. Mounting of the panels and equipment in any other room, area or above-finished ceilings is not acceptable. Mark panels with the nurse call subsystem number and function served.

c. Master Station equipment that does not require attendant access for programming or call activities (such as the battery back-up) may be wall mounted in a protected area under the counter top at the master station location. If the under counter mounted equipment can be kicked and damaged by staff sitting at the counter, provide a protective shield for the equipment.

d. Firmly secure mounted equipment in place, plumb, square, and level.

e. Locate equipment to provide adequate ventilation and equipment access for service and repair.

f. Mount dome lights, corridor lights, zone lights so they are visible for the entire length of the corridor or room in which they are installed.

g. Develop zone light operational matrix, to ensure zone lights operate to notify and direct staff to the associated dome light and annunciated call device. Incorporate operational matrix into the system shop drawings.

h. Incorporate facility's final room naming convention and room numbering into the programming of the nurse call system. Provide permanent label for each new panel and equipment.

i. Install cabling in raceway and cable trays. Segregate cabling in separate raceways or cable tray as required per wiring diagrams. Install cable tray and raceway parallel and perpendicular to structural members, concealed from view except where specifically noted per drawings.

j. Install cables without damaging conductors or jacketing, pulling cables within manufacturer's recommended pulling tension.

k. For nurse call devices in behavioral health areas, provide tamper-proof screws, pushbutton devices, ceiling mount speakers, ability to limit calls from patient devices, and ability to mute calls from the master station.

3.2 FIELD QUALITY CONTROL

3.2.1 Periodic Inspection and Testing

All work and workmanship is subject to inspection and testing as requested by the Contracting Officer at any and all times during preparation and installation. The Contracting Officer, in his or her sole discretion, may reject defective work and workmanship and require its correction. The Government's right to inspect, test, and reject, or its failure to exercise such right, as provided herein, in no way diminishes the system Contractor's duty to inspect and reject work as necessary to comply fully with the requirements of the contract documents.

3.2.2 Final Inspection and Acceptance Testing

Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.2.2.1 Inspection

a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Verify that the system and individual devices are installed in accordance with manufacturer's instructions.

b. Notify the Contracting Officer when the installation of ~~[each phase of]~~the system is completed and operating in accordance with specifications and ready for final inspection.

c. After installation ~~[of each phase]~~has been completed, and the system components installed ~~[during the phase]~~have been final inspected, checked out, and approved by the Contracting Officer, conduct acceptance tests in accordance with the approved Acceptance Test Plan.

3.2.2.2 Acceptance and Operational Testing

a. Develop an Acceptance Test Plan, to include step-by-step actions and the expected results to demonstrate system compliance. Include tests defined in the Manufacturer's installation instructions; list of all test equipment, including data indicating that calibration of the test

equipment is current; test data sheets; and names and qualifications of the person(s) who will perform the tests.~~[For project's with phased construction schedules, identify acceptance test criteria for each phase in the test plan.]~~

b. Conduct acceptance tests in accordance with the approved Acceptance Test Plan upon approval of final inspection ~~[of each phase]~~by the Contracting Officer.

c. Operational Test: After completion of the acceptance testing, perform an operational system test to demonstrate proper operations as defined in UL 1069. Test each station capable of originating calls by activating a call from the station and observing the proper sequence of operation. Demonstrate each call type and priority for stations capable of placing multiple types or priorities of calls. Perform tests that include originating station-to-station messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Simulate power outage to demonstrate operation on battery back-up source and transition to the essential electrical system. Submit an Operational Test Report to document results.

d. Upon successful completion of ~~[all phased]~~final acceptance tests, and 30 calendar days of consecutive operationwithout the occurrence of any major malfunctions, submit the final acceptance test report, including certificates of compliance stating that all requirements and conditions have been satisfied. Submit test reports in both electronic media form and hard copy booklet form. Indicate in the field reports all field tests performed to adjust each component and to prove compliance with the performance criteria.

e. Indicate in each test report the final position of controls and operating mode of the system, and the manufacturer, model number, and serial number of the test equipment used in each test. The effective date of final system acceptance is the date when the system has satisfied 30 days of operation without a major malfunction.

f. Submit as-built system drawings in accordance with Section 01 78 00.

3.2.2.3 Corrective Action for Rejected Work

Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets the system requirements and complies with applicable standards. Report corrective action results in writing.

3.2.2.4 Warranty Period Inspection and Testing

At the end of 3rd and 7th months of operation, observe the system in operation and conduct tests to assure system performance. Include interviews of users to determine if the system is satisfying requirements and that training is adequate. Coordinate this service with the Contracting Officer. During the ~~[~~11~~][____]~~th month of operation conduct an inspection and test of the system to identify and correct any deficiencies before the end of warranty period. Conduct this inspection and testing in the presence of a medical facility representative to witness this procedure and certify that all necessary corrective actions have been taken. Submit the warranty period inspection and test report to

the Contracting Officer. Submit warranty period inspection and testing plan, including contact information and dates of proposed warranty period inspection prior to final system acceptance.

3.3 TRAINING

~~[~~Engage a factory-authorized service representative to train~~][Train]~~ Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment. Provide training for each role assignable in the nurse call system. Coordinate number of roles with using services. Provide minimum two training sessions for system users and minimum two training sessions for maintenance personnel scheduled to accommodate shift work. ~~[~~Eleven~~][_____]~~ months after ~~[~~the system is installed~~][beneficial occupancy]~~, provide a refresher course for each group of trainees.

3.4 MAINTENANCE

Submit Data Package 5 operation and maintenance data for the installed nurse call system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

a. Utilize systems and devices in accordance with the UL 1069 listing of the nurse call system and the Cybersecurity approvals noted in this Section. Coordinate with Government to establish a plan of action for approval and dissemination of required Information Assurance Vulnerability Alert (IAVA) patches as well as software and security updates. Provide perpetual licenses for the nurse call system.

b. Provide equipment spare parts list for all spare parts furnished.

~~[c. Upgrade Service: Update software to latest version at project completion. [Install and program software upgrades that become available within [two][_____] years from date of Substantial Completion.]Upgrade operating system if required to support software upgrade. Provide new or revised licenses to enable use of upgraded software. Ensure cybersecurity approval is maintained through the upgrade(s).~~

~~][[c][d]. Technical Support: Beginning with Substantial Completion, provide software support for [two][___] years. Follow the DHA Business to Business (B2B) process, or other process as coordinated with the Using Services to provide connectivity to support remote repair, maintenance, and sustainment of the system.~~

~~][[c][d][e]. Provide [30][___] days notice to Using Service to allow scheduling and access to system and to allow Using Service to upgrade computer equipment if necessary.~~

~~]~~ -- End of Section --

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

~~AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)~~ASME INTERNATIONAL (ASME)

ASME A17.1/CSA B44	(2021) Safety Code for Elevators and Escalators

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 72	(2019; TIA 19-1; ERTA 1 2019; TIA 21-1; ERTA 1 2021) National Fire Alarm and Signaling Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2021) Standard for Fire Safety and

Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2021; with Change 6, 2021) Fire Protection Engineering for Facilities
UFC 3-601-02	(2010) Operations and Maintenance: Inspection, Testing, and Maintenance of Fire Protection Systems
UFC 4-010-06	(2016; with Change 1, 2017) Cybersecurity of Facility-Related Control Systems

UNDERWRITERS LABORATORIES (UL)

UL 268	(2016; Reprint Oct 2019) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Oct 2014) Smoke Detectors for Duct Application
UL 464	(2016; Reprint Sep 2017) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Dec 2012) Protectors for Data Communication Circuits
UL 864	(2014; Reprint May 2020) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1480	(2016; Reprint Sep 2017) UL Standard for Safety Speakers for Fire Alarm and Signaling Systems, Including Accessories
UL 1638	(2016; Reprint Sep 2017) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired
UL 2017	(2008; Reprint Dec 2018) UL Standard for Safety General-Purpose Signaling Devices

	and Systems
UL 2034	(2017; Reprint Sep 2018) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL 2572	(2016; Bul. 2018) UL Standard for Safety Mass Notification Systems
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 RELATED SECTIONS

Section 25 05 11 Cybersecurity for Facility-Related Control Systems, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

[Section 21 13 13 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
][Section 21 30 00 FIRE PUMPS
][Section 21 23 00.00 20 WET CHEMICAL FIRE EXTINGUISHING for KITCHEN CABINET
][Section 21 13 16 DRY PIPE FIRE SPRINKLER SYSTEMS
][Section 21 13 18 PREACTION FIRE SPRINKLER SYSTEMS
][Section 21 13 19 DELUGE FIRE SPRINKLER SYSTEMS
][Section 23 30 00 HVAC AIR DISTRIBUTION
][Section 21 13 24.00 10 AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM
][Section 21 13 25 HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION
][Section 21 13 20.00 20 FOAM FIRE EXTINGUISHING FOR AIRCRAFT HANGARS
][Section 21 13 21.00 20 FOAM FIRE EXTINGUISHING FOR FUEL TANK PROTECTION
][Section 21 13 22.00 20 FOAM FIRE EXTINGUISHING FOR HAZ/FLAM MATERIAL FACILITY
][Section 21 21 01.00 20 CARBON DIOXIDE FIRE EXTINGUISHING (HIGH PRESSURE)
][Section 21 21 02.00 20 CARBON DIOXIDE FIRE EXTINGUISHING (LOW PRESSURE)
][Section 21 21 03.00 10 WET CHEMICAL FIRE EXTINGUISHING SYSTEM
][Section 08 71 00 DOOR HARDWARE for [door release][door unlocking] and additional work related to finish hardware.
][Section[s] [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS] [14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS] [and] [14 24 13 HYDRAULIC FREIGHT ELEVATORS] [14 24 23 HYDRAULIC PASSENGER ELEVATORS] for additional work related to elevators.
][Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

]1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and [providing a new, complete,][modifying the existing] fire alarm and mass notification (MNS) system as described herein and on the contract drawings[for the _____]. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm

transmitters/mass notification transceiver, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system~~[s]~~ complete and ready for operation.~~[~~ ~~Existing interior fire alarm system was manufactured by [_____].]~~ Design and installation must comply with UFGS 25 05 11, UFC 3-600-01, UFC 4-010-06 and AFGM 2019-320-02.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. ~~[The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.]~~

~~[~~ c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

~~][d. Where a fire pump is provided, the fire alarm and mass notification system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.~~

~~][e. Where an emergency generator provides standby power supply for life safety system circuits, the generator must be monitored by the FMCU and transmit emergency generator signals in accordance with NFPA 72.~~

~~]~~ ~~f~~d. The fire alarm and mass notification system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

The scope includes the services of QFPE. The QFPE must be a registered professional engineer who has passed the Fire Protection Engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and have relevant experience.

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government ~~[~~and final Government ~~]~~functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm and Mass Notification Control Unit (FMCU)

A master control unit having the features of a fire alarm control unit (FACU) and an autonomous control unit (ACU) where these units are interconnected to function as a combined fire alarm/mass notification system. The FACU and ACU functions may be contained in a single cabinet or in independent, interconnected, and co-located cabinets.

1.4.3 Remote Fire Alarm and Mass Notification Control Unit

A control unit, physically remote from the fire alarm and mass notification control unit, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm and mass notification control unit.

1.4.4 Local Operating Console (LOC)

A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery of recorded messages and/or live voice announcements, initiate visual, textual visual, and audible appliance operation and other relayed functions.

1.4.5 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.6 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.7 Designated Fire Protection Engineer (DFPE)

The ~~DoD~~NAVFAC fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.8 Qualified Fire Protection Engineer (QFPE)

~~A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience~~ See Part 1.3 Scope for qualifications and services required by QFPE.~~.~~

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[for Contractor Quality Control approval.][~~for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.~~]~~ Partial Sumittals and submittals not fully complying with NFPA 72 and this specification section must be returned disapproved without review. SD-02, SD-03, and SD-05 must be submitted simultaneously during the design phase starting with the Pre-Final design submittal. The SD-02, SD-03, and SD-05 will be approved during the design phase and must be stamped approved by the Issued For Construction design set. SD-02, SD-03, and SD-05 will not be submitted or reviewed during construction.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

The Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE will be returned disapproved without review. All resultant delays will be the sole responsibility of the Contractor.

Qualified Fire Protection Engineer (QFPE); G~~[, [_____]]~~

Fire alarm system designer; G~~[, [_____]]~~

Supervisor; G~~[, [_____]]~~

Technician; G~~[, [_____]]~~

Installer; G~~[, [_____]]~~

Test Technician; G~~[, [_____]]~~

Fire Alarm System Site-Specific Software Acknowledgement; G~~[,~~

~~[_____]]~~

SD-02 Shop Drawings

Shop drawings must not be smaller than 1/8" = 1' scale. Drawings must comply with the requirements of NFPA 72 and NFPA 170.

Nameplates; G~~[, [_____]]~~

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

Instructions; G~~[, [_____]]~~

Wiring Diagrams; G~~[, [_____]]~~

Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote fire alarm control units, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

System Layout; G~~[, [_____]]~~

Plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, etc. Show/identify all acoustically similar spaces.

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

Notification Appliances; G~~[, [_____]]~~

Data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

Initiating devices; G~~[, [_____]]~~

Amplifiers; G[, [_____]]

Data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers plus 25 percent spare capacity. Annotate data for each circuit on the drawings.

Battery Power; G[, [_____]]

Provide battery calculations as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each panel component, and the battery recharging period, must be included on the drawings.

Voltage Drop Calculations; G[, [_____]]

Voltage drop calculations indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

System Operation; G

A complete list of device addresses and corresponding messages.

SD-03 Product Data

Include annotated catalog data as required in the paragraph SUBMITTAL, in table format on the drawings, showing manufacturer's name, model, voltage, and catalog numbers for equipment and components. Product data for all equipment must be combined into a single submittal.

Fire Alarm and Mass Notification Control Unit (FMCU); G[, [_____]]

Local Operating Console (LOC); G[, [_____]]

Amplifiers; G[, [_____]]

Tone Generators; G[, [_____]]

Digitalized voice generators; G[, [_____]]

[Video Display Unit (VDU); G[, [_____]]

] LCD Annunciator; G[, [_____]]

Manual Stations; G[, [_____]]

Smoke Detectors; G[, [_____]]

Duct Smoke Detectors; G[, [_____]]

[Projected Beam Smoke Detector; G[, [_____]]

]| Air sampling smoke detectors; G[, [_____]]

] Heat Detectors; G[, [_____]]

[Flame Detectors; G[, [_____]]

][Multi-Criteria Detectors; G[, [_____]]

] Carbon monoxide detector; G[, [_____]]

Addressable Interface Devices; G[, [_____]]

Addressable Control Modules; G[, [_____]]

Isolation Modules; G[, [_____]]

Notification Appliances; G[, [_____]]

Textual Display Sign Control Panel; G[, [_____]]

Textual Display Signs; G[, [_____]]

Batteries; G[, [_____]]

Battery Chargers; G[, [_____]]

[Supplemental Notification Appliance Circuit Panels; G[, [_____]]

][Auxiliary Power Supply Panels; G[, [_____]]

] Surge Protective Devices; G[, [_____]]

Alarm Wiring; G[, [_____]]

[Back Boxes and Conduit; G[, [_____]]

][Ceiling Bridges for Ceiling-Mounted Appliances; G[, [_____]]

] Terminal Cabinets; G[, [_____]]

Digital Alarm Communicator Transmitter (DACT); G[, [_____]]

[Automatic Fire Alarm Transmitters (including housing); G[, [_____]]

][Radio Transmitter and Interface Panels; G[, [_____]]

][Mass Notification Transceiver; G[, [_____]]

] Electromagnetic Door Holders; G[, [_____]]

Environmental Enclosures or Guards; G[, [_____]]

[Firefighter Telephone; G[, [_____]]

][Printer; G[, [_____]]

] Document Storage Cabinet; G[, [_____]]

SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G[, [_____]]

~~]~~ SD-06 Test Reports

Test Procedures; ~~G[, [_____]]~~

SD-07 Certificates

Verification of Compliant Installation; ~~G[, [_____]]~~

Request for Government Final Test; ~~G[, [_____]]~~

SD-10 Operation and Maintenance Data

Four copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software delivered for this project on each type of CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, etc.) must comply with UFC 3-601-02.

h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

Operation and Maintenance (O&M) Instructions; ~~G[, [_____]]~~

Instruction of Government Employees; ~~G[, [_____]]~~

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

Fire alarm system/mass notification system including textual display sign control panel(s), components requiring power, except for the FMCU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm and mass notification system must be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864, and UL 2572. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, FMCU, or remotely from authorized locations/users.

~~[Provide the system with an interconnected riser loop or network having Class [A][X] supervision. Ensure that the return portion of the loop is remote from the supply portion of the loop.][Where the building has two stairs for egress from floors above grade or floors below grade, ensure that a single impairment cannot adversely affect more than one floor. Where three or more stairs are provided for egress from floors above grade or below grade, ensure that a single impairment cannot adversely affect more than one-half of any floor.][Ensure that any single impairment of the system does not affect the system on more than [one][one-half] of any floor.]~~

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textual)

a. Connect alarm initiating devices to initiating device circuits (IDC) ~~[Class "A"][~~Class "B"~~]~~, or to signaling line circuits (SLC) Class ~~["A"][~~"B"~~]["X"]~~ and installed in accordance with NFPA 72.

b. Connect notification appliances to notification appliance circuits (NAC) ~~[Class "A"][~~Class "B"~~]~~.

c. The system must be activated into the alarm mode by actuation of any alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control panel is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, FMCU, or remotely from authorized locations/users.

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Visual alarm notification appliances must be synchronized as required

by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault~~[(or short circuit for Class "X")]~~. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Program capability via switches in a locked portion of the FMCU to bypass the automatic notification appliance circuits, ~~[~~fire reporting system~~]~~, ~~[~~air handler shutdown~~][smoke control operation][~~, elevator recall~~]~~, ~~[~~door release~~]~~, ~~[~~door unlocking~~]~~ features. Operation of this programmed action must indicate on the FMCU display~~[and printer output]~~ as a supervisory or trouble condition.~~[Notification appliance bypass must be selectable by floor.]~~

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.

i. The system must be capable of operating, supervising, and/or monitoring non-addressable alarm and supervisory devices.

j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.

k. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as ~~[~~HVAC, ~~][atrium exhaust,][smoke control,][~~elevator recall, ~~][releasing service,]~~ the addressable fire alarm relay must be located in the vicinity of the emergency control device.

l. An alarm signal must automatically initiate the following functions:

(1) Transmission of an alarm signal to ~~[the fire department][a remote supervising station]~~the dispatch center. Transmission must be point specific via contact ID format with the address, location, and description of the condition as it appears on the FMCP.~~.~~

(2) Visual indication of the device operated on the FMCU, ~~[Video Display unit (VDU),]~~ ~~[~~and on the ~~[graphic][~~remote ~~]~~annunciator~~]~~. ~~[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]~~

[(3) Record the event on the system printer.

] (43) Actuation of alarm notification appliances.

(54) Recording of the event electronically in the history log of the FMCU.

[(6) Release of doors held open by electromagnetic devices.

][(7) Operation of the [smoke control system][atrium exhaust system].

][(85) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.

][(96) Elevator recall as described in this section.
]
[(10) Operation of [_____] must release the [_____] fire extinguishing system after a [_____] second time delay.

][(117) Operation of a sprinkler waterflow switch serving an elevator machinery room or elevator shaft must operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1/CSA B44.

][(12) Operation of an interface that operates vibrating pagers worn by hearing-impaired occupants.

] m. A supervisory signal must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator]. [Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

[(2) Record the event on the system printer.

] (32) Transmission of a supervisory signal to [the fire department][a remote supervising station].

(43) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

(54) Recording of the event electronically in the history log of the FMCU.

n. A trouble condition must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator]. [Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

[(2) Record the event on the system printer.

] (32) Transmission of a trouble signal to [the fire department][a remote supervising station].

(43) Recording of the event electronically in the history log of the FMCU.

~~[~~ o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU,~~[LCD, LED Display unit (VDU),][~~ and on the ~~[graphic][~~remote ~~]~~annunciator ~~].[Indication on the graphic annunciator must be by floor and room number, device address, and device type.]~~

(2) Transmission of a carbon monoxide alarm signal to ~~[the fire department][~~a remote supervising station~~]~~.

(3) Activation of all strobes and the audible carbon monoxide message throughout the building.

(4) Recording of the event electronically in the history log of the FMCU.

~~]~~ p. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

~~[~~ q. Activation of a LOC pushbutton must activate the audible and visual alarms in the facility. The audible message must be the one associated with the pushbutton activated.

~~][~~1.6.3 Elevator Recall

Provide elevator recall in accordance with ASME A17.1/CSA B44, Section ~~[14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS][14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS][14 24 13 HYDRAULIC FREIGHT ELEVATORS][~~14 24 23 HYDRAULIC PASSENGER ELEVATORS~~]~~, and as specified herein. Activation of any smoke detector in an elevator shaft, machine room, or lobby (except at designated recall level) must cause all elevators associated with that shaft, machine room, or lobby to return nonstop to the designated level. Activation of a smoke detector in the lobby or machine room at the designated level must cause all elevators associated with that lobby to return nonstop to the assigned alternate level. Activation of a detector in an elevator shaft, machine room, or lobby must also cause illumination of elevator cab warning signal (fire hat) and complete operation of fire alarm system as specified in paragraph titled "Functions and Operating Features".

~~]~~1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "Fire Alarm System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include

the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for fire alarm and mass notification.

e. Description of Fire Alarm and Mass Notification Control Unit equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

~~[1.8 EXISTING EQUIPMENT~~

~~a. Equipment and devices must be compatible and operable with the existing fire alarm/mass notification system and must not impair reliability or operational functions of existing supervising station fire alarm system.[The proprietary type supervising station (PSS) is located [in Building [_____].][_____].][The supervising equipment is existing and consists of the following brands and models: [supervising station control unit [_____].][_____][signal reporting components [_____]], [annunciator [_____]][_____]].~~

~~[b. Equipment and devices must be compatible and operable with the existing building fire alarm/mass notification system. Equipment must not impair reliability or operational functions of the existing system. The existing building system control unit is [_____].~~

~~] c. Equipment and devices must be compatible and operable with the existing installation-wide mass notification system and must not impair reliability or operational functions of the existing system. The installation-wide mass notification system utilizes [_____] transceivers.~~

~~]~~1.8 QUALITY ASSURANCE

1.8.1 Submittal Documents

1.8.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than ~~[~~14 days~~][_____]~~ prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.8.1.2 Shop Drawings

Shop drawings must not be smaller than ~~[ISO A1][ANSI D][~~the Contract Drawings~~]~~. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.8.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.8.1.4 Wiring Diagrams

~~[_____]~~Provide copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote FMCU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.8.1.5 System Layout

~~[_____]~~Provide copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Show/identify all acoustically similar spaces. Indicate if the environment for the FMCU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

~~[For air sampling smoke detection systems, provide floor plan layouts indicating location of fire alarm control unit, air sampling piping (lengths of pipe) and sampling ports (sizes and locations). Floor plan must also indicate geographic monitor zone boundaries, location of display control unit, bar level annunciation panels if separate, and all other associated equipment that is required to provide a complete operational system.~~

~~]~~1.8.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.8.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least ~~[~~25~~][_____]~~ percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.8.1.8 Amplifiers

Calculations and supporting data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers at tapped settings plus ~~[~~25~~][_____]~~ percent spare capacity. Annotate data for each circuit on the drawings.

1.8.1.9 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.8.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.8.1.11 Product Data

~~[_____]~~Provide copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

~~[1.8.1.12 Air Sampling Smoke Detection System Calculations~~

~~Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.~~

~~]~~1.8.1.12 Operation and Maintenance (O&M) Instructions

~~[~~Six~~][_____]~~ copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance

Instructions must include the following:

a. "Manufacturer Data Package [five][_____]" as specified in [Section 01 78 23 OPERATION AND MAINTENANCE DATA][_____].

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software submitted for this project on CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.8.1.13 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.8.2 Qualifications

1.8.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.8.2.2 Supervisor

[A NICET Level [III][or][IV] fire alarm technician must supervise the installation of the fire alarm/mass notification system[, including the air sampling smoke detection system].][A fire alarm technician with a minimum of eight years of experience must supervise the installation of the fire alarm/mass notification system.] The fire alarm technicians

supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings~~[, and must be thoroughly experienced in the installation of air sampling detection systems]~~.

1.8.2.4 Installer

~~[~~Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and control units~~]~~ ~~[~~NICET Level II technician to assist in the installation of fire alarm/mass notification devices, cabinets and control units~~]~~. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level ~~[~~III~~][or][IV]~~ utilized in testing and certification of the installation of the fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.8.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.8.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.10 MAINTENANCE

1.10.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. ~~[~~Five~~][_____]~~ complete sets of system keys.

b. ~~[Two][_____]~~Four of each type of fuse required by the system.

c. ~~[One][_____]~~Two manual stations.

~~[~~ d. ~~[~~Two~~][_____]~~ of each type of detector installed.

~~]~~ e. ~~[~~Two~~][_____]~~ of each type of detector base and head installed.

~~[f. [One][_____] electromagnetic door holders.~~

~~][g. One smoke detector manufacturer's test screen, card or magnet for each ten beam smoke detectors, or fraction thereof, installed in the system.~~

~~][h. Two air sampling smoke detection system filter assemblies.~~

~~]~~ ~~i~~f. ~~[~~Two~~][_____]~~ of each type of audible and visual alarm device installed.

~~j. [One][_____] textual visual notification appliance.~~

~~k~~g. ~~[~~Two~~][_____]~~ of each type of addressable monitor module installed.

~~l~~h. ~~[~~Two~~][_____]~~ of each type of addressable control module installed.

~~m~~i. ~~[~~Two~~][_____]~~ low voltage, ~~[~~one~~][_____]~~ ~~[~~telephone~~][internet][ethernet]~~, and ~~[~~one~~][_____]~~ 120 VAC surge protective device.

~~[n. [Two][_____] spare reams of paper for the system printer, plus sufficient paper for testing.~~

~~][o. [Two][_____] spare printer ribbons.~~

~~]~~1.10.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment must be listed for use under the applicable reference standards. Interfacing of UL 864 or similar approved industry listing with Mass Notification equipment listed to UL 2572 must be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least ~~[~~2~~][_____]~~ years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls. Lettering on the nameplate must say "Fire Alarm and Mass Notification Control Panel" and must not be less than 1-inch high.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. ~~[~~Master all keys and locks to a single key as required by the ~~[~~ Installation Fire Department~~][_____]]~~. ~~[Keys must be CAT [60][_____].]~~

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. ~~[Install the instructions on the interior of the FMCU.][~~Install the frame in a conspicuous location observable from the FMCU.~~]~~ The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must also include procedures for operating live voice microphones. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM AND MASS NOTIFICATION CONTROL UNIT

Provide a complete fire alarm and mass notification control unit (FMCU) fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the unit cabinets must match exactly.~~[~~ If more than a single unit is required, and is located in the lobby/entrance, notify the Contracting Officer's Designated Representative (COR), prior to installing the equipment.~~]~~ The system must be capable of defining any module as an alarm

module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FMCU must be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit must have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.

c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight prerecorded messages. Provide the ability to automatically repeat prerecorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, initiate/synchronize strobes and initiate textual visual notification appliances. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and ~~[~~surface~~][semi-recessed]~~ mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm and Mass Notification control unit" and must not be less than 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated

if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FMCU after the initiating device or devices have been restored to normal.

2.3.4 Audible Notification System

The Audible Notification System must comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements, except as specified herein. The system must be a one-way, multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of recorded messages. Audible appliances must produce a three-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. For carbon monoxide detector activation, audible appliances must produce a four-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. Automatic messages must be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message must override the automatic audible output through use of a microphone input at the control unit or the LOC.

a. When using the microphone, live messages must be broadcast ~~[~~throughout ~~a selected floor or floors,][selectable by zone,]~~the buildings or all call. The system must be capable of operating all speakers at the same time. ~~[~~The Audible Notification System must support Public Address (PA) paging for the facility.~~]~~~~[~~ This must be accomplished with the provision of a separate microphone with a head unit that interfaces with the FMCU. The public address paging function must not override any fire alarm or mass notification functions. The microphone must be ~~[desktop]~~[hand-held~~][_____]~~ style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphone(s) must be approved by the ~~[_____]~~ Designated Fire Protection Engineer (DFPE).~~]~~ Activation of the public address microphone must not initiate activation of visual notification appliances or LED text displays.

b. The microprocessor must actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative must automatically cause the three-pulse temporal pattern to take over all functions assigned to the failed unit in the event an alarm is activated.

2.3.4.1 Outputs and Operational Modules

All outputs and operational modules must be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Mass Notification event, the control unit must not generate nor cause any trouble alarms to

be generated with the Fire Alarm system.

2.3.4.2 Mass Notification

a. The system must have the capability of utilizing an LOC with redundant controls of the FMCU. Notification Appliance Circuits (NAC) must be provided for the activation of strobe appliances. Audio output must be selectable for line level. A hand-held microphone must be provided and, upon activation, must take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC circuit activation.

b. The Mass Notification functions must override the manual or automatic fire alarm notification,~~[~~ and public address (PA) functions~~]~~. Other fire alarm functions including transmission of a signal(s) to the fire department must remain operational. When a mass notification announcement is disengaged and a fire alarm condition still exists, the audible and visual notification appliances must resume activation for alarm conditions. The fire alarm message must be of lower priority that all other messages (except any "test" messages) and must not override any other messages.

~~[~~ c. Messages must be recorded professionally utilizing standard industry methods, in a professional ~~[male][~~female~~]~~ voice. Message and tone volumes must both be at the same decibel level. Messages recorded from the system microphone must not be accepted. A 1000 Hz tone (as required by NFPA 72) must precede messages~~ and be similar to the following unless Installation or Facility specific messages are required:~~. Messages shall be coordinated with the base.

~~(1) "May I have your attention please. May I have your attention please. [Insert installation specific message here.]" (Provide a [2][_____] second pause.) "May I have your attention please, (repeat the tones and message [on a continuous loop][[_____] times]).~~

~~(2) Carbon Monoxide: "May I have your attention please. May I have your attention please. Carbon monoxide has been detected in the building. Please walk to the nearest exit and leave the building." (Provide a [2][_____] second pause.) "May I have your attention please, (repeat the tones and message [on a continuous loop][[_____] times])."~~

~~(3) Fire: "May I have your attention please. May I have your attention please. A fire emergency has been reported in the building. Please leave the building by the nearest exit[or exit stairway].[Do not use the elevators.]" (Provide a [2][_____] second pause.) "May I have your attention please, (repeat the tones and message on a continuous loop)."~~

~~(4) Test: "May I have your attention please. May I have your attention please. This is a test of the building mass notification system. Please continue your normal duties. This is only a test." (Provide a [2][_____] second pause.)~~

~~(5) All Clear: "May I have your attention please. May I have your attention please. An all clear has been issued, resume normal activities." (Provide a [2][_____] second pause.)~~

] d. Auxiliary Input Module must be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface.

[2.3.4.3 Installation-Wide Control

If an installation-wide control system for mass notification exists on the Base, the autonomous control unit must communicate with the central control unit of the Installation-wide system. The autonomous control unit must receive commands/messages from the central control unit and provide status information.

]2.3.5 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.6 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be provided as part of this contract.

2.3.7 Input/Output Modifications

The FMCU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad[and a keyboard]. Any bypass or modification to the system must indicate a trouble condition on the FMCU.

2.3.8 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.3.9 Walk Test

The FMCU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log[and on the system printer], but no other outputs occur.

2.3.10 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.11 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Detector range (normal, dirty).

~~[2.3.12 Heat Detector Self-Test Routines~~

~~Automatic self-test routines must be performed on each detector that will functionally check detector sensitivity electronics and ensure the accuracy of the value being transmitted. Any detector that fails this test must indicate a trouble condition with the detector location at the control unit.~~

~~]~~2.4 LOCAL OPERATING CONSOLES (LOC)

2.4.1 General

The LOC must consist of a remote microphone station incorporating a push-to-talk (PTT) hand-held microphone and system status indicators. The LOC must have the capability of being utilized to activate prerecorded messages. The unit must incorporate microphone override of any tone generation or recorded messages. The unit must be fully supervised from the FMCU. The housing for the LOC must not be lockable.~~[~~ The LOC must have public address capability with the provision of a separate microphone. The PA paging function must not override any alarm or notification functions. The PA microphone must be ~~[desktop][~~hand-held ~~][_____]~~ style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphone~~[s]~~ must be approved by the ~~[_____]~~ Designated Fire Protection Engineer (DFPE). Activation of the PA microphone must not initiate activation of visual notification appliances or LED text displays. The PA paging function must not override any alarm or notification functions.~~]~~

2.4.2 Multiple LOCs

When an installation has more than one LOC, the LOCs must be programmed to allow only one LOC to be available for paging or messaging at a time. Once one LOC becomes active, all other LOC's will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time. This is to avoid two messages being given at the same time. It must be possible to override or lockout the LOC's from the FMCU.

2.5 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, ~~digitalized voice generators,~~ and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 must be housed in a remote

FMCU, terminal cabinet, or in the FMCU. Individual amplifiers must be 100 watts maximum.

2.5.1 Operation

The system must automatically operate and control all building speakers~~[except those installed in the stairs][and within elevator cabs].[The speakers in the stairs[and elevator cabs] must operate only when the microphone is used to deliver live messages.]~~.

2.5.2 Construction

Amplifiers must utilize computer grade solid state components and must be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.5.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and control unit mounted microphone ~~[~~Public Address Paging Function~~]~~. Microphone inputs must be of the low impedance, balanced line type. Both microphone and tone generator input must be operational on any amplifier.

2.5.4 Tone Generator

The tone generator must produce a three-pulse temporal pattern and must be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator must be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay. The tone generator must be provided with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces.

2.5.5 Protection Circuits

Each amplifier must be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component must cause illumination of a visual "amplifier trouble" indicator on the control unit, appropriate logging of the condition in the history log~~[and on the system printer]~~, and other actions for trouble conditions as specified.

~~[2.6 VIDEO DISPLAY UNIT (VDU)~~

~~a. The VDU must be the secondary operator-to-system interface for data retrieval, alarm annunciation, commands, and programming functions. The desk mounted VDU must consist of a LCD monitor and a keyboard. The VDU must have a [12][17][_____]-inch minimum [touch]screen, capable of displaying 25 lines of 80 characters each. Communications with the FMCU must be supervised. Faults must be recorded in the history log[and on the printer]. Power required must be 120 VAC, 60 Hz from the same source as the FMCU.~~

~~b. To eliminate confusion during an alarm situation, the screen must have~~

dedicated areas for the following functions:

(1) Alarm and return to normal.

(2) Commands, reports, and programming.

(3) Time, day, and date.

c. Use full English language throughout to describe system activity and instructions. Full English language descriptors defining system points must be 100 percent field programmable by factory trained personnel, alterable and user definable to accurately describe building areas.

d. Alarms and other changes of status must be displayed in the screen area reserved for this information. Upon receipt of alarm, an audible alarm must sound and the condition and point type must flash until acknowledged by the operator. Return to normal must also be annunciated and must require operator acknowledgment. The following information must be provided in full English:

(1) Condition of device (alarm, trouble, or supervisory).

(2) Type of device (for example, manual pull, waterflow)

(3) Location of device plus numerical system address.

e. The system must have multiple levels of priority for displaying alarms to conform with UL 864. Priority levels must be as follows:

(1) Level 1 - Mass Notification Signals

(2) Level 2 - Fire Alarm Signals

(3) Level 3 - Carbon Monoxide Alarm Signals

(4) Level 4 - Supervisory Signals

(5) Level 5 - Trouble Signals

f. Provide the system with memory so that no alarm is lost. A highlighted message must advise the operator when unacknowledged alarms are in the system.

g. Multiple levels of access must be provided for operators and supervisors via user-defined passwords. Provide the following functions for each level:

(1) Operator level access functions:

(a) Display system directory, definable by device.

(b) Display status of an individual device.

(c) Manual command (alarm device with an associated command must use the same system address for both functions).

(d) Report generation, definable by device, output on the VDU[or printer], as desired by the operator.

~~(e) Activate building notification appliances.~~

~~(2) Supervisor level access functions:~~

~~(a) Reset time and date.~~

~~(b) Enable or disable event initiated programs[, printouts,] and initiators.~~

~~(c) Enable or disable individual devices and system components.~~

~~h. The above supervisor level functions must not require computer programming skills. Changes to system programs must be [recorded on the printer and]maintained in the control unit as a trouble condition.~~

~~[~~2.6 REMOTE ANNUNCIATOR

~~[~~2.6.1 LCD Annunciator

Provide a ~~[semi-recessed][~~flush~~]~~ mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or any supervisory device. Display the device name, address~~[, and actual building location]~~. The remote annunciator must duplicate functions of the FMCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator must require the use of a key for accessing the reset, control and other functions.

~~A building floor plan must be provided and mounted (behind Plexiglass or similar protective material) at the annunciator location. The floor plan must indicate all rooms by name and number including the locations of stairs and elevators. The floor plan must show all devices and their programmed address to facilitate identification of their physical location from the LCD display information.~~Provide a laminated building floor plan (22" by 34") mounted at the main entrance of the building, adjacent to the annunciator. The drawing must indicate the FMCU, LOC, remote power supply panels, and all initiating devices. The drawing must include room numbers.

~~][2.6.2 Graphic Annunciator~~

~~Graphic annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Annunciator must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Annunciator graphic must also show the locations of the annunciator and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic(i.e., the direction the viewer is facing must be toward the top of the graphic display). Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings, [on ceilings,]and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Annunciator must have a lamp test switch.~~

~~2.6.2.1 Materials~~

~~Construct the graphic annunciator face plate of [smoked Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.~~

~~2.6.2.2 Programming~~

~~Where programming for the operation of the graphic annunciator is accomplished by a separate software program other than the software for the FMCU, the software program must not require reprogramming after loss of power. The software must be reprogrammable in the field.~~

~~][2.6.3 Printer~~

~~a. Provide a system printer [with no stored memory] to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout must be by circuit, device, and function as provided in the FMCU. Printer must operate on a 120 VAC, 60 Hz power supply.~~

~~b. The printer must have at least 80 characters per line and have a 96 ASCII character set. The printer must have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second utilizing a 9 by 7 dot matrix print head. Printer must not contain internal software which is essential for proper operation.~~

~~c. When the FMCU receives a signal, the alarm, supervisory, and trouble condition must be printed. The printout must include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer must differentiate alarm signals from other printed indications. When the system is reset, this condition must also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system must have a buffer to retain the data and it must be printed when the printer is restored to service. The printer must have an indicator to alert the operator that the paper has run out.~~

~~]~~2.7 MANUAL STATIONS

Provide metal or plastic, ~~[~~semi-flush~~]~~~~[flush]~~~~[surface]~~ mounted, ~~[single][~~double~~]~~-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.8 SMOKE DETECTORS

2.8.1 Spot Type Detectors

Provide addressable ~~[~~photoelectric~~]~~~~[ionization]~~~~[laser]~~ smoke detectors as follows:

a. Provide analog/addressable ~~[~~photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268~~]~~~~[smoke detectors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion]~~~~[laser smoke detectors utilizing laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the FMCU, send data to the control unit representing the analog level of smoke density]~~. Smoke detectors must be listed for use with the FMCU.

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FMCU to restore them to normal operation. The detector must have a visual indicator to show actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases ~~[~~with sounder that produces a minimum of 90 dBA at 10 feet~~]~~ with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

e. The detector address must identify the particular unit, its location within the system~~[, and its sensitivity setting]~~. Detectors must be of the low voltage type rated for use on a 24 VDC system.

~~[~~ ~~f. Laser smoke detector must be listed for use with the FMCU. Detector must be able to achieve sensitivities from 0.02 percent-per-foot to 2 percent-per-foot obscuration.~~

~~g. Laser smoke detector must provide point identification of the fire location through addressability, must experience no delay in response time due to smoke dilution or smoke transportation time, and must offer complete supervision of wiring and detector.~~

~~]~~~~[2.8.2 Projected Beam Smoke Detector~~

~~Detectors must consist of [combined transmitter and receiver unit] [separate transmitter and receiver units]. The transmitter unit must emit an infrared beam to the receiver unit [the use of a supplied reflector is required for the combined unit]. When the signal at the receiver falls below a preset threshold, the detector must initiate an alarm. The receiver must contain an LED status indicator that illuminates when an alarm condition exists. Long-term changes to the received signal caused by environmental variations must be automatically compensated. Detectors must incorporate features to assure that they are operational; a trouble signal must be initiated if the beam is obstructed for more than 3 seconds, the limits of the compensation circuit are reached, or the~~

housing cover is removed. Detectors must have multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam.

]2.8.2 Duct Smoke Detectors

Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct.[It is not permitted to cut the duct insulation to install the duct detector directly on the duct.] Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FMCU.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FMCU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 to INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function must be located within 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

[2.9 AIR SAMPLING SMOKE DETECTION SYSTEM

The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the pre-Government system tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the Government test.

(1) Alarm Level 1: set ALERT at [_____][0.0250] percent obscuration/foot

(2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot

(3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot

(4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

(1) Preventing large particles from affecting the true smoke reading.

(2) Monitoring contamination of the filter (for example, dust and dirt) to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

(1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

(2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

(3) Faults, including airflow, detector, power, filter and network, as

well as an indication of the urgency of the fault.

(4) Configuration of relay outputs for remote indication of alarm and fault conditions.

(5) General purpose input functionality.

]2.10 HEAT DETECTORS

2.10.1 Heat Detectors

Heat detectors must be analog/addressable and designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle][rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations [as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.10.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting. Detector must operate at [135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 135 degrees F must not respond to momentary temperature fluctuations less than 30 degrees F per minute between 60 and 100 degrees F].[Detectors rated to operate at 194 degrees F must not respond to momentary temperature fluctuations less than 50 degrees F per minute between 60 and 150 degrees F.][The detector assembly must be [weatherproof][and][explosionproof].]

][2.10.1.2 Rate Compensating Detectors

Detector backbox must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed.[The detector assembly must be [weatherproof][and][explosionproof].]

][2.10.1.3 Line-Type Fixed Temperature Detectors

Provide [thermostatic][or][thermistor] line-type heat detection cable [with weather-resistant outer covering] where indicated. Cable must be nominally rated for a temperature of [155][190][280] degrees F and must operate on fixed temperature principle only.

][2.10.1.4 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [135][_____] degrees F][as shown].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.11 FLAME DETECTORS

Detectors must be sensitive to the micron range best suited for their intended use. Detectors must operate over electrically supervised wiring circuits and the loss of power to the detector must result in a trouble

signal. A self-test feature must be provided for each detector to be individually tested.

[2.11.1 Infrared (IR) Single Frequency Flame Detector

The detector must be sensitive in the range of [_____] to [_____] micrometers only.

][2.11.2 Infrared (IR) Multi Frequency Flame Detector

The IR detector must consist of three or more IR sensors, each selected for a different IR frequency. The primary sensor must be sensitive in the range of [_____] to [_____] micrometers only. Secondary sensors are tuned to different IR wavelengths to null out the effect of black body radiation to the primary sensor.

][2.11.3 Ultraviolet (UV) Flame Detectors

UV flame detector must be of the narrow band response type which operates on radiated ultraviolet energy and must be sensitive in the range of [_____] to [_____] micrometers only. The cone of vision must be 80 degrees or greater. Each detector must be completely insensitive to light sources in the visible frequency range.

][2.11.4 Combination UV/IR Flame Detector

The UV/IR detector must provide discrimination against false alarms by requiring both UV and IR flame detection before an alarm is sent. The UV sensor must be sensitive in the range of 0.185 to 0.265 micrometers only. The IR sensor must be sensitive in the range of [_____] to [_____] micrometers only. Detectors must be completely insensitive to light sources in the visible frequency range.

]][2.12 MULTI-CRITERIA DETECTORS

Multi-criteria detectors must contain [fixed temperature [_____] degrees F heat sensor], [rate-of-rise heat sensor], [photoelectric smoke detector], [_____] elements in a single housing.

]2.9 CARBON MONOXIDE DETECTOR

Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be [surface] [semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. For FMCU with no listed compatible addressable CO detectors, provide listed 4-wire detectors.[Do not provide CO detectors with local alarms.] Detector must be provided with an LED status indicator.

a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.

b. Wiring connections must be made by means of screw terminals and

detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FMCU.

d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.10 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a ~~[Class "A"][~~ Class "B"~~]~~ initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.~~[Existing fire alarm system initiating device circuits must be connected to a single module to supervise the circuit.]~~ Modules must be listed for the environmental conditions in which they will be installed.

2.11 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as ~~[~~Class B~~]~~~~[Class A]~~ notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

~~[~~2.12 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit ~~[into groups of not more than [20 addressable devices][_____]][each floor]~~[in accordance with NFPA 72~~]~~ between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and must report faults to the FMCU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

~~]~~2.13 NOTIFICATION APPLIANCES

2.13.1 Audible Notification Appliances

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted ~~[~~red~~]~~ or ~~[~~white~~][_____]~~. Recessed audible appliances must be installed with a grill that is painted ~~[~~red~~]~~ or ~~[~~white~~][_____][with a factory finish to match the surface to which it is mounted]~~.

2.13.1.1 Speakers

a. Speakers must conform to the applicable requirements of UL 1480. Speakers must have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum. Exterior speakers must also be multi-tapped with no more than 15 watt maximum setting. Speakers must incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and must have a sealed back construction. Speakers must be capable of installation on standard 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single ~~[wall mounted]~~ unit. All inputs must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCU.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gage or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes must be ground and finished to provide a smooth and neat appearance for each plate. Each plate must be primed and painted.

c. Speakers must utilize screw terminals for termination of all field wiring.

2.13.2 Visual Notification Appliances

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be dispersed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of ~~[~~15~~][30][75][_____]~~ candela based on the UL 1971 test. Strobe must be ~~[surface][~~semi-flush~~]~~ mounted.

~~2.13.3 Textual Display Signs~~

~~Textual display signs must be [LED][LCD flat panel][LED scrolling] and must not exceed 16 inches long by 6 inches high by 3 inches deep with a height necessary to meet the requirements of NFPA 72. The text display must spell out the word "EVACUATE" or "ANNOUNCEMENT" [and the remainder of the emergency instructions]as appropriate. The design of text display must be such that it cannot be read when not illuminated.~~

~~[LCD or LED scrolling text displays must meet the following requirements at a minimum:~~

~~a. Two lines of information for high priority messaging.~~

~~b. Minimum of 20 characters per line (40 total) displayed.~~

~~c. Text must be no less than height requirements and color/contrast requirements of NFPA 72.~~

~~d. 32K character memory.~~

~~e. Display must be wall or ceiling mounted.~~

~~f. Mounting brackets for a convenient wall/cubicle mount.~~

~~[g. During non-emergency periods, display date and time.]~~

~~h. The system must interface with the textual display sign control panel to activate the proper message.]~~

2.14 ELECTRIC POWER

2.14.1 Primary Power

Power must be ~~[~~120~~][_____]~~ VAC ~~[50][~~60~~]~~ Hz service for the FMCU from the AC service to the building in accordance with NFPA 72.

2.15 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.15.1 Batteries

Provide sealed, maintenance-free, ~~[~~sealed lead acid~~][lead-calcium][gel cell]~~ batteries as the source for emergency power to the FMCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.15.1.1 Capacity

Battery size must be the greater of the following two capacities. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, fire alarm transmitters, and Base-wide mass notification transceivers. When determining the required capacity under alarm condition, visual notification appliances must include both textual and non-textual type appliances.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.15.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

(1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with UL 864.

(2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

(3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

2.15.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.16 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FMCU breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting

diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

(1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

(2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

(3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

(4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.17 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.17.1 Alarm Wiring

IDC and SLC wiring must be ~~[fiber optic][or][~~solid copper~~]~~ cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. ~~[~~14 ~~][16][18][_____]~~ AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Speaker circuits must be copper No. ~~[~~16~~][_____]~~ AWG size twisted and shielded conductors at a minimum.~~[~~ Wiring for textual notification appliance circuits must be in accordance with manufacturer's requirements but must be supervised by the FMCU.~~]~~ Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.18 INTERFACE TO THE BASE-WIDE MASS NOTIFICATION NETWORK

~~[2.18.1 Fiber Optic~~

~~The fiber optic transceiver must be fully compatible with EIA standards for RS-232, RS-422 and RS-485 at data rates from 0 (DC) to 2.1 mbps (200 kbps for RS-232) in the low speed mode or from 10 kbps to 10 mbps in the high-speed mode. The fiber optic transceiver must be capable of simplex or full duplex asynchronous transmissions in both point-to-point systems and drop-and-repeat data networks. The fiber optic transceiver must be user configurable for the protocol, speed and mode of operation required. The fiber optic transceiver must be installed as a [stand-alone][card-cage] unit. The fiber optic transceiver must operate on [Multi-mode][Single-mode] fiber optic cable. The fiber optic transceiver must be supplied with [ST][or][FCPC] type optical connectors. Cabling: as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.~~

~~][~~2.18.1 Radio

The mass notification transceiver must be bi-direction and meet all the requirements of paragraph, RADIO TRANSMITTER AND INTERFACE PANELS as specified in this specification section. The transceiver utilized in the mass notification system must be capable of the following:

a. Communication with the central control/monitoring system to provide supervision of communication link and status changes are reported by automatic and manual poll/reply/acknowledge routines.

b. All monitored points/status changes are transmitted immediately and at programmed intervals until acknowledged by the central control/monitoring system.

c. Each transceiver must transmits a unique identity code as part of all messages; the code is set by the user at the transceiver.

~~][2.18.2 Telephone~~

~~A modem must be provided for communication with the central control/monitoring system. The modem must be 56k, compatible with data mode V.90, utilizing Hayes compatible command codes. The modem must be capable of auto dialing a preset number based on preprogrammed events. The modem must auto answer and provide a secure password protection system. Cabling: as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.~~

~~][2.18.3 Secure Radio System~~

~~2.18.3.1 Communications Network~~

~~The communications network provides two-way signals between central control units and autonomous control units (in individual building systems), and should include redundant (primary and backup) communication links. The system must incorporate technology to prevent easy interruption of the radio traffic for MNS alerting.~~

~~2.18.3.2 Radio Frequency Communications~~

~~Use of radio frequency-type communications systems must comply with~~

National Telecommunications and Information Administration (NTIA) requirements. The systems must be designed to minimize the potential for interference, jamming, eavesdropping, and spoofing.

2.18.3.3 Licensed Radio Frequency Systems

An approved DD Form 1494 for the system is required prior to operation.

]2.19 AUTOMATIC FIRE ALARM TRANSMITTERS

[2.19.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is [_____] and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FMCU. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.19.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.19.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.19.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is keyed [identical to the fire alarm system for the building][identical to radio alarm transmitter housings on the Installation]. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.19.1.4 Antenna

Antenna must be [omnidirectional, coaxial, halfwave dipole antennas][_____] for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 100 mph. Do not mount antennas to any portion of the building roofing

~~system. Protect the antenna from physical damage.~~

~~]~~[2.19.1 Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter must have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter must have a source of power for operation that conforms to NFPA 72. Transmitter must be capable of initiating a test signal daily at any selected time. Transmitter must be arranged to seize telephone circuits in accordance with NFPA 72.

~~]~~2.19.2 Signals to Be Transmitted to the Base Receiving Station

The following signals must be sent to the base receiving station:

~~[~~ a. Sprinkler waterflow

~~]~~[b. Manual pull stations

~~]~~[c. Smoke detectors

~~]~~[d. Duct smoke detectors

~~]~~[e. Sleeping room smoke detectors

~~]~~[f. Carbon monoxide detectors

~~]~~[~~g. Heat detectors~~

~~]~~[~~h~~g. Fire extinguishing system

~~]~~[~~i~~h. Sprinkler valve supervision

~~][j. Fire pump running~~

~~][k. Fire pump supervision~~

~~][l. Water supply level and temperature~~

~~][m. Combustion engine drive fire pump running~~

~~(1) Selector switch in position than automatic~~

~~(2) Engine over-speed~~

~~(3) Low fuel~~

~~(4) Low battery~~

~~(5) Engine trouble (for example, low oil, over temp)~~

~~]~~2.20 SYSTEM MONITORING

2.20.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves,~~[standpipe control valves,]~~ sprinkler service entrance valve,~~[valves at fire pumps,]~~ isolating valves

for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address[, unless they are within the same room, then a maximum of five can use the same address].

[2.20.2 High/Low [Air][Nitrogen] Supervisory Switches

Provide monitoring of high and low supervisory [air][nitrogen] for [dry pipe][and][preaction] systems. Each air supervisory switch must have a separate address. Switches must be listed extinguishing system attachments. The device must contain double pole, double throw contacts. Operation of the switch must cause a supervisory signal to be transmitted to the FMCU when [air][nitrogen] pressure in the system monitored sprinkler system increases more than 5 psi above the normal system pressure or drops halfway from the normal pressure to the tripping point.

][2.20.3 Room Low Temperature Supervisory Switch

Provide [monitoring of the]listed supervisory air temperature switch for the [fire pump][sprinkler riser] room[s]. Switch must cause a supervisory signal to be transmitted to the FMCU whenever the temperature in the room drops to below 40 degrees F. Device must reset when temperature rises above 40 degrees F.

][2.20.4 Electromagnetic Door Holders

Electromagnetic holding devices must operate on [120 VAC][24 VDC], and require not more than [3][_____] watts of power to develop 25 psi of holding force. Under normal conditions, the magnets must attract and hold the doors open. Operation must be fail safe with no moving parts. Electromagnetic door hold-open devices must not be required to be held open during building power failure. The device must be listed based on UL 228 tests.

]2.21 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm/mass notification components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

[2.22 FIREFIGHTER TELEPHONE COMMUNICATION SYSTEM

2.22.1 General

Provide a firefighter telephone communication system with complete, common talk, closed circuits. The system must include, but not be limited to, a master control station mounted in the fire alarm control unit, a power supply and standby battery system, and remote telephone stations.

2.22.2 Features

The system must include the following features:

a. A master control station which must provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone hand set from its cradle must cause both a visual and audible signal to annunciate at the master control station. Removing the hand set at the master control station and depressing a button at the remote telephone hand set must cause the automatic silencing of the audible signal.

b. Communication between the master control station hand set and any/or all remote hand sets must require the depressing of a push-to-talk switch located on any/all remote hand sets. During the time that the master control hand set is removed from its cradle it must be possible to communicate between five remote hand sets and the master control station.

c. Hand sets must be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It must not be possible to communicate between two or more remote hand sets with the master control station hand set in its cradle.

d. The master control station hand set must be red in color and equipped with a 5-foot long strain-relieved coiled cord.

e. The master control station must monitor wire and connections for any opens, shorts, or grounds which would render the system inoperable or unintelligible.

f. The master control station must be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and must be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the amber LED must be extinguished.

g. The master control station must be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs must provide for the annunciation of operating and supervisory power.

h. The loss of operating or supervisory power must cause an audible and visual indication at the master control station and must also cause the fire alarm trouble signal to sound on the FMCU.

i. Switches, LEDs, and controls must be fully labeled.

2.22.3 Handsets

Handsets must have the following features:

a. Provide [surface][flush] mounted remote telephone stations.

b. Each station must be equipped with a hinged door that is magnetically locked.

c. Each hand set must be permanently wired in place with a coiled cord.

d. Each hand set must be red high-impact cycolac and must be equipped with a push-to-talk switch which, when operated, must signal the master control station and a switch-equipped, storage cradle.

e. Provide operating and supervising power from the same supply

~~circuit(s) utilized for the FMCU.~~

~~]~~PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm and Mass Notification Control Unit (FMCU)

Locate the FMCU ~~[~~where indicated on the drawings~~][_____]~~. ~~[Recess][Semi-recess][~~Surface mount~~]~~ the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at ~~[~~5~~][_____]~~ feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FMCU. Locate the document storage cabinet adjacent to the FMCU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FMCU, locate battery cabinets below or adjacent to the FMCU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72~~[~~ and as indicated on the drawings~~]~~. Mount stations so they are located no farther than ~~[~~5~~][_____]~~ feet from the exit door they serve, measured horizontally. Manual stations must be mounted at ~~[~~42~~][~~44~~][_____]~~ inches measured to the operating handle. Manual Stations must be semi-recessed.

3.2.4 Notification Appliances

a. Locate notification appliance devices~~[~~ as required by NFPA 72~~][~~ where indicated~~][~~ and to meet the intelligibility requirements~~]~~. Where two or more visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.~~[~~ Audible and visual

notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.]

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FMCU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors[as required by NFPA 72 and their listing][as indicated on the drawings] on a 4-inch mounting box. Install heat detectors not less than 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect[225 square feet per detector][_____].] Install smoke detectors no closer than 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors[as required by NFPA 72 and their listings][as indicated on the drawings] on a 4-inch mounting box.[Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.]

[3.2.7 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

(1) Detector assembly must be mounted to a wall at a height between 48 to 60 inches to top of detector measured above the finished floor.

(2) Mounting must be in a fully accessible and visible location.

(3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

(4) Piping network insertion into the detector inlet must not be glued.

(5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

(6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

(7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 0.25-inch block lettering to indicate detector and zone. For example: "AIR SAMPLING SOME DETECTOR No. 1-1 No. 5".

(8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

(1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

(2) To minimize flexing, pipes must be secured every 5 feet.

(3) Pipes must be suspended between 1 and 4 inches below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

(4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

(5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example:

"SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 20-foot intervals. Provide labels every 10 feet where piping is installed above suspended ceilings and every 2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 0.125 INCHES". Indicate fractional dimensions in decimal format with a minimum of three decimal places.

][3.2.8 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the annunciator, with the top 6 feet above the finished floor or center the annunciator at [5][_____] feet, whichever is lower.

]3.2.7 LCD REMOTE Annunciator

Locate the LCD annunciator as shown on the drawings. Mount the annunciator, with the top 6 feet above the finished floor or center the annunciator at [5][_____] feet, whichever is lower.

[3.2.8 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

][3.2.9 Firefighter Telephones

Mount telephone[hand sets][jacks] on the wall in each stair at each floor landing, in each emergency generator room, in each fire pump room, in each elevator machine room, in each elevator lobby, and in each elevator cab 4 feet above the finished floor.

]3.2.8 Local Operating Console (LOC)

Locate the LOC(s) as required by NFPA 72 and as indicated. Mount the console so that the top message button and microphone is no higher than 4 feet above the floor and the bottom (lowest) message button and microphone is at least 3 feet above the finished floor.

3.2.9 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote fire alarm/mass notification control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FMCU.

c. ~~[~~Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.~~]~~ T-tapping using screw terminal blocks is allowed for Class "B" signaling line circuits.~~]~~

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the ~~[_____]~~ Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits 6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

~~[g. For Class "A" or "X" circuits with conductor lengths of 10 feet or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.~~

~~]~~3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCU~~[~~, and remote FMCU~~]~~ and the LOC must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCU, and remote FMCU must contain a laminated drawing that indicates each conductor, its label,

circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

~~[3.4 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM~~

~~Maintain existing fire alarm/mass notification equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it must be placed in service and connected to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.~~

~~a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.~~

~~b. Disconnect and remove the existing fire alarm/mass notification and smoke detection systems where indicated and elsewhere in the specification.~~

~~c. Control units and fire alarm devices and appliances disconnected and removed must be turned over to the Contracting Officer.~~

~~d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.~~

3.4 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

a. Connection of new relays to existing magnetic door hold-open devices.

b. Connection of new elevator recall relays to existing wiring and conduit.

c. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

~~]~~3.5 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.6 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm

conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 3/4-inch wide at 10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level ~~[~~ III~~][or][IV]~~ Fire Alarm Technician, and the representative of the installing company, ~~[~~and reviewed by the QFPE~~] [60][_____] days prior to performing system tests~~. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Intelligibility test results with marked-up floor plans.

f. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the ~~[_____]~~[Designated Fire Protection Engineer (DFPE)~~]~~[~~Contracting Officer's Representative (COR)~~]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system~~[~~ and the installation-wide mass notification system have~~]~~ been completed and tested to confirm communications are fully functional. Submit request for test at least ~~[~~15 ~~]~~[~~_____~~]~~ calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

[b. The contractor's Qualified Fire Protection Engineer (QFPE).

] c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

g. Audibility test results with marked-up floor plans.

h. Intelligibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer's Representative (COR)][, Qualified Fire Protection Engineer (QFPE)]. At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

3.8.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the

secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FMCU. Hard copy records of the software must be provided to the Contracting Officer.

l. Verify that red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

q. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.8.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.8.3 Intelligibility Tests

Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ASA S3.2. Following are the specific requirements for intelligibility tests:

a. Intelligibility Requirements: Verify intelligibility by measurement after installation.

b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is ~~[~~.7~~][.8]~~. Rounding of values is permitted.

c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound

reflections may be permitted to have a CIS score less than the minimum required value if approved by the DFPE, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.

d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value must be measured on the floor or other walking surface as follows:

(1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

(2) Curving around any corners or obstructions, with a 12 inches clearance there from.

(3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility as specified by NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

a. ~~[~~ The drawings must be prepared electronically and sized no less than the contract drawings.~~][Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation] [AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]~~

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions.

~~[In existing buildings, the transfer of devices from the existing system~~

~~to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.]~~

3.10 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.10.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.10.2 Required Instruction Time

~~Provide [8][16][_____] hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.~~Provide training for the active systems consisting of a minimum of two (2) eight (8)-hour sessions to accommodate all shifts of the base fire department and allow for rescheduling for unforeseen fire department responses. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer.

~~[~~3.10.2.1 Technical Training

Equipment manufacturer or a factory representative must provide training for the active systems consisting of two (2) eight (8)-hour sessions to accommodate all shifts of the base fire department and allow for rescheduling for unforeseen fire department responses.~~[1][3][_____] days of on site[and 5 days of technical training to the Government at the manufacturing facility]~~. Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises.~~[Factory training must occur within [6][12][_____] months of system acceptance.]~~

~~]~~3.10.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.11 EXTRA MATERIALS

3.11.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for

a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer~~[s]~~. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.11.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system~~[s]~~. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.11.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06.

-- End of Section --

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SECTION 31 31 16.13

CHEMICAL TERMITE CONTROL
08/16

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 4150.07 (2019) DOD Pest Management Program

1.2 ADMINISTRATIVE REQUIREMENTS

Coordinate work related to final grades, landscape plantings, foundations, or any other alterations to finished construction which might alter the condition of treated soils with this specification.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are ~~[~~ for Contractor Quality Control approval.~~]~~~~[for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.]~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Termiticide Application Plan; ~~G[, [_____]]~~

SD-03 Product Data

Termiticides

SD-05 Design Data

Mixing Formulation~~SD-06 Test ReportsSoil MoistureCalibration Test~~

SD-07 Certificates

Qualifications~~; G[, [_____]]~~
~~Foundation Exterior~~

~~Utilities and Vents~~

~~Crawl and Plenum Air Spaces~~

~~List of Equipment~~

SD-08 Manufacturer's Instructions

Termiticides

SD-11 Closeout Submittals
~~Verification of Measurement~~

~~Warranty~~
Pest Management Report

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Comply with DODI 4150.07 for requirements on Contractor's licensing, certification, and record keeping. Maintain daily records using the Pest Management Maintenance Record, DD Form 1532-1, or a computer generated equivalent, and submit copies of records when requested by the Contracting Officer. These forms may be obtained from the main web site: http://www.dtic.mil/whs/directives/forms/eforms/dd1532-1.pdf

1.4.2 Qualifications

For the application of pesticides, use the services of an ~~—~~applicator whose principal business is pest control. The applicator must be commercially certified in the state where the work is to be performed as required by DODI 4150.07. Termiticide applicators must also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control. Submit a copy of the pest control business license and pesticide applicator certificates.

1.4.3 Safety Requirements

Formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Contracting Officer, and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. Perform filling operations under the direct and continuous observation of a contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers off Government property.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver termiticide material to the site in the original unopened containers bearing legible labels indicating the EPA registration number, manufacturer's registered uses and in new or otherwise good condition as supplied by the manufacturer or formulator.

1.5.2 Inspection

Inspect termiticides upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDES. Each label must bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended or under appropriate regulations of the host county. Inspect other materials for conformance with specified requirements. Remove unacceptable materials from the job site.

1.5.3 Storage

Storage of pesticides on the installation will not be permitted unless it is written into the contract.

1.5.4 Handling

Handle and mix termiticides in accordance with the manufacturer's label and SDS, preventing contamination by dirt, water, and organic material. Protect termiticides from weather elements as recommended by the manufacturer's label and SDS. Spill kits must be maintained on pest control vehicles and must be available at the mixing site. Conduct termiticide mixing in an area with adequate spill containment.

1.6 SITE CONDITIONS

The following site conditions determine the acceptable time of application.

~~1.6.1 Soil Moisture~~

~~Test soils to be treated immediately before application. Test soil moisture content to a minimum depth of 3 inches. The soil moisture must be as recommended by the termiticide manufacturer. Application of thetermiticide is not permitted when soil moisture content exceeds manufacturer's recommendations.~~

1.6.1 Runoff and Wind Drift

Application of termiticide will not be permitted during or immediately following heavy rains, when conditions may allow runoff, or create an environmental hazard or when average wind speed exceeds 10 miles per hour. Termiticide is not permitted to enter water systems, aquifers, or endanger humans or animals.

1.7 WARRANTY

Provide a ~~5~~3 year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Include in the warranty annual inspections of the buildings or building additions during the warranty period. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim:

a. Retreat the site and perform other treatment as may be necessary for elimination of subterranean termite infestation;

b. Repair damage caused by termite infestation; and

c. Reinspect the building approximately 180 days after the re-treatment.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Chemical termite control uses liquid termiticide treatments applied to the soil to form a continuous chemical barrier in the soil around both sides of the foundation. The application can be surface applied or rodded and trenched. This barrier prevents foraging termites from reaching the

foundation and piers. Only the soil adjacent to these foundation elements is treated. For slab construction (including foundations, patios and garages), the entire soil (or gravel) surface is treated before the vapor barrier is installed and the slab poured over it. Soil treatment is coordinated with all building activities from foundation construction through final grading of the soil around the building's exterior. In order for the treatment to be effective, the final phase of the application must be done after final grading and sometimes after landscaping is completed so that the treated soil is not disturbed.

2.2 MATERIALS

2.2.1 Termiticides

Provide termiticides currently registered by the EPA or approved for such use by the appropriate agency of the host county and as approved by the Contracting Officer. Select non-repellant termiticides for maximum effectiveness and duration after application. Select a termiticide that is suitable for the soil and climatic conditions at the project site and apply at the highest labeled rate. Submit manufacturer's label and Safety Data Sheet (SDS) for termiticides proposed for use.

PART 3 EXECUTION

3.1 PREPARATION

Eliminate food sources by removing debris from clearing and grubbing and post construction wood scraps such as ground stakes, form boards, and scrap lumber from the site, before termiticide application begins.

3.1.1 Verification

Before work starts, verify that final grades are as indicated and smooth grading has been completed ~~in accordance with Section 31 00 00 EARTHWORK~~. Finely grade soil and remove particles larger than 1 inch. Compact soil particles to eliminate soil movement.

~~3.1.2 Foundation Exterior~~

~~If the exterior perimeter treatment is applied when the horizontal barrier is applied it will be damaged or removed before construction is completed. The exterior foundation perimeter treatment will have to occur in phases when any pads, porches, aprons, sidewalks, final grading or landscape planting are simultaneously involved adjacent to the building foundation. This treatment area should be coordinated after all major construction but before any pads, porches, or other items requiring special consideration are poured adjacent to the foundation walls. Submit written verification that final grading, landscape planting and other items adjacent to the foundation will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.~~

~~3.1.3 Utilities and Vents~~

~~Turn off and block HVAC ducts and vents located in treatment area prior to application, to protect people and animals from termiticide. Submit written verification that the HVAC ducts and vents, water and sewer lines, and plumbing have been turned off or blocked prior to applying termiticide.~~

~~3.1.4 Crawl and Plenum Air Spaces~~

~~Submit written verification that crawl and plenum air spaces have been located and identified prior to applying termiticide.~~

3.1.2 Application Plan

Prior to commencing application of termiticide, submit a Termiticide Application Plan addressing the following items:

a. proposed sequence of treatment work including dates and times of application
b. termiticide trade name
c. EPA registration number
d. chemical composition
e. concentration of original and diluted material
f. formulation
g. manufacturer's recommended application rates
h. regional requirements
i. application rate of active ingredients
j. method of application
k. area or volume to be treated
l. amount to be applied
m. copy of the pest control business license
n. copy of the pesticide applicator certificates

3.2 APPLICATION

For areas to be treated, establish complete and unbroken vertical and horizontal soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Make applications to crawl spaces in accordance with label directions. Applications to crawl space areas that are used as plenum air spaces will not be permitted.

3.2.1 Equipment Calibration and Tank Measurement

Submit a list of equipment to be used. Conduct calibration test on the application equipment to be used immediately prior to commencement of termiticide application. Measure the volume and contents of the application tank. Testing must confirm that the application equipment is operating within the manufacturer's specifications and meets the specified requirements. Submit written certification of the equipment calibration test results within 1 week of testing. Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

3.2.2 Mixing and Application

Perform all work related to formulating, mixing, and application in the presence of the Contracting Officer and a DOD certified pesticide applicator, Pest Management QAE/PAR, or Integrated Pest Management Coordinator. Submit mixing formulation:

a. Quantity of pesticide used.

b. Rate of dispersion.

c. Percent of use.

d. Total amount used.

A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Only use water from designated locations. Fit filling hoses with a backflow preventer meeting local plumbing codes or standards. Prevent overflow during the filling operation. Spill kits must be maintained on pest control vehicles and must be available at the mixing site. Termiticide mixing must be conducted in an area that has been designated by the Government representative and that has adequate spill containment. Inspect the application equipment for applying termiticides prior to each day of use for leaks, clogging, wear, or damage. Immediately perform repairs on the application equipment to prevent or eliminate leaks and clogging.

3.2.2.1 Application Method

[3.2.2.1.1 Surface Application

Use surface application for establishing horizontal barriers. Apply surface applicants as a coarse spray and provide uniform distribution over the soil surface. Termiticide must penetrate a minimum of 1 inch into the soil, or as recommended by the manufacturer. If soils are treated to a depth less than specified or approved, repeat work performed to the depth specified at no additional cost to the Government.

]3.2.2.1.2 Rodding and Trenching

Use rodding and trenching for establishing vertical soil barriers. Trenching must be to the depth of the foundation footing. Width of trench must be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Backfill the trench immediately after termiticide has reached maximum penetration as recommended by the manufacturer. If maximum penetration is not achieved, as recommended by the manufacturer, repeat work performed to maximum penetration as recommended by the manufacturer at no additional cost to the Government. Backfill in 6 inch rises or layers. Treat each rise or layer with termiticide.

]3.2.3 Sampling

The Contracting Officer may draw samples for analysis, at any time and without prior notice, from stocks at the job site to determine if the amount of active ingredient specified on the label is being applied. When analysis, performed by the Government, indicates samples contain less than the amount of active ingredient specified on the label, repeat work performed with pesticides conforming to this specification at no additional cost to the Government.

3.2.4 Vapor Barriers and Waterproof Membranes

Apply termiticide prior to placement of a vapor barrier or waterproof membrane.

3.2.5 Placement of Concrete

Place concrete covering treated soils as soon as the termiticide has reached maximum penetration into the soil as recommended by the manufacturer.

3.2.6 Clean Up, Disposal, And Protection

Once application has been completed, proceed with clean up and protection of the site without delay.

3.2.6.1 Clean Up

Clean the site of all material associated with the treatment measures, according to label instructions, and as indicated. Remove and dispose of excess and waste material off Government property.

3.2.6.2 Disposal of Termiticide

Dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

3.3 FIELD QUALITY CONTROL

3.3.1 Verification of Measurement

Once termiticide application has been completed, measure tank contents to determine the remaining volume. The total volume measurement of used contents for the application must equal the application rate established in the application plan. Submit written verification that the volume of termiticide used meets the application rate established in the application plan.

3.3.2 Inspection

3.3.2.1 Technical Representative

Provide a technical representative who is a DOD certified pesticide applicator or Pest Management Quality Assurance Evaluator (QAE)/Performance Assessment Representative (PAR). The technical representative must be present at all meetings concerning treatment measures for subterranean termites and during treatment application. Contact the Integrated Pest Management Coordinator prior to starting work.

3.4 CLOSEOUT ACTIVITIES

Upon completion of this work, submit the Pest Management Report DD Form 1532, or an equivalent computer product, to the Integrated Pest Management Coordinator. This form identifies the target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used.

3.5 PROTECTION

3.5.1 Protection of Treated Area

Immediately after the application, protect the area from other use by erecting barricades as required or directed. Provide signage ~~in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE. Place signage~~ inside the entrances to crawl spaces and identify the space as treated

with termiticide and not safe for children or animals. Cover treated areas with plastic if slab is not to be poured immediately following termiticide application.

3.5.2 Disturbance of Treated Soils

Re-treat soil and fill material disturbed after treatment before placement of slabs or other covering structures.

-- End of Section --

SECTION 31 62 50

DISPLACEMENT AGGREGATE PIERS
10/09

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 00 and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

Work shall consist of designing, furnishing and installing materials, and constructing a ground improvement system at the locations noted on the drawings and as specified herein. The ground improvement system shall be either vibro-displacement stone columns or displacement rammed aggregate piers. "Aggregate Piers" referenced in these specifications refer to both vibro-displacement stone columns and displacement rammed aggregate piers. The aggregate piers shall be constructed by either using a bottom-feed vibroflot, or driving and/or vibrating a hollow mandrel to the design depth and vertically ramming lifts of aggregate, placed with bottom-feed dry methods, using high-energy impact or vibratory densification equipment to create the compacted aggregate pier. The aggregate pier elements shall be in a columnar-type configuration and shall be used to produce an intermediate foundation system for support of foundation loads. Aggregate pier locations shall be predrilled, if necessary, to permit installation to the design depth.

1.3 SUMMARY

1.3.1 Work Included

Provision of all equipment, material, labor, and supervision to design and install the aggregate pier elements. Design shall rely on subsurface information presented on the Geotechnical Plan Sheets. The information on ground conditions shall be assessed to determine its suitability for the selected ground improvement system. The aggregate pier elements shall be fully-grouted if this is determined to be necessary by the Designer based on the available subsurface information. Layout of the aggregate pier elements, removal of spoils from the site (as required from any pre-drilling operations), removal of spoils off the working pad, footing excavation, and subgrade preparation following aggregate pier installation is not included. The aggregate pier design and installation shall adhere to all methods and standards described in this Specification.

1.3.2 Related Sections & Information

a. Section 03 30 00 CAST-IN-PLACE CONCRETE.
b. Section 31 23 00.00 20 EXCAVATION AND FILL.
c. Geotechnical Plan Sheets.

1.4 INSTALLER QUALIFICATIONS

Installers of aggregate pier foundation systems shall have a minimum of 5 years of experience with the installation of aggregate piers and shall

have completed at least 10 projects. Installers shall have demonstrated experience in the construction of similar size and types of projects in similar subsurface conditions.

1.5 REFERENCE STANDARDS

a. Design: The ground improvement Installer shall be responsible for design of an Aggregate Pier ground improvement system that meets the global stability, allowable bearing capacity, and settlement requirements stated in the Specifications. Industry recognized standards of design methods specific to the installer's equipment and construction methods shall be used.

b. Materials and Inspection:

ASTM INTERNATIONAL (ASTM)

ASTM D 1241	(2007) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

c. Modulus Testing:

ASTM INTERNATIONAL (ASTM)

ASTM D 1143/D 1143M	(2007e1) Piles Under Static Axial Compressive Load
ASTM D 1194	(1994)Standard Test Method for Bearing Capacity of Soil for Static Load and Spread Footings

d. Conflicts in Specifications/References: Where specifications and reference documents conflict, the Aggregate Pier Designer shall make the final determination of the applicable document.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications Documentation; G
Independent Geotechnical Engineering & Testing Agency Documentation; G
Professional Liability Insurance

The Aggregate Pier Designer shall have Errors and Omissions design insurance for the work. The insurance policy should provide a minimum coverage of $2 million per occurence.

SD-02 Shop Drawings

Design Calculations; G
Construction Drawings; G

The Installer shall submit detailed design calculations and construction drawings prepared by the Aggregate Pier Designer (referred to in this specification as "the Designer") at least three (3) weeks prior to the start of construction. All plans shall be stamped by a Professional Engineer currently licensed in the Commonwealth of Virginia.

SD-06 Test Reports

Aggregate Pier Modulus Test; G

A modulus test(s) will be performed on at least one non-production Aggregate Pier element as required by the Aggregate Pier Designer to verify the design assumptions. The Designer shall furnish the General Contractor and Contracting Officer a comprehensive report that includes a description of the installation equipment, installation records, complete test data, analysis of the test data and recommended design parameter values based on the modulus test results. The report shall be prepared and stamped by the Professional Engineer that designed the Aggregate Pier system.

Daily Aggregate Pier Progress Reports; G

The Installer shall furnish a complete and accurate record of each Aggregate Pier installation to the General Contractor and Contracting Officer on a daily basis. The record shall indicate the pier location, length, volume of aggregate used and number of lifts, densification forces during installation, and final elevations of the base and top of piers. The record shall also indicate the type and size of the densification equipment used, and type of aggregate used. The Installer shall immediately report any unusual conditions encountered during installation to the General Contractor, to the Designer, the Contracting Officer, and to the Testing Agency.

Crowd Stabilization Testing; G

IGETA Inspection Summary Report; G

1.7 AGGREGATE PIER DESIGN REQUIREMENTS

The design of the Aggregate Pier system shall be based on the service load bearing pressure and the allowable total and differential settlement criteria of all footings indicated on the structural plans for support by the Aggregate Pier system. The Aggregate Pier system shall be designed in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design life of the structure shall be 50 years. The design shall demonstrate by calculation that the spacing and layout fulfills the requirements for maximum allowable bearing capacity and total and differential settlement criteria.

1.7.1 Design Criteria

The design shall meet the following criteria:

a. Maximum Allowable Bearing Pressure for Aggregate Pier Reinforced Soils: ~~2,500~~3000 psf.

b. Estimated Total Long-Term Settlement for Footings: Less than or equal to 1-inch.

c. Estimated Long-Term Differential Settlement of Adjacent Footings: ~~Less than or equal to 1/2-inch~~Angular distortion of 1/500.

d. ~~All Aggregate Piers shall extend at least into the Stratum 5 soil layer and possibly the Stratum 6 soil layer (as identified on Plan Sheet B-107) as determined by the Designer~~Aggregate piers should extend a minimum of 17 feet to 25 feet below the bearing elevations of support foundation elements as determined by the Specialty Contractor.

e. Aggregate Pier design analysis shall consider adjacent footing stress influence and supporting calculations shall be provided.

f. Aggregate Pier design analysis shall consider stresses imposed by new fill placed in the building area and adjacent to the building area.

1.7.2 Aggregate Pier Elements

The Aggregate Pier elements shall be designed using an Aggregate Pier stiffness modulus to be verified by the results of the modulus test(s) described in the Aggregate Pier Modulus Test paragraph of these specifications. The Aggregate Pier system shall be designed to preclude plastic bulging deformations at the top-of–pier design stress and to preclude significant tip stresses as determined from the shape of the telltale test curve from telltales installed in modulus test piers.

1.7.3 Aggregate Pier Installation and Location Drawings

All drawings shall be signed and stamped by the Designer and shall include the following information:

a. Aggregate pier numbering.

b. Dimensioned aggregate pier locations relative to building column grid as defined in contract drawings. Include layout of piers beneath all designated footings. This information shall be shown on the project foundation plan sheet(s).

c. Length of Aggregate Piers.

d. Aggregate Pier diameter.

e. Aggregate Pier design load (compression and tension).

f. Identification of any uplift Aggregate Piers.

1.7.4 Aggregate Pier Design Submittal

The installer shall submit eight (8) sets of detailed Design Calculations, Construction Drawings for approval at least three (3) weeks prior to the beginning of construction. A detailed explanation of the design

parameters for settlement calculations shall be included in the Design Submittal. Additionally, a quality control test program for Aggregate Pier system, meeting these design requirements, shall be submitted. Material certifications and calibrations for all test and monitoring equipment shall be furnished with the submittal. The certifications and calibrations shall be completed within six (6) months of executing the work. All computer-generated calculations and drawings shall be prepared and stamped by a Professional Engineer currently licensed in the Commonwealth of Virginia.

1.8 BASIS OF PAYMENT

This work will be paid for on a lump sum basis and shall be included in the general contractor's base bid.

1.9 QUALITY ASSURANCE

1.9.1 Installer Qualifications Documentation

Documentation shall be provided that the Aggregate Pier installer has qualifications that meet or exceed the requirements of Part 1.4 of this Specification.

1.9.2 Independent Geotechnical Engineering & Testing Agency Documentation

The General Contractor is responsible for retaining an independent geotechnical engineering and testing agency (IGETA) to provide Quality Assurance services. The IGETA shall meet the accreditation requirements and comply with the testing and reporting requirements of Specification Section 01 45 00.00 20, Part 1.13.

1.9.3 Responsibilities of Geotechnical Engineering & Testing Agency

a. The IGETA shall monitor the modulus test pier(s) installation and testing. The Installer shall provide and install all necessary dial indicators, load cells, and other measuring devices. The Aggregate Pier Designer is responsible for directing and supervising the modulus test.

b. The IGETA shall monitor the installation of aggregate pier elements to verify that the production installation practices are similar to those used during the installation of the modulus test elements.

c. The IGETA shall report any discrepancies to the Installer and General Contractor and Contracting Officer immediately.

d. The IGETA shall observe the excavation of the foundations, compaction, and placement of the foundations in accordance with the requirements of this Specification. Dynamic Cone Penetration testing may be performed to evaluate the footing bottom condition as determined by the IGETA.

1.9.4 Preconstruction Meeting

A preconstruction meeting shall be held at the jobsite at least 5 business days prior to the start of Aggregate Pier installation operations on the project. The preconstruction meeting shall be arranged by the Contractor. The purpose of this meeting is to review the requirements of this specification, Aggregate Pier design details, and the Aggregate Pier

system quality control test program developed by the Designer. The following individuals as a minimum will be in attendance this meeting: Contractor's Project Manager and Project Superintendent, Aggregate Pier Designer, Aggregate Pier Installer's Project Manager and Site Foreman, Contractor's IGETA, NAVFAC MIDLANT Geotechnical and Civil Engineers, NAVFAC MIDLANT Construction Manager and Engineering Technician(s). The minutes of this meeeting shall be recorded by the Contractor and published via email within 48 hours to all attendees. The minutes shall be re-published within 48 hours via email pending any subsequent comments from the attendees.

PART 2 PRODUCTS

2.1 MATERIALS

a. Aggregate used for the piers shall meet the requirements of ASTM D 1241 Type II, except that there shall be no particles passing the No. 40 sieve. Alternatively, No. 57 crushed stone or other open-graded crushed stone as selected by the Aggregate Pier designer and used successfully in the modulus test may be used.

b. Materials shall be selcted to remain stable during construction and throughout the service life of structure in the anticipated soil and ground water conditions. The aggregate pier elements shall be fully-grouted if this is determined to be necessary by the Designer based on the available subsurface information.

c. General Contractor to coordinate adequate and suitable marshalling areas on the project site for the storage of aggregate and equipment.

d. Potable water or other suitable source shall be used to increase aggregate moisture content where required. The General Contractor shall provide the Installer access to such water onsite.

PART 3 EXECUTION

3.1 APPROVED INSTALLATION PROCEDURES

The following sections provide general criteria for the construction of Aggregate Pier elements. Unless otherwise approved by the Designer, the installation method used for Aggregate Pier construction shall be that as used in the construction of the successful modulus test.

3.1.1 Displacement Rammed Aggregate Pier Systems

a. Displacement Rammed Aggregate Pier Systems shall be constructed by advancing a specially designed mandrel with a minimum 15 ton static force augmented by dynamic vertical ramming energy to the full design depth. The hollow-shaft mandrel, filled with aggregate, is incrementally raised, permitting the aggregate to be released into the cavity, and then lowered by vertically advancing and/or ramming to densify the aggregate and force it laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated to the top of pier elevation. The cycle and distance shall be determined by the Rammed Aggregate Pier Designer.

b. Special high-energy impact densification apparatus shall be employed to vertically densify the Rammed Aggregate Pier elements during installation of each constructed lift of aggregate.

c. Densification shall be performed using a mandrel/tamper. The mandrel/tamper foot is required to adequately increase the lateral earth pressure in the matrix soil during installation.

d. Downward crowd pressure shall be applied to the mandrel during installation.

e. The volume of aggregate flow shall be periodically checked throughout installation to verify volume of aggregate is consistent with the modulus test pier volume.

f. At the completion of the pier installation, the hammer shall be turned off and the mandrel pushed downward applying crowd pressure on the top of the pier to provide preloading.

3.1.2 Vibro-displacement Stone Columns

a. The stone column installation equipment shall use the bottom feed vibratory method. Only the construction methods that install stone columns by: (a) displacing the materials to be treated by vibratory means and (b) delivering crushed stone backfill material for the column to the bottom of the pipe or probe using a “dry” tremie system are acceptable. The top feed system, wet methods, vibro-rod compaction systems, and rotary displacement systems for constructing stone columns are not acceptable.

b. Install stone columns with a down-hole vibrator capable of densifying the aggregate by forcing it radially into the surrounding soil. The vibrator shall be of sufficient size and capacity to construct stone columns to the diameters and lengths shown on the Designer’s approved construction drawings.

c. The probe and follower tubes shall be of sufficient length to reach the elevations shown on the Designer’s approved construction drawings. The probe, used in combination with the available air pressure to the tip jet, shall be capable of penetration to the required tip elevation. Predrilling shall be permitted if it is specified in the Designer’s approved construction procedure submittal.

d. The probe and follower shall have visible markings at regular increments to enable measurement of penetration and repenetration depths.

e. Provide methods for supplying to the tip of the probe a sufficient quality of air to widen the probe hole to allow adequate space for stone backfill placement around the probe.

f. The probe shall penetrate into the foundation soil layer to the minimum depths required in the Designer’s construction plans.

g. Lift thickness shall not exceed 4 feet. After penetration to the treatment depth, slowly retrieve the vibrator in 12-inch to 18-inch increments to allow backfill placement.

h. Compact the backfill in each lift by repenetrating it at least twice with the vibrating probe to densify and force the stone into the surrounding soil.

i. Install stone columns so that each completed column is continuous throughout its length.

3.2 PLAN LOCATION AND ELEVATION OF AGGREGATE PIER ELEMENTS

The as-built center of each pier shall be within six (6) inches of the plan locations indicated. The final measurement of the top of piers shall be the lowest point on the aggregate in the last compacted lift. Piers installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Government.

3.3 REJECTED AGGREGATE PIER ELEMENTS

Aggregate pier elements improperly located or installed beyond the maximum allowable tolerances shall be abandoned and replaced with new piers, unless the Designer approves other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Government, unless the cause of the rejection is due to an obstruction.

3.4 QUALITY CONTROL

3.4.1 Quality Control Representative

a. The Installer shall have a full-time Quality Control (QC) representative onsite to verify and report all QC installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Design Engineer, the General Contractor, Contracting Office, and to the IGETA. The QC procedures shall include the preparation of Daily Aggregate Pier Progress Reports completed during each day of installation and containing the following information:

1. Footing and Aggregate Pier location.

2. Aggregate Pier length and drilled diameter.

3. Planned and actual Aggregate Pier elevations at the top and bottom of the element.

4. Average lift thickness for each Aggregate Pier.

5. Soil types encountered at the bottom of the Aggregate Pier and along the length of the element.

6. Depth to groundwater, if encountered.

7. Documentation of any unusual conditions encountered.

8. Type and size of densification equipment used.

3.4.2 Quality Control Verification Program

a. The Designer shall be responsible for design of a verification program to assure the quality of the construction. The program shall verify that the installed ground improvement system satisfies the performance requirements noted on the contract plans and the design requirements determined by the ground improvement system Designer. As a minimum, the verification program shall include the following:

1. Program to monitor performance of the ground improvement system during and after construction of the proposed structure. This program may include installation of settlement plates, monitoring points, inclinometers, piezometers, or other instrumentation.

2. Stone column installation shall be monitored by an on board computer monitoring system. Monitoring system shall log stone column number, time of installation, depth, hydraulic pressure applied during the boring process and during the compacting process. Recorded data for each stone column shall be plotted depth/pressure versus time. Installation records for each shall be made available upon request in electronic format within 24 hours of installation.

3. Proposed means and methods for verification that the installed aggregate piers meet the strength and/or stiffness criteria required by the design. This may include, but shall not be limited to modulus or load testes on individual elements and/or groups, soil borings, and other methods as approved by the Design Engineer.

4. Quality control program to verify that the ground improvement system is installed in accordance with the Designer's specifications and the requirements in this special provision. The quality control program shall include testing and observations by qualified personnel employed by the ground improvement installer or and IGETA.

3.4.3 Aggregate Pier Modulus Test

As required by the Designer, at least one Aggregate Pier Modulus Test will be performed at location(s) directed by the Designer to verify or modify Aggregate Pier design. Modulus Test procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194, as outlined in the Aggregate Pier design submittal.

~~3.4.4 Crowd Stabilization Testing~~

~~Bottom Stabilization Testing and/or Crowd Stabilization Testing shall be performed by the Control Technician during the installation of the Modulus Test Pier as directed by the Designer. Additional testing as required by the Aggregate Pier Designer shall be performed on selected production Aggregate Pier elements to compare results with the Modulus Test Pier.~~

3.5 RESPONSIBILITIES OF GENERAL CONTRACTOR

3.5.1 Site Preparation and Protection and Survey Layout

a. The General Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the Aggregate Pier elements.

b. Site grades for Aggregate Pier installation shall be at least one (1) foot above bottom of footing elevation, or as otherwise agreed to by the Designer and Installer to minimize Aggregate Pier installation depths. Ground elevations and bottom of footing elevations shall be provided to the Aggregate Pier Installer in sufficient detail to estimate installation depth elevations within three (3) inches.

c. The General Contractor will provide site access to the Installer, after earthwork in the area has been completed. A working surface shall be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the Aggregate Pier installation.

d. The General Contractor shall be provided copies of all reports prepared by the IGETA for proofrolling and compaction testing to verify the suitability of subgrade and proper compaction of any building pad fill placed a minimum of one (1) week before initiation of the Aggregate Pier installation.

e. The General Contractor shall be responsible for the layout and location of the Aggregate Pier supported foundations for this project, including layout of individual Aggregate Piers. These piers shall be makred in the field using survey stakes or similar means at locations shown on the drawings.

f. Prior to, during, and following Aggregate Pier installation, the General Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.

g. If spoils are generated by Aggregate Pier installation, the General Contractor shall remove the spoils from the Aggregate Pier work area in a timely manner to prevent interruption of Aggregate Pier installation. Also, the General Contractor shall be responsible for disposal of surplus spoil materials in accordance with Section 31 23 00.00 20.

3.5.2 Excavation of Obstructions

Should any obstruction be encountered during Aggregate Pier installation, the General Contractor shall be responsible for promptly removing such obstruction, or the pier will be relocated or abandonded. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., which prevent placing the piers to the required depth, of cause the pier to drift from the required location.

3.5.3 Utility Excavations

The General Contractor shall coordinate all excavations made subsequent to Aggregate Pier installations so that at least five (5) feet of horizontal distance remains between the edge of any installed Aggregate Pier and the excavation. In the event that utility excavations are required at horizontal distances of less than five (5)feet from installed Aggregate Piers, the General Contractor shall notify the Aggregate Pier Designer to develop construction solutions to minimize impacts on the installed Aggregate Piers.

3.5.4 Footing Bottoms

a. Excavation and surface compaction of all footings shall be the responsibility of the General Contractor.

b. Foundation excavations to expose the tops of Aggregate Pier elements shall be made in a workman like manner, and shall be protected until concrete placement, with procedures and equipment best suited to (1) avoid exposure to standing water, (2) prevent softening of the matrix

soil between and around the Aggregate Pier elements before placing structural concrete, and (3) achieving direct and firm contact between the dense, undisturbed Aggregate Pier elements and the concrete footing.

c. All excavations for footing bottoms supported by Aggregate Pier foundations shall be prepared in the following manner by the General Contractor. Recommended procedures for achieving these goals are to:

1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment).

2. Compaction of surface soil and top of Rammed Aggregate Pier elements shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar). Sled-type tamping devices shall only be used in granular soils and when approved by the designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the aggregate pier shall be recompacted prior to completing footing bottom preparation.

3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation. A lean concrete mud-mat may be used to accomplish this. Other methods must be pre-approved by the Designer.

d. The following criteria shall apply, and a written inspection report stamped by the project Geotechnical Engineer from the IGETA IGETA Inspection Summary Report shall be furnished to the Installer and Designer and Contracting Officer to confirm:

1. That water (which may soften the unconfined matrix soil between and around the Aggregate Pier elements, and may have detrimental effects on the supporting capability of the Aggregate Pier reinforced subgrade) has not been allowed to pond in the footing excavation at any time.

2. That all Aggregate Pier elements designed for each footing have been exposed in the footing excavation.

3. That immediately before footing construction, the tops of all Aggregate Pier elements exposed in each footing excavation have been inspected and recompacted as necessary with mechanical compaction equipment, and that the tops of any Aggregate Pier elements which may have been disturbed by footing excavation and related activity have been recompacted to a dry density equivalent to at least 95 percent of the maximum dry density obtainable by the modified Proctor method ASTM D 1557.

4. That no excavations or drill shafts (elevator, etc) have been made after installation of Aggregate Pier elements within horizontal distance of five feet from the edge of any pier, without the written approval of the Installer of Designer.

e. Failure to provide the above inspection and certification by the

IGETA, which is beyond the responsibility of the Aggregate Pier Installer and Designer, may void any written or implied warranty on the performance of the Aggregate Pier system.

-- End of Section --

SECTION 32 05 33

LANDSCAPE ESTABLISHMENT
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA Z133	(2017) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

1.2 DEFINITIONS

1.2.1 Pesticide

Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and are specifically labeled for use by the U.S. Environmental Protection Agency (EPA). Also, any substance used as a plant regulator, defoliant, disinfectant, or biocide. Examples of pesticides include fumigants, herbicides, insecticides, fungicides, nematicides, molluscicides and rodenticides.

1.2.2 Stand of Turf

~~[100][~~95~~]~~ percent ground cover of the established species.

1.2.3 Planter Beds

A planter bed is defined as an area containing one or a combination of the following plant types: shrubs~~, vines, wildflowers, annuals, perennials, ground cover, [and a mulch topdressing] excluding turf. Trees may also be found in planter beds.~~

1.3 RELATED REQUIREMENTS

~~[~~ ~~Section 32 84 24 IRRIGATION SPRINKLER SYSTEM applies to this section for installation of irrigation equipment requirements, with additions and modifications herein.~~

~~]~~ ~~[Section 32 92 19 SEEDING][Section 32 92 23 SODDING][Section 32 92 26 SPRIGGING] applies to this section for installation of [seed][sod][sprigging] requirements, with additions and modifications herein.~~

~~[~~ Section 32 93 00 EXTERIOR PLANTS applies to this section for installation of ~~[~~trees,~~]~~ ~~[~~shrubs,~~]~~ ~~[ground cover,] [vines,] and [wildflower,]~~ with additions and modifications herein.

~~][Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS applies to this section for transplanting of [trees,] [shrubs,] [ground cover,] [vines,] and [wildflower,] with additions and modifications herein.~~

~~]~~1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are ~~[~~for Contractor Quality Control approval.~~][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Integrated Pest Management Plan; ~~G~~

SD-03 Product Data

Fertilizer; G

Mulches ~~Topdressing~~

Organic Mulch Materials

SD-07 Certificates

Maintenance Inspection Report

~~[~~ Plant Quantities; ~~G~~

~~]~~ SD-11 Closeout Submittals

~~Tree Staking and Guying Removal~~

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Delivery

Deliver fertilizer, ~~[~~gypsum,~~]~~ ~~[~~iron~~]~~ to the site in original containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, ~~[~~gypsum~~]~~ may be furnished in bulk with a certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Fertilizer, ~~[~~Lime~~e]~~, ~~[~~Iron,~~]~~ ~~[~~Mulch~~]~~ Storage

Store material in designated areas. Store ~~[~~lime and~~]~~ fertilizer in cool, dry locations away from contaminants.

1.5.2.2 Antidesiccant's Storage

Do not store with fertilizers or other landscape maintenance materials.

1.5.3 Handling

Do not drop or dump materials from vehicles.

PART 2 PRODUCTS

2.1 POST-PLANT FERTILIZER

2.1.1 Granular Fertilizer

Organic, granular controlled release fertilizer shall contain~~ing~~ the ~~following~~ minimum percentages, by weight, of plant food nutrients~~:~~ as indicated in the lab soil analysis recommendations.

~~[_____] percent available nitrogen~~
~~[_____] percent available phosphorus~~
~~[_____] percent available potassium~~
~~[_____] percent sulfur~~
~~[[_____] percent iron~~

~~]~~2.2 WATER

Source of water must be approved by the Contracting Officer, and be of suitable quality for irrigation.

2.3 MULCHES TOPDRESSING

Free from noxious weeds, mold, or other deleterious materials.

~~2.3.1 Inert Mulch Materials~~

~~Provide [recycled] [stone,] [riverbank stone,] [crushed pit-run rock,] [granite chips,] [_____,] [or other recycled material] complying with ASTM D6155, ranging in size from [_____] to [_____] inches.[Provide materials from site and construction waste to the greatest extent possible.]~~

2.3.1 Organic Mulch Materials

Provide ~~[wood cellulose fiber,] [wood chips,] [~~shredded hardwood,~~]~~ ~~[shredded redwood bark,] [pine straw mulch,] [pine needles,] or [recycled] [_____]~~ from site when available. ~~Wood cellulose fiber must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch must contain a minimum of 100 percent post-consumer recycled content. Wood-based hydraulic mulch must contain a minimum of 100 percent total recovered materials content.~~

~~2.3.2 Recycled Organic Mulch~~

~~Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 by 2-1/2 inch screen. Clean recycled mulch of all sticks a minimum one inch in diameter and plastic materials a minimum 3 inch length. The material must be treated to retard the growth of mold and fungi.~~

2.4 PESTICIDES

Pesticides and herbicides are not permitted. [Use black sheet polyethylene conforming to ASTM D2103, minimum thickness 5/32 inch.]Submit an Integrated Pest Management Plan, including [weed and pest management strategies] [proposed alternatives to herbicides and pesticides]. Use biological pest controls as approved in the Plan.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide landscape construction maintenance to include [irrigation equipment cleaning and adjustments,] [mowing,] [edging,] [overseeding,] [aeration,] [fertilizing,] [watering,] [weeding and,] [pruning,] [stake and guy adjusting,] [and] [_____] for all [newly installed] [renovated] landscape areas [and existing plant material], unless indicated otherwise, and at all areas inside or outside the limits of the construction that are disturbed by the Contractor's operations.

[3.1.1 Policing

Police all landscaped areas. Policing includes removal of leaves, branches and limbs regardless of length or diameter, dead vegetation, paper, trash, cigarette butts, garbage, rocks or other debris. [Policing must extend to both sides of fencing or walls.] Collected debris must be promptly removed and disposed of at an approved disposal site.

][3.1.2 Drainage System Maintenance

Remove all obstructions from surface and subsurface drain lines to allow water to flow unrestricted in [swales,] [gutters,] [catch basins,] [storm drain curb inlets,] [and] [yard drains]. Remove grates and clear debris in catch basins. Open drainage channels are to be maintained free of all debris and vegetation at all times. Edges of these channels must be clear of any encroachment by vegetation.

][3.2 IRRIGATION ESTABLISHMENT PERIOD

The irrigation establishment period will commence on the date that inspection by the Contracting Officer shows that the [new] [repaired] irrigation equipment furnished under this contract have been satisfactorily installed and is functional and must continue for a period of [365] [_____] days.

3.2.1 Maintenance During the Irrigation Establishment Period

Begin maintenance immediately after irrigation equipment has been installed and is functional. Inspect irrigation equipment at least [once a week][_____] during the installation and establishment period and perform needed maintenance promptly. Automatic controllers not equipped with rain shut-off sensors must be turned off during periods of rain that exceed twelve hours of continuous rainfall in one day or during rain storms of one day or more. Once the rain has subsided timers must be reactivated. Irrigation controllers must be inspected and reprogrammed after power outages. Contractor must be responsible for winterization and startup. Sprinkler heads must direct water away from buildings and hard surfaced areas.

~~3.2.2 Water Restrictions~~

~~aabide by state, local or other water conservation regulations in force during the establishment period. Automatic controller must be adjusted to comply with the water conservation regulations schedule.~~

~~3.2.3 Fire Hydrants~~

~~To use a fire hydrant for irrigation, obtain prior clearance from the Contracting Officer and provide the tools and connections approved for use on fire hydrants. If a fire hydrant is used, Provide a reduced pressure backflow preventer for each connection between hose and fire hydrant. Backflow preventer used must be tested once per month by a certified backflow preventer tester.~~

~~3.2.4 Final Acceptance~~

~~[Upon completion of the irrigation establishment period and final acceptance of groundcover and exterior plants, irrigation equipment must be removed.][Operation and coverage test is acceptable if system operates through at least one complete cycle for areas to be irrigated and all leaks or repairs have been completed.]~~

~~3.2.5 Controller Charts~~

~~Provide one chart for each controller supplied. Indicate in chart area controlled by the automatic controller. The chart is a reduction of the actual plan[s] that will fit the maximum dimensions inside the controller housing. Use a black line print for the chart and a different pastel or transparent color to indicate each station zone of coverage. After chart is completed and approved for final acceptance, seal chart between two 20 mil pieces of clear plastic.~~

~~]~~3.2 GROUNDCOVER ESTABLISHMENT PERIOD

Groundcover establishment period will commence on the date that inspection by the Contracting Officer shows that the ~~[~~new~~]~~ ~~[renovated]~~ turf furnished under this contract has been satisfactorily installed to a ~~[_____][95 percent]~~[100 percent~~]~~ stand of coverage. The establishment period must continue for a period of ~~[~~365~~]~~ ~~[_____]~~ days.

3.2.1 Frequency of Maintenance

Begin maintenance immediately after turf has been ~~[~~installed~~]~~ ~~[fully renovated]~~. Inspect area~~[s]~~ ~~[~~once a week~~][_____]~~ during the installation and establishment period and perform needed maintenance promptly.

3.2.2 Promotion of Growth

Maintain groundcover in a manner that promotes proper health, growth, natural color. Turf must have a neat uniform manicured appearance, free of bare areas, ruts, holes, weeds, pests, dead vegetation, debris, and unwanted vegetation that present an unsightly appearance. Mow, remove excess clippings, eradicate weeds, water, fertilize, ~~[~~overseed,~~]~~ ~~[~~aerate,~~]~~ ~~[~~topdress~~]~~ and perform other operations necessary to promote growth, as approved by Contracting Officer and consistent with approved Integrated Pest Management Plan. Remove noxious weeds common to the area from planting areas by mechanical means.

3.2.3 Mowing

3.2.3.1 Turf

Mow turf at a uniform finished height. Mow turfed area~~[s]~~ to a minimum average height of ~~[3][~~4~~][_____]~~ inches when average height of grass becomes 6~~[_____]~~ inches for spring/summer maintenance and to a minimum average height of ~~[3][~~4~~][_____]~~ inches when the average height of grass reaches 6~~[_____]~~ inches for fall and winter~~[winter]~~ maintenance. The height of turf is measured from the soil. Perform mowing of turf in a manner that prevents scalping, rutting, bruising, uneven and rough cutting. Prior to mowing, all rubbish, debris, trash, leaves, rocks, paper, and limbs or branches on a turf area must be picked up and disposed. Adjacent paved areas must be swept/vacuumed clean.

~~3.2.3.2 Native Grasses~~

~~[Mow above height of native grass seedlings (approximately 3.5 to 4 inches). Mow during spring or early summer. Do not mow after early summer during the second growing season.~~

~~]3.2.3.3 Wildflowers~~

~~[Mow three times per season above height of the wildflowers (approximately 12 to 15 inches).~~

~~]~~3.2.4 Turf Edging and Trimming

Perimeter of planter bed edges, sidewalks, driveways, curbs, and other paved surfaces must be edged. Uniformly edge these areas to prevent encroachment of vegetation onto paved surfaces and to provide a clear cut division line between planter beds, turf, and ground cover. Edging is to be accomplished in a manner that prevents scalping, rutting, bruising, uneven and rough cutting. Perform edging on the same day that turf is mowed. Use of string line trimmers is permitted in "soft" areas such as an edge between turfgrass and a planter bed. Exercise care to avoid damage to any plant materials, structures, and other landscape features.

Trimming around ~~[~~trees,~~]~~ ~~[~~fences,~~]~~ ~~[~~poles,~~]~~ ~~[~~walls,~~]~~ ~~[irrigation valve boxes]~~ and other similar objects is to be accomplished to match the height and appearance of surrounding mowed turf growth. Trimming must be performed on the same day the turf's mowed. Care must be exercised to avoid "Girdling" trees located in turf areas. The use of protective tree collars on trees in turf areas may be utilized as a temporary means to avoid injury to tree trunks. At the end of the plant establishment period Contractor will be responsible for removing all protective tree collars.

3.2.5 Post-Fertilizer Application

Apply turf fertilizer in a manner that promotes health, growth, vigor, color and appearance of cultivated turf areas. The method of application, fertilizer type and frequencies must be determined by the laboratory soil analysis results the requirements of the particular turf species.~~[~~ Organic fertilizer must be used. In the event that organic fertilizer is not producing the desired effect, the Contractor must contract the Contracting Officer for approval prior to the use of a synthetic type of fertilizer.~~]~~ Apply fertilizer by approved methods in accordance with the manufacturer's recommendations.

3.2.6 Turf Watering

Perform irrigation in a manner that promotes the health, growth, color and appearance of cultivated vegetation and that complies with all Federal, State, and local water agencies and authorities directives. The Contractor must be responsible to prevent over watering, water run-off, erosion, and ponding due to excessive quantities or rate of application. Abide by state, local or other water conservation regulations or restrictions in force during the establishment period.~~[Adjust irrigation controllers to comply with the water conservation regulations schedule]~~.

~~[~~3.2.7 Turf Aeration

Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas by approved device. Core, by pulling soil plugs, to a minimum depth of 3~~[_____]~~ inches. Leave all soil plugs that are produced in the turf area.~~[~~ After aeration operations are complete, topdress entire area ~~[~~1/4~~]~~ ~~[1/2]~~ inch depth with the ~~following~~ mixture as indicated in the soils test~~:~~

~~[[_____] percent sand~~
~~][[_____] percent humus~~
~~][[_____] percent gypsum~~
~~][[_____] percent lime~~

~~]~~ Blend all parts of topdressing mixture to a uniform consistency throughout. ~~]~~ Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete. ~~This work must commence [_____] days prior final acceptance of the maintenance establishment period.~~

~~]][~~3.2.8 Turf Clearance Area

Trees located in turf areas must be maintained with a growth free clearance of ~~[~~18 inches~~]~~[_____] from the tree trunk base. The use of mechanical weed whips to accomplish the turf growth free bed area is prohibited.

~~]~~3.2.9 Replanting

Replant in accordance with ~~[Section 32 92 19 SEEDING]~~[Section 32 92 23 SODDING~~]~~[~~Section 32 92 26 SPRIGGING]~~ and within specified planting dates areas which do not have a satisfactory stand of turf.

3.2.10 Final Inspection and Acceptance

Final inspection will be make upon written request from the Contractor at least 10 days prior to the last day of the turf establishment period. Final turf acceptance will be based upon a satisfactory stand of turf.

3.3 EXTERIOR PLANT ESTABLISHMENT PERIOD

The exterior plant establishment period will commence on the date that inspection by the Contractor Officer shows that the ~~[~~new plants ~~][transplanted plants]~~ furnished under this contract ~~[has]~~[have~~]~~ been satisfactorily installed and must continue for a period of ~~[~~365~~]~~ ~~[_____]~~ days.

3.3.1 Frequency of Maintenance

Begin maintenance immediately after plants have been installed. Inspect exterior plants at least ~~[~~once a week~~][_____]~~ during the installation and establishment period and perform needed maintenance promptly.

3.3.2 Promotion of Plant Growth and Vigor

Water, prune, fertilize, mulch, adjust stakes, ~~guys and turnbuckles,~~ eradicate weeds and perform other operations necessary to promote plant growth, and vigor.

3.3.3 Planter Bed Maintenance

Planter beds must be weeded, fertilized, irrigated, kept pest free, turf free, pruned, and mulch levels maintained. ~~Planter beds will not be allowed to encroach into turf areas. A definite break must be maintained between turf areas and planter beds.~~

~~3.3.3.1 Shrub Selective Maintenance~~

~~In addition to the above requirements, shrubs must be selectively pruned, and shaped for health and safety when the following conditions exist: Remove growth in front of windows, over entrance ways or walks, and any growth which will obstruct vision at street intersections or of security personnel; Remove dead, damaged or diseased branches or limbs; where shrub growth obstructs pedestrian walkways; where shrub growth is found growing against or over structures; where shrub growth permits concealment of unauthorized persons. Dispose of all pruning debris in a proper manner.~~

3.3.3.1 Tree Maintenance

Tree maintenance must include adjustment of stakes, ties~~, guy supports [and turnbuckles]~~, watering, fertilizing, pest control, mulching, pruning for health and safety ~~[~~and fall leaf cleanup~~]~~. Inspect and adjust stakes, ties~~, guy supports [and turnbuckles]~~ to avoid girdling and promote natural development. All trees within the project boundaries, regardless of caliper, must be selectively pruned for safety and health reasons. These include but are not limited to removal of dead and broken branches and correction of structural defects. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced. Pruning of all trees ~~including palm trees~~ must be accomplished by or in the presence of a certified member of the International Society of Arboriculture and in accordance with TCIA Z133. All pruning debris generated must be disposed of in a proper manner.

~~[~~3.3.4 Slope Erosion Control Maintenance

Provide slope erosion control maintenance to prevent undermining of all slopes in ~~[~~newly landscaped~~]~~ ~~[and] [natural growth areas]~~. Maintenance tasks include immediate repairs to weak spots in sloped areas, ~~[and] [~~ maintaining clean, clear ~~[~~culverts,~~]~~ and graded ~~[~~berms,~~]~~ ~~[and] [terraces]~~ to intercept and direct water flow to prevent development of large gullies and slope erosion~~]~~ ~~[~~and~~]~~ ~~[~~during periods of extended rainfall, irrigation systems must be secured.~~]~~ Eroded areas must be filled with amended topsoil and replanted with the same plant species. ~~[~~Erosion control ~~[~~ netting~~]~~ ~~[blankets]~~ damaged due to slope erosion must be reinstalled.~~]~~

~~]~~3.3.5 Removal of Dying or Dead Plants

Remove dead and dying plants and provide new plants immediately upon commencement of the specified planting season, and replace ~~[~~stakes,~~]~~ ~~[guys,]~~ mulch and eroded earth mound water basins. Provide an additional 90 day establishment period for replacement plants beyond the original warranty period. A tree must be considered dying or dead when the main leader has died back, or a minimum of 20 percent of the crown has died. A shrub or ground cover must be considered dying or dead when a minimum of 20 percent of the plant has died. This condition must be determined by scraping on a branch an area 1/16 inch square, maximum, to determine the cause for dying plant material and must provide recommendations for replacement. The Contractor must determine the cause for dying plant material and provide recommendations for replacement.

3.3.6 Tracking of Unhealthy Plants

Note plants not in healthy growing condition, as determined by the Contracting Officer, and as soon as seasonal conditions permit, remove and replace with plants of the same species and sizes as originally specified. Install replacement plantings in accordance with Section 32 93 00 EXTERIOR PLANTS.

3.3.7 Final Inspection

Final inspection will be made upon written request from the Contractor at least 10 days prior to the last day of the establishment period. Final inspection will be based upon satisfactory health and growth of plants and on the following:

3.3.7.1 Total Plants on Site

Plants have been accepted and required number of replacements have been installed.

3.3.7.2 Mulching and Weeding

Planter beds and earth mound water basins are properly mulched and free of weeds.

~~[3.3.7.3 Tree Supports~~

~~[Stakes] [guys] guys and turnbuckles are in good condition.~~

~~]~~3.3.7.3 Remedial Work

Remedial measures directed by the Contracting Officer to ensure plant material survival and promote healthy growth have been completed.

3.4 FIELD QUALITY CONTROL

3.4.1 Maintenance Inspection Report

Provide maintenance inspection report to assure that landscape maintenance is being performed in accordance with the specifications and in the best interest of plant growth and survivability. Site observations must be documented at the start of the establishment period, then quarterly following the start, and at the end of establishment period. Submit results of site observation visits to the Contracting Officer within 7

calendar days of each site observation visit.

~~[3.4.2 Plant Quantities~~

~~Provide Contracting Officer with the number of plant quantities. In addition, provide total exterior area of hardscape and landscaping such as turf and total number of shrubs.~~

~~]3.4.3 Tree Staking and Guying Removal~~

~~Provide a certified letter that all stakes and guys are removed from all project trees at the end of the establishment period.~~

-- End of Section --

SECTION 32 31 19

DECORATIVE METAL FENCES AND GATES
02/21

PART 1 GENERAL

~~1.1 UNIT PRICES~~

~~Enter text here.~~

~~1.2 REFERENCES~~

~~The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.~~

~~NAME (ACRONYM)~~

~~IDENTIFIER (Date) Title~~

1.1 DEFINITIONS

~~Enter text here~~Only use this paragraph to define terms used in the specification section that are not defined by a commercial or Government standard and to provide a common interpretation of a term for contractual purposes.

~~1.2 ADMINISTRATIVE REQUIREMENTS~~

~~1.2.1 Pre-Installation Meetings~~

~~Enter text here.~~

~~1.2.2 Sequencing~~

~~Enter text here.~~

~~1.2.3 Scheduling~~

~~Enter text here.~~

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are ~~[~~for Contractor Quality Control approval.~~][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING.~~ Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURE:

~~[~~ ~~SD-01 Preconstruction Submittals~~

~~[Enter Submittal Item in Initial Caps]; G[, [_____]]~~

]][SD-02 Shop Drawings

[Enter Submittal Item in Initial CapsShop Drawings]; G[, [_____]]

]][SD-03 Product Data

[Enter Submittal Item in Initial Caps]Welded Ornamental Fences; G[, [_____]]

]][SD-04 Samples

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]][SD-05 Design Data

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]][SD-06 Test Reports

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]][SD-07 Certificates

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]][SD-08 Manufacturer's Instructions

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]][SD-09 Manufacturer's Field Reports

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]][SD-10 Operation and Maintenance Data

[Enter Submittal Item in Initial CapsMaintenance Manuals]; G[, [_____]]

]][SD-11 Closeout Submittals

[Enter Submittal Item in Initial Caps]; G[, [_____]]

]1.3 QUALITY ASSURANCEMAINTENANCE MATERIAL SUBMITTALS

Enter text hereInstaller Qualifications: Fabricator of products.

1.3.1 Pre-Installation ConferenceSpare Parts

Enter text here.Conduct a Preparatory meeting at the site. Review approved submittal,Contract Documents, and visit the site for any coordination prior to installation.

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Enter text here.

~~1.4.2 Qualifications~~

~~Enter text here.~~

1.4 DELIVERY, STORAGE, AND HANDLING

~~Enter text here.~~Upon receipt at the jobsite, all materials shall be checked to ensure that no damage occurred during shipping and handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage,and weather.

~~1.5 PROJECT/SITE CONDITIONS~~

~~1.5.1 Environmental Requirements~~

~~Enter text here.~~

~~1.5.2 Existing Conditions~~

~~Enter text here.~~

1.5 WARRANTY

~~Enter text here.~~Manufacturer's standard Warranty.

~~]~~PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

~~Enter text here.~~The manufacturer shall supply a total fence system of Commercial, 2-rail, standard ornamental steel. The system shall include all components including panels, posts, gates and hardware. Refer to Contract Drawings for additional information.

~~2.1.1 Design Requirements~~

~~Enter text here.~~

~~2.1.2 Performance Requirements~~

~~Enter text here.~~

~~2.2 ASSEMBLY [OR] FABRICATION~~

~~Enter text here.~~

~~2.2.1 Factory Assembly~~

~~Enter text here.~~

~~2.2.2 Shop Fabrication~~

~~Enter text here.~~

~~2.2.3 Tolerances~~

~~Enter text here.~~

~~2.2.4 Finishes~~

~~Enter text here.~~

~~2.3 MANUFACTURED UNITS~~

~~Enter text here.~~

~~2.4 EQUIPMENT~~

~~Enter text here.~~

~~2.5 COMPONENTS~~

~~Enter text here.~~

2.2 MATERIALS

~~Enter text here.~~Decorative Welded Ornamental Steel Fences: Comply with ASTM F2408 Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets, for commercial application unless otherwise indicated.

a. Posts: Posts shall be square and as manufactured from a qualified manufacturer, Commercial welded and rackable ornamental steel fences, refer to Contract Drawings for addition information. Comply with Camp Lejeune Base Exterior Architectural Plan.

b. Fence Posts : Fence Posts shall be per manufacturer's recommendation and shall be from the same manufacturer, of Commercial ornamental
steel fences.

c. Rails shall be 2-rail system with bottom rail treatment to be extended
picket. Rails shall be 1 3/4 inches steel channel or tube, 14 gage with the profile as indicated on contract drawings.

d. Pickets: Square tubes. Material for pickets shall be 1 inch square by 14 gage and 3-3/4 inches on center, unless noted otherwise on Contract Drawings.

e. Fasteners: Manufacturer's standard concealed fastening system. Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components.

f. Provide minimum 18 gage perforated metal panels, over 1 by 1 inch by 14 gage steel pickets as shown on Contract Drawings.

g. Steel Kick Tube: As shown on Contract Drawings.

h. Finish:Galvanized and powder coated or as equivalent. Comply with manufacturer's anticorrosive finishes to withstand the project site environment.

2.3 SWING GATES~~MIXES~~

~~Enter text here.~~Gate Configuration: Single or double leaf as indicated on drawings and in manufacturer's gate shop drawings. Gates shall be fabricated using fusion welded ornamental panel material. Gate posts shall square tube,

and sized per manufacturer's recommendation. All rail and upright intersections shall be joined by welding. Height shall match the fences. Finish shall match the fences.

2.4 HARDWARE~~ACCESSORIES~~

~~Enter text here.~~Provide manufacturer's standard hardware. Provide latch and means of keeping open while service is being performed.

2.5 FOOTINGS~~TESTS, INSPECTIONS, AND VERIFICATIONS~~

~~Enter text here.~~Provide minimum 18 by 18 by 36 inches footings, with 3000 psi compressive strength, unless noted otherwise on Contract Drawings.

2.6 PRE-MANUFACTURED MESH FENCING

The pre-manufactured mesh fencing system shall be located on the north and east sides of the mechanical yard, with an 8-foot wide gate opening. Provide 75% opacity solid/ perforated panel double gate with self closing mechanism. Provide 75% opacity solid/ perforted panel fencing. Refer to Contract Drawings for additional information

PART 3 EXECUTION

3.1 EXAMINATION

~~Enter text here.~~Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work. Do not begin installation before final grading is completed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

~~Enter text here.~~Install fences according to manufacturer's written instructions and shop drawings. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.

~~3.2.1 Protection~~

~~Enter text here.~~

~~3.2.2 Surface Preparation~~

~~Enter text here~~

~~3.3 ERECTION~~

~~Enter text here.~~

~~3.4 INSTALLATION~~

~~Enter text here.~~

~~3.5 APPLICATION~~

~~Enter text here.~~

~~3.5.1 Special Techniques~~

~~Enter text here.~~

~~3.5.2 Interface with Other Products~~

~~Enter text here.~~

~~3.5.3 Tolerances~~

~~Enter text here.~~

3.3 FIELD QUALITY CONTROL

Ensure work is completed in compliance with manufacturer's installation requirements and Contract Documents.

~~3.3.1 Tests~~

~~Enter text here.~~

~~3.3.2 Inspection~~

~~Enter text here.~~

~~3.3.3 Manufacturer Field Service~~

~~Enter text here.~~

~~3.4 SYSTEM STARTUP~~

~~Enter text here.~~

3.4 ADJUSTING AND CLEANING

~~Enter text here.~~Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.Lubricate hardware, and other moving parts.

~~3.5 CLOSEOUT ACTIVITIES~~

~~3.5.1 Demonstration~~

~~Enter text here.~~

~~3.5.2 Training~~

~~Enter text here.~~

~~3.6 PROTECTION~~

~~Enter text here.~~

3.5 MAINTENANCE

~~Enter text here.~~When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces. Remove all metal shavings from cut area. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. Apply 2 coats of custom finish paint matching fence color.

~~3.5.1 Extra Materials~~

~~Enter text here.~~

~~3.5.2 Maintenance Service~~

~~Enter text here.~~

~~3.6 SCHEDULES~~

~~Enter text here.~~

-- End of Section --

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SECTION 32 92 19

SEEDING
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

1.2 DEFINITIONS

1.2.1 Stand of ~~[~~Turf~~][_____]~~

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

~~[Section 31 00 00 EARTHWORK,]~~ ~~[Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS,]~~ ~~[Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS,]~~ [Section 32 92 23 SODDING,~~]~~ ~~[Section 32 92 26 SPRIGGING,]~~ [Section 32 93 00 EXTERIOR PLANTS,~~]~~ and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are ~~[~~for Contractor Quality Control approval.~~][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood Cellulose Fiber Mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil Composition Tests (reports and recommendations).

SD-07 Certificates

State Certification and Approval for Seed

[SD-08 Manufacturer's Instructions

Erosion Control Materials

]1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, [fertilizer] [gypsum] [sulphur] [iron] [and] [lime] may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Seed, [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Storage

Store in cool, dry locations away from contaminants.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is [frozen,] [snow covered,] muddy, or when air temperature exceeds [90] [_____] degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide [State-certified] [State-approved] [Endophyte-enhanced] seed of the latest season's crop delivered in original sealed packages, bearing

producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. ~~Field mixes will be acceptable when field mix is performed on site in the presence of the [Contracting Officer] [_____].~~

~~2.1.2 Planting Dates~~

~~Planting Season~~	~~Planting Dates~~
~~[Season 1]~~	~~[_____]~~
~~[Season 2]~~	~~[_____]~~
~~[Temporary Seeding]~~	~~[_____]~~

~~2.1.3 Seed Purity~~

~~Botanical Name~~	~~Common Name~~	~~Minimum Percent Pure Seed~~	~~Minimum Percent Germination and Hard Seed~~	~~Maximum Percent Weed Seed~~
~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~
~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~
~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~	~~[_____]~~

~~2.1.4 Seed Mixture by Weight~~

~~Planting Season~~	~~Variety~~	~~Percent (by Weight)~~
~~[Season 1]~~	~~[_____]~~	~~[_____]~~
~~[Season 2]~~	~~[_____]~~	~~[_____]~~
~~[Temporary Seeding]~~	~~[_____]~~	~~[_____]~~

~~Proportion seed mixtures by weight. Temporary seeding must later be replaced by [Season 1][Season 2] plantings for a permanent stand of grass. The same requirements of turf establishment for [Season 1][Season 2] apply for temporary seeding.~~

2.2 TOPSOIL

2.2.1 On-Site Topsoil

~~Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section [31 00 00 EARTHWORK][~~

~~31 23 00.00 20 EXCAVATION AND FILL].~~Top soil to be ammended according to soils analysis report.

~~2.2.2 Off-Site Topsoil~~

~~Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be [furnished by the Contractor] [obtained from topsoil borrow areas indicated].~~

~~2.2.3 Composition~~

~~Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, and other debris and objectionable materials. Other components must conform to the following limits:~~

~~Silt~~	~~[25-50][7 to 17][_____] percent~~
~~Clay~~	~~[10-30][4 to 12][_____] percent~~
~~Sand~~	~~[20-35][70 to 82][_____] percent~~
~~pH~~	~~[5.5 to 7.0][_____]~~
~~Soluble Salts~~	~~[600] [_____] ppm maximum~~

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with ~~"composition" standard for topsoil as specified herein~~soils analysis report.

~~2.3.1 Lime~~

~~Commercial grade [hydrate] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [_____] percent.~~

~~2.3.2 Aluminum Sulfate~~

~~Commercial grade.~~

~~2.3.3 Sulfur~~

~~100 percent elemental~~

~~2.3.4 Iron~~

~~100 percent elemental~~

~~2.3.5 Peat~~

~~Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [as modified herein]. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.~~

~~2.3.6 Sand~~

~~Clean and free of materials harmful to plants.~~

~~2.3.7 Perlite~~

~~Horticultural grade.~~

~~2.3.8 Composted Derivatives~~

~~Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:~~

~~2.3.8.1 Particle Size~~

~~Minimum percent by weight passing:~~

~~No. 4 mesh screen 95~~
~~No. 8 mesh screen 80~~

~~2.3.8.2 Nitrogen Content~~

~~Minimum percent based on dry weight:~~

~~Fir Sawdust 0.7~~
~~Fir or Pine Bark 1.0~~

~~2.3.9 Gypsum~~

~~Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.~~

~~2.3.10 Calcined Clay~~

~~Calcined clay must be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent must pass a No. 8 sieve; a minimum 99 percent must be retained on a No. 60 sieve; and material passing a No. 100 sieve must not exceed 2 percent. Bulk density: A maximum 40 pounds per cubic foot.~~

2.4 FERTILIZER

2.4.1 Granular Fertilizer

~~[Organic][synthetic], g~~Granular controlled release fertilizer containing ~~the following minimum percentages, by weight, of plant food nutrients:~~

~~[_____] percent available nitrogen~~
~~[_____] percent available phosphorus~~
~~[_____] percent available potassium~~
~~[_____] percent sulfur~~
~~[[_____] percent iron~~as required by the soils analysis report.

~~]~~2.4.2 Hydroseeding Fertilizer

Controlled release fertilizer, to use with hydroseeding and composed of

pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing ~~the following minimum percentages, by weight, of plant food nutrients.~~nutrients as required by the soils analysis report.

~~[_____] percent available nitrogen~~
~~[_____] percent available phosphorus~~
~~[_____] percent available potassium~~
~~[~~ ~~[_____] percent sulfur~~
~~][~~ ~~[_____] percent iron~~

~~]~~2.5 MULCH

Mulch must be free from noxious weeds, mold, and other deleterious materials.

~~2.5.1 Straw~~

~~Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw must contain no fertile seed.~~

~~2.5.2 Hay~~

~~Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.~~

~~2.5.3 Wood Cellulose Fiber Mulch~~

~~Use recovered materials of either paper-based (100 percent post-consumer content) or wood-based (100 percent total recovered content) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2 [_____]. Use with hydraulic application of grass seed and fertilizer.~~

2.6 WATER

Source of water must be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

~~[2.7 EROSION CONTROL MATERIALS~~

~~Erosion control material must conform to the following:~~

~~[2.7.1 Erosion Control Blanket~~

~~[100 percent agricultural straw][70 percent agricultural straw/30 percent coconut fiber matrix] stitched with a degradable nettings, designed to degrade within [12 months][18 months].~~

~~][2.7.2 Erosion Control Fabric~~

~~Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.~~

~~][2.7.3 Erosion Control Net~~

~~Net must be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately one inch square.~~

~~][2.7.4 Hydrophilic Colloids~~

~~Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.~~

~~]2.7.5 Erosion Control Material Anchors~~

~~Erosion control anchors must be as recommended by the manufacturer.~~

~~[~~PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation prior to planting (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 4 inches of ~~[off-site topsoil][on-site topsoil][~~existing soil~~]~~ to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate ~~[~~fertilizer~~]~~ ~~[~~pH adjusters~~]~~ ~~[~~soil conditioners~~]~~ into soil a minimum depth of ~~[~~4~~]~~ ~~[_____]~~ inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

~~[~~3.1.1.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. ~~For bidding purposes only apply at rates for the following:~~

~~[Lime [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]~~

~~][Sulfur [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]~~

~~][Iron [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]~~

~~][Aluminum Sulfate [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]~~

~~][Peat [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]~~

][Sand [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]

][Perlite [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]

][Compost Derivatives [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]

][Calcined Clay [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]

][Gypsum [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]

]][3.1.1.3 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Organic Granular Fertilizer [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]

][Synthetic Fertilizer [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]

][Hydroseeding Fertilizer [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]

]]3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy [frozen] [snow covered] or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method must be [broadcasted and drop seeding][drill seeding][hydroseeding].

[3.2.2.1 Broadcast and Drop Seeding

Seed must be uniformly broadcast at the rate of [_____] pounds per 1000 square feet. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and [1/2] [_____] inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

~~][3.2.2.2 Drill Seeding~~

~~Seed must be drilled at the rate of [_____] pounds per 1000 square feet. Use [cultipacker seeders] [grass seed drills] [_____]. Drill seed uniformly to average depth of [1/2] [_____] inch.~~

~~][~~3.2.2.1 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper must be applied as part of the hydroseeding operation. Fiber must be added at 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed must be mixed to ensure broadcasting at the rate of required by seed manufacturer. ~~[_____] pounds per 1000 square feet.~~ When hydraulically sprayed on the ground, material must form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

~~]3.2.3 Mulching~~

~~[3.2.3.1 Hay or Straw Mulch~~

~~Hay or straw mulch must be spread uniformly at the rate of 2 tons per acre. Mulch must be spread by hand, blower-type mulch spreader, or other approved method. Mulching must be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch must not be bunched or clumped. Sunlight must not be completely excluded from penetrating to the ground surface. All areas installed with seed must be mulched on the same day as the seeding. Mulch must be anchored immediately following spreading.~~

~~][3.2.3.2 Mechanical Anchor~~

~~Mechanical anchor must be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.~~

~~][3.2.3.3 Asphalt Adhesive Tackifier~~

~~Asphalt adhesive tackifier must be sprayed at a rate between 10 to 13 gallons per 1000 square feet. Sunlight must not be completely excluded from penetrating to the ground surface.~~

~~][3.2.3.4 Non-Asphaltic Tackifier~~

~~Hydrophilic colloid must be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture must be applied over the area.~~

~~][3.2.3.5 Asphalt Adhesive Coated Mulch~~

~~Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons per 1000 square feet, using power mulch equipment which must be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch must be applied evenly over the surface. Sunlight must not be completely excluded from penetrating to the ground surface.~~

~~][3.2.4 Rolling~~

~~Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding [90] [_____] pounds for each foot of roller width.[If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.]~~

~~]3.2.5 Erosion Control Material~~

~~Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.~~

3.2.3 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of ~~[~~2~~]~~ ~~[_____]~~ inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

~~[~~3.4 RENOVATION OF EXISTING TURF AREA

~~[3.4.1 Aeration~~

~~Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas indicated , by approved device. Core, by pulling soil plugs, to a minimum depth of [_____] inches.[Leave all soil plugs, that are produced, in the turf area.][Remove all debris generated during this operation off site.][After aeration operations are complete, topdress entire area [1/4 inch] [1/2 inch] depth with the following mixture:~~

~~[[_____] percent sand~~

~~][[_____] percent humus~~

~~][[_____] percent gypsum~~

~~][[_____] percent organic fertilizer~~

~~][[_____] percent synthetic fertilizer~~

~~] Blend all parts of topdressing mixture to a uniform consistency throughout.] Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete.~~

~~][3.4.2 Vertical Mowing~~

~~Upon completion of aerating operation and Contracting Officer's approval to proceed, vertical mow turf areas indicated, by approved device, to a depth of [1/4 inch] [1/2 inch] above existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all~~

~~debris generated during this operation off site.~~

~~][3.4.3 Dethatching~~

~~Upon completion of aerating operation and Contracting Officer's approval to proceed, dethatch turf areas indicated, by approved device, to a depth of [1/4 inch] [1/2 inch] below existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.~~

~~][3.4.4 Overseeding~~

~~Apply seed in accordance with and at rates indicated in applicable portions of paragraph SEED APPLICATION METHOD.~~

~~]]~~3.5 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

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SECTION 32 92 23

SODDING
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4972	(2018) Standard Test Methods for pH of Soils

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

~~[~~Section 31 00 00 EARTHWORK~~]~~, ~~[Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS]~~, ~~[Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS]~~, ~~[Section 32 92 19 SEEDING]~~, ~~[Section 32 92 26 SPRIGGING]~~, ~~[~~Section 32 93 00 EXTERIOR PLANTS~~]~~, and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are ~~[~~for Contractor Quality Control approval.~~]~~~~[for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]~~ Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

~~[Nursery]~~ ~~[~~Sod farm~~]~~ certification for sods. Indicate type of sod in accordance with TPI GSS.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 ~~[Fertilizer] [Gypsum] [Sulfur] [Iron] [and~~Soil Ammendments~~]~~ ~~[Lime]~~ Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, ~~[fertilizer] [gypsum] [sulphur] [iron] [and] [lime~~soil ammendments~~]~~ may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is ~~[~~frozen,~~]~~ ~~[~~snow covered,~~]~~ muddy, or when air temperature exceeds ~~[~~90~~]~~ ~~[_____]~~ degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Nursery grown, certified as classified in the TPI GSS. Machine cut sod at a uniform thickness of 3/4 inch within a tolerance of 1/4 inch, excluding top growth and thatch. Each individual sod piece shall be strong enough to support its own weight when lifted by the ends. Broken pads, irregularly shaped pieces, and torn or uneven ends will be rejected. ~~[Wood pegs and wire staples for anchorage shall be as recommended by sod supplier.]~~

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.1.3 Planting Dates

Lay sod from April 1~~[_____]~~ to June 30~~[_____]~~ for warm season spring planting and from July 15~~[_____]~~ to August 1~~[_____]~~ for cool season fall planting.

2.1.4 Composition

2.1.4.1 Proportion

Proportion grass species as follows.

~~Botanical Name~~	~~Common Name~~	~~Percent~~
~~[_____]~~	~~[_____]~~	~~[_____]~~
~~[_____]~~	~~[_____]~~	~~[_____]~~

Centipede Grass 100 percent

~~[~~2.1.4.2 Sod Farm Overseeding

At the sod farm provide sod with overseeding of ~~[annual rye grass seed] [_____]][~~type recommended by seed producer~~]~~.

~~]][2.2 WILDFLOWER SOD~~

~~2.2.1 Classification~~

~~[Certified,] [Field grown] wildflower sod, machine cut at a uniform thickness of [one] [_____] inch within a tolerance of 1/4 inch, excluding top growth. Top growth shall be a maximum height of [3] [_____] inches. Each individual wildflower sod piece shall be strong enough to support its~~

own weight when lifted by the ends. Broken pads, irregular shaped pieces, and torn or uneven ends will be rejected. [Wood pegs and wire staples for anchorage on slope conditions, three to one or greater, shall be used as recommended by wildflower sod supplier.]

2.2.2 Composition

Proportion wildflower species as follows:

Botanical Name	Common Name	Percent
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section [31 00 00 EARTHWORK][31 23 00.00 20 EXCAVATION AND FILL].

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be [furnished by the Contractor] [obtained from topsoil borrow areas indicated].

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	[25-50][7 to 17][_____] percent
Clay	[10-30][4 to 12][_____] percent
Sand	[20-35][70 to 82][_____] percent
pH	[5.5 to 7.0][_____]
Soluble Salts	[600] [_____] ppm maximum

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein within the soils

analysis report.

~~2.3.1 Lime~~

~~Commercial grade [hydrate] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [_____] percent.~~

~~2.3.2 Aluminum Sulfate~~

~~Commercial grade.~~

~~2.3.3 Sulfur~~

~~100 percent elemental~~

~~2.3.4 Iron~~

~~100 percent elemental~~

~~2.3.5 Peat~~

~~Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [as modified herein]. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.~~

~~2.3.6 Sand~~

~~Clean and free of materials harmful to plants.~~

~~2.3.7 Perlite~~

~~Horticultural grade.~~

~~2.3.8 Composted Derivatives~~

~~Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:~~

~~2.3.8.1 Particle Size~~

~~Minimum percent by weight passing:~~

~~No. 4 mesh screen 95~~
~~No. 8 mesh screen 80~~

~~2.3.8.2 Nitrogen Content~~

~~Minimum percent based on dry weight:~~

~~Fir Sawdust 0.7~~
~~Fir or Pine Bark 1.0~~

~~2.3.9 Gypsum~~

~~Coarsely ground gypsum comprised of calcium sulfate dihydrate 91 percent, calcium 22 percent, sulfur 17 percent; minimum 96 percent passing through~~

20 mesh screen, 100 percent passing thru 16 mesh screen.

2.3.10 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

[Organic][synthetic], granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[_____] percent sulfur
[[_____] percent iron]

2.4 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent Of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Soil Preparation

Provide 4 inches of [off-site topsoil][on-site topsoil] to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate [fertilizer] [pH adjusters] [soil conditioners] into soil a minimum depth of [4] [_____] inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.2.1 [Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Lime [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]]

~~[Sulfur [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]]~~

~~[Iron [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]]~~

~~[Aluminum Sulfate [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]]~~

~~[Peat [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]]~~

~~[Sand [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]]~~

~~[Perlite [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]]~~

~~[Compost Derivatives [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]]~~

~~[Calcined Clay [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]]~~

~~[Gypsum [[_____] cubic yard per acre] [[_____] cubic yards per 1000 square feet.]]~~

~~]3.1.2.2 [Fertilizer Application Rates~~

~~Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:~~

~~[Organic Granular Fertilizer [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]]~~

~~[Synthetic Granular Fertilizer [[_____] pounds per acre] [[_____] pounds per 1000 square feet.]]~~

~~]~~3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section ~~[31 00 00 EARTHWORK]~~[31 23 00.00 20 EXCAVATION AND FILL~~]~~.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water. ~~[~~Anchor each piece of sod with wood pegs or wire staples maximum 2 feet on center.~~]~~ ~~[~~On slope areas, start sodding at bottom of the slope.~~]~~

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding ~~[~~90~~]~~ ~~[_____]~~ pounds for each foot of roller width.

3.2.6 Watering

Start watering areas sodded as required by daily temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to minimum depth of ~~[~~6~~]~~ ~~[_____]~~ inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

~~3.4 [RENOVATION OF EXISTING TURF AREA~~

~~3.4.1 [Aeration~~

~~Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas indicated , by approved device. Core, by pulling soil plugs, to a minimum depth of [_____] inches. [Leave all soil plugs, that are produced, in the turf area.] [Remove all debris generated during this operation off site.] [After aeration operations are complete, topdress entire area [1/4 inch] [1/2 inch] depth with the following mixture:~~

~~[[_____] percent sand]~~
~~[[_____] percent humus]~~
~~[[_____] percent gypsum]~~
~~[[_____] percent organic fertilizer]~~
~~[[_____] percent synthetic fertilizer]~~

~~Blend all parts of topdressing mixture to a uniform consistency throughout.] Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete.~~

~~]3.4.2 [Vertical Mowing~~

~~Upon completion of aerating operation and Contracting Officer's approval to proceed, vertical mow turf areas indicated, by approved device, to a depth of [1/4 inch] [1/2 inch] above existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.~~

~~]3.4.3 [Dethatching~~

~~Upon completion of aerating operation and Contracting Officer's approval to proceed, dethatch turf areas indicated, by approved device, to a depth of [1/4 inch] [1/2 inch] below existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.~~

~~]]~~3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

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SECTION 32 93 00

EXTERIOR PLANTS
08/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICANHORT (AH)

ANSI/ANLA Z60.1	(2004) American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM C602	(2013a) Agricultural Liming Materials
ASTM D4427	(2018) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2018) Standard Test Methods for pH of Soils
ASTM D5268	(2013) Topsoil Used for Landscaping Purposes
ASTM D5539	(2013) Seed Starter Mix
ASTM D6155	(2019) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures

L.H. BAILEY HORTORIUM (LHBH)

LHBH	(1976) Hortus Third

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA A300P1	(2017) ANSI A300 Part1: Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices - Pruning
TCIA Z133	(2017) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 RELATED REQUIREMENTS

[Section 31 00 00 EARTHWORK,] [Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS,] [Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS,] [Section 32 92 19 SEEDING,] [Section 32 92 23 SODDING,] [Section 32 92 26 SPRIGGING,] and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29.05 20 SUSTAINABILITY REPORTING FOR DESIGN BUILD. Submit the following in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

State Landscape Contractor's License

Time Restrictions and Planting Conditions

Indicate anticipated dates and locations for each type of planting.

SD-03 Product Data

Peat

Composted Derivatives

Organic Mulch Materials

Gypsum

[Drainage Pipe

] Mulch; G

Ground Stakes

Recycled Plastic Edging

Fertilizer

Weed Control Fabric; G

[Root Control Barrier; G

] Staking Material

Wood Edging

Metal Anchors

[Antidesiccants

][Erosion Control Materials

][Photographs; G

] SD-04 Samples

[Mulch; G

][Submit [one pint] of mulch.

] SD-06 Test Reports

Topsoil Composition Tests; [Soil Test of current growing area]; [Soil Test of proposed area]; [Soil Test location map]

Percolation Test; [Percolation Test of current growing area]; [Percolation Test of proposed area]

SD-07 Certificates

Nursery Certifications

SD-10 Operation and Maintenance Data

Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

1.4.1 Topsoil Composition Tests

Commercial test from an independent testing laboratory including basic soil groups (moisture and saturation percentages, Nitrogen-Phosphorus-Potassium (N-P-K) ratio, pH (ASTM D4972), soil salinity), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper), toxic soil elements (boron, chloride, sulfate), cation exchange and base saturation percentages, and soil amendment and fertilizer recommendations with quantities for plant material being transplanted. Soil required for each test must include a maximum depth of 18 inches of approximately one quart volume for each test. Areas sampled should not be larger than one acre and should contain at least 6-8 cores for each sample area and be thoroughly mixed. Problem areas should be sampled separately and compared with samples taken from adjacent non-problem areas. The location of the sample areas should be noted and marked on a parcel or planting map for future reference.

1.4.2 Nursery Certifications

[a. Indicate on nursery letterhead the name of plants in accordance with the LHBH, including botanical common names, quality, and size.

][b. Inspection certificate.

][c. Mycorrhizal fungi inoculum for plant material treated

~~]~~1.4.3 State Landscape Contractor's License

Construction company must hold a landscape contractors license in the state where the work is performed and have a minimum of five years landscape construction experience. Submit copy of license and three references for similar work completed in the last five years.

~~[~~1.4.4 Plant Material Photographs

Contractor must submit nursery photographs, for ~~government~~ approval prior to ordering, for each tree larger than ~~24-inch box/~~ 2-inch caliper size.

~~]~~1.4.5 Percolation Test

Immediately following rough grading operation, identify a typical location for one of the ~~largest trees and or~~ shrubs and excavate a pit per the project details. Fill the pit with water to a depth of 12 inches. The length of time required for the water to percolate into the soil, leaving the pit empty, must be measured by the project Landscape Architect and verified by the Contracting Officer. Within six hours of the time the water has drained from the pit, the Contractor, with the Contracting Officer ~~and project Landscape Architect present,~~ must again fill the pit with water to a depth of 12 inches. If the water does not completely percolate into the soil within 9 hours, a determination must be made whether a drainage system or a soil penetrant will be required for each ~~tree and or~~ shrub being transplanted.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Branched Plant Delivery

Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.

1.5.1.2 Soil Amendment Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, ~~[~~fertilizer,~~]~~ ~~[~~gypsum,~~]~~ ~~[~~sulfur,~~]~~ ~~[~~iron,~~]~~ ~~[~~and~~]~~ ~~[~~lime~~]~~ may be furnished in bulk with a certificate indicating the above information. Store in dry locations away from contaminates.

1.5.1.3 Plant Labels

Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels must be legible for a minimum of 60 days after delivery to the planting site.

1.5.2 Storage

1.5.2.1 Plant Storage and Protection

Store and protect plants not planted on the day of arrival at the site as follows:

a. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

~~b. Heel-in bare root plants.~~

c. ~~P~~protect balled and burlapped plants from freezing or drying out by covering the balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering which allows air circulation.

d. ~~K~~keep plants in a moist condition until planted by watering with a fine mist spray.

~~e~~d. Do not store plant material directly on concrete or bituminous surfaces.

1.5.2.2 ~~[~~Fertilizer,~~]~~ ~~[~~Gypsum,~~]~~ ~~[pH Adjusters]~~ and ~~[~~Mulch~~]~~ Storage

Store in dry locations away from contaminants.

1.5.2.3 Topsoil

Prior to stockpiling topsoil, eradicate on site undesirable growing vegetation. Clear and grub existing vegetation three to four weeks prior to stockpiling existing topsoil.

~~[~~1.5.2.4 ~~[Root Control Barrier]~~ ~~[and]~~ ~~[~~Weed Control Fabric~~]~~

Store materials on site in enclosures or under protective covering in dry location. Store under cover out of direct sunlight. Do not store materials directly on ground.

~~]~~1.5.3 Handling

Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle ~~[boxed][~~ balled and burlapped~~]~~ ~~[bare root] [balled and potted][processed balled][in-ground fabric bag grown]~~ [and container~~]~~ plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem.~~[Puddle bare-root plants after removal from the heeling-in bed to protect roots from drying out.]~~ Remove damaged plants from the site.

1.5.4 TIME LIMITATION

Except for container-grown plant material, the time limitation from digging to installing plant material must be a maximum of 90 days. The time limitation between installing the plant material and placing the mulch must be a maximum of 24 hours.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

~~1.6.1 Planting Dates~~

~~[Plant all plants from [_____] to [_____].~~

~~][1.6.1.1 Deciduous Material~~

~~Deciduous material from [_____] to [_____] for spring [/summer] planting and from [_____] to [_____] for fall [/winter] planting.~~

~~][1.6.1.2 Evergreen Material~~

~~Evergreen material from [_____] to [_____] for spring [/summer] planting and from [_____] to [_____] for fall [/winter] planting.~~

~~]~~1.6.1 Restrictions

Do not plant when ground is ~~[frozen,] [snow covered,]~~ muddy, or when air temperature exceeds ~~[~~90~~]~~ ~~[_____]~~ degrees Fahrenheit

1.7 GUARANTEE

~~[~~ ~~[~~All plants must be guaranteed for ~~[~~one year~~]~~ ~~[_____]~~ beginning on the date of inspection by the Contracting Officer to commence the plant establishment period, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by the Government or by weather conditions unusual for the warranty period.~~][Transplanted plants require no guarantee.]~~

~~][Guarantee plants [except palms] installed during fall planting season until the following [August 1] [_____]; guarantee plants installed during spring planting season until the following [October 1] [_____].[Transplanted plants require no guarantee.][The minimum guarantee must be 90 days from the time of planting.] [Replace palms which are not alive at the end of a one-year period.]~~

~~]~~ ~~[~~Remove and replace dead planting materials immediately unless required to plant in the succeeding planting season. ~~]~~At end of warranty period, replace planting materials that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period.

1.8 PLASTIC IDENTIFICATION

Provide product data indicating polymeric information in Operation and Maintenance Manual.

Type 1: Polyethylene Terephthalate (PET, PETE).
Type 2: High Density Polyethylene (HDPE).
Type 3: Vinyl (Polyvinyl Chloride or PVC).
Type 4: Low Density Polyethylene (LDPE).
Type 5: Polypropylene (PP).
Type 6: Polystyrene (PS).
Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

PART 2 PRODUCTS

2.1 PLANTS

2.1.1 Regulations and Varieties

Furnish nursery stock in accordance with ANSI/ANLA Z60.1, except as otherwise specified or indicated. Each plant or group of planting must have a "key" number indicated on the nursery certifications of the plant schedule. Furnish plants, ~~including turf grass,~~ grown under climatic conditions similar to those in the locality of the project. ~~[Spray plants budding into leaf or having soft growth with an antidesiccant before digging].~~ Plants of the same specified size must be of uniform size and character of growth. All plants must comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

2.1.2 Shape and Condition

Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

2.1.2.1 Deciduous Trees ~~and Shrubs~~

Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

2.1.2.2 Evergreen Trees~~ and Shrubs~~

Well developed symmetrical tops with typical spread of branches for each particular species or variety.

~~2.1.2.3 Ground Covers and Vines~~

~~Number and length of runners and clump sizes indicated, and of the proper age for the grade of plants indicated, furnished in removable containers, integral containers, or formed homogeneous soil section.~~

2.1.3 Plant Size

Minimum sizes measured after pruning and with branches in normal position, must conform to measurements indicated, based on the average width or height of the plant for the species as specified in ANSI/ANLA Z60.1. Plants larger in size than specified may be provided with approval of the ~~[~~ Contracting Officer~~]~~ ~~[_____]~~. When larger plants are provided, increase the ball of earth or spread of roots in accordance with ANSI/ANLA Z60.1.

2.1.4 Root Ball Size

All ~~box-grown, field potted, field boxed, collected, plantation grown, bare root,~~ balled and burlapped,and container grown~~, processed-balled, and in-ground fabric bag-grown~~ root balls must conform to ANSI/ANLA Z60.1. ~~All wrappings and ties must be biodegradable.~~ Root growth in container grown plants must be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

~~[~~2.1.4.1 Mycorrhizal fungi inoculum

Before shipment, root systems must contain mycorrhizal fungi inoculum.

]2.1.5 Growth of Trunk and Crown

2.1.5.1 Deciduous Trees

A height to caliper relationship must be provided in accordance with ANSI/ANLA Z60.1. Height of branching must bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees must not be "poled" or the leader removed.

a. Single stem: The trunk must be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, must average the size specified. To be considered a stem, there must be no division of the trunk which branches more than 6 inches from ground level.

~~2.1.5.2 Palms~~

~~Palms must have the specified height as measured from the base of the trunk to the base of the fronds or foliage in accordance with ANSI/ANLA Z60.1. The palm must have straight trunk and healthy fronds or foliage as typical for the variety grown in the region of the project. Palms trimmed or pruned for delivery must retain a minimum of 6 inches of foliage at the crown as a means of determining plant health.~~

~~2.1.5.3 Deciduous Shrubs~~

~~Deciduous shrubs must have the height and number of primary stems recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.~~

2.1.5.2 Coniferous Evergreen Plant Material

Coniferous Evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. The coniferous evergreen trees must not be "poled" or the leader removed. Acceptable plant material must be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired must be as indicated.

2.1.5.3 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

~~2.1.5.4 Ground Cover and Vine Plant Material~~

~~Ground cover and vine plant material must have the minimum number of runners and length of runner recommended by ANSI/ANLA Z60.1. Plant material must have heavy, well developed and balanced crown with vigorous, well developed root system and must be furnished in containers.~~

2.2 TOPSOIL

[2.2.1 Existing Soil

Modify to conform to requirements specified in paragraph COMPOSITION.

][2.2.2 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section [31 00 00 EARTHWORK][31 23 00.00 20 EXCAVATION AND FILL].

][2.2.3 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be [furnished by the Contractor][obtained from topsoil borrow areas indicated].

]2.2.2 Composition

Evaluate soil for use as topsoil in accordance with ASTM D5268. From 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, plants, and other debris and objectionable materials. Other components must conform to the following limits:

Silt	[25-50][7 to 17][_____] percent
Clay	[10-30][4 to 12][_____] percent
Sand	[20-35][70 to 82][_____] percent
pH	[5.5 to 7.0][_____]
Soluble Salts	[600] [_____] ppm maximum

2.3 SOIL CONDITIONERS

Provide singly or in combination as required to meet specified requirements for topsoil. Soil conditioners must be nontoxic to plants.

2.3.1 Lime

Commercial grade [hydrated] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [80][_____] percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of ~~[~~peat moss~~]~~ derived from a freshwater site and conforming to ~~[~~ASTM D4427~~]~~ ~~[~~ASTM D5539~~]~~ as modified herein. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation. Peat must not contain invasive species, including seeds.

~~2.3.6 Sand~~

~~Clean and free of materials harmful to plants.~~

2.3.6 Perlite

Horticultural grade.

2.3.7 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having the following properties:

2.3.7.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.7.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.8 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.

2.4 PLANTING SOIL MIXTURES

~~[100 percent topsoil as specified herein.~~

~~][100 percent on-site topsoil.~~

~~][[_____] parts topsoil, [_____] parts [_____], and [_____] parts [_____]. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.~~

~~][Sandy topsoil: one part topsoil to one part peat; clay topsoil: two parts topsoil to one part peat. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.~~Planting soil backfill mixtures

shall be per lab soil analysis recommendations. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.

]2.5 FERTILIZER

2.5.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:Organic, granular controlled release fertilizer containing the minimum percentages, by weight, of plant food nutrients as indicated in the lab soil analysis recommendations.

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[_____] percent sulfur
[[_____] percent iron

]2.5.2 Fertilizer Tablets

Organic, plant tablets composed of tightly compressed fertilizer chips forming a tablet that is insoluble in water, is designed to provide a continuous release of nutrients for at least 24 months and contains the following minimum percentages, by weight, of plant food nutrients:and contains the minimum percentages, by weight, of plant food nutrients as indicated in the lab soil analysis recommendations.

[20] [_____] percent available nitrogen
[20] [_____] percent available phosphorus
[5] [_____] percent available potassium

2.6 WEED CONTROL FABRIC

[2.6.1 Roll Type Polypropylene or Polyester Mats

Fabric must be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric must be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring, yet allowing air, water and nutrients to pass thru to the roots. Minimum weight must be 5 ounces per square yard with a minimum thickness of 20 mils with a 20 year (minimum) guarantee.

][2.7 DRAINAGE PIPE FOR PLANT PITS AND BEDS

[Plastic polyvinyl chloride pipe, [_____] inches in diameter, [unperforated] conforming to ASTM D3034 SDR 35 [perforated] conforming to ASTM D2729.][Plastic HDPE pipe, [_____] inches in diameter, [unperforated] [perforated].][Plastic ABS pipe, [_____] inches in diameter, [unperforated] [perforated].][Corrugated plastic drainage tubing, [_____] inches in diameter, [unperforated] [perforated] conforming to ASTM F667/F667M.][Clay drain tile, [_____] inches in diameter, [unperforated conforming to ASTM C4] [perforated conforming to ASTM C4] [[extra strength] [standard strength] conforming to ASTM C700].

]]2.6 MULCH

Free from noxious weeds, mold, pesticides, or other deleterious materials.

~~[~~2.6.1 Inert Mulch Materials

~~[~~ Provide ~~[recycled] [~~stone,~~]~~ ~~[~~riverbank stone,~~]~~ ~~[~~crushed pit-run rock,~~]~~ ~~[granite chips,] [_____,] [or other recycled material]~~ complying with ASTM D6155, ranging in size ~~from~~ as indicated in the drawings.~~[___(____)] to [____(____)] mm (inches).[Provide materials from site and construction waste to the greatest extent possible.]~~

~~]]~~2.6.2 Organic Mulch Materials

Provide ~~[wood cellulose fiber,] [wood chips,] [~~shredded hardwood,~~]~~ ~~[shredded redwood bark,] [pine straw mulch,] [pine needles,]~~ or ~~[recycled] [_____]~~ from site when available. ~~Wood cellulose fiber must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch must contain 100 percent post-consumer recycled content. Wood-based hydraulic mulch must contain 100 percent total recovered materials content.~~

~~[2.6.3 Recycled Organic Mulch~~

~~Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 by 2-1/2 inch screen. It must be cleaned of all sticks a minimum one inch in diameter and plastic materials a minimum 3 inches length. The material must be treated to retard the growth of mold and fungi.~~

~~]~~2.7 STAKING ~~AND GUYING~~ MATERIAL

2.7.1 Staking Material

2.7.1.1 Tree Support Stakes

Rough sawn hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes must be minimum 2 inches square or 2-1/2 inch diameter by 8 feet long, pointed at one end.~~[Paint or stain wood stakes dark brown.]~~.

~~2.7.1.2 Ground Stakes~~

~~Rough sawn hard wood or plastic, 2 inches square are by 3 feet long, pointed at one end.~~

~~2.7.2 Guying Material~~

~~2.7.2.1 Guying Wire~~

~~12 gauge annealed galvanized steel, ASTM A580/A580M.~~

~~2.7.2.2 Guying Cable~~

~~Minimum five-strand, 3/16 inch diameter galvanized steel cable [plastic coated].~~

2.7.2 Hose Chafing Guards

New or used 2 ply 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

~~2.7.3 Flags~~

~~White [surveyor's plastic tape,] [1/2 inch diameter PVC pipe], [6 inches] [12 inches] long, fastened to guying wires or cables.~~

~~2.7.4 Turnbuckles~~

~~Galvanized or cadmium-plated steel with minimum 3 inch long openings fitted with screw eyes. Eye bolts must be galvanized or cadmium-plated steel with one inch diameter eyes and screw length 1-1/2 inches, minimum.~~

~~2.7.5 Deadmen~~

~~4 by 8 inch rectangular or 8 inch diameter by 36 inch long, [pine] [fir] [_____] wood material.~~

~~2.7.6 Metal Anchors~~

~~2.7.6.1 Driven Anchors~~

~~Malleable iron, arrow shaped, galvanized, sized as follows:~~

~~Tree Caliper~~	~~Anchor Size~~
~~2 inches and under~~	~~3 inches~~
~~3 to 6 inches~~	~~4 inches~~
~~6 to 8 inches~~	~~6 inches~~
~~8 to 10 inches~~	~~8 inches~~
~~10 to 12 inches~~	~~10 inches~~

~~2.7.6.2 Screw Anchors~~

~~Steel, screw type with welded-on 3 inch round helical steel plate, minimum 3/8 inch diameter, 15 inches long.~~

2.8 EDGING MATERIAL

~~2.8.1 Wood Edging~~

~~As specified in Section 06 10 00 ROUGH CARPENTRY. [Redwood] [Cypress] [Western Red Cedar] [_____] wood edging must be free of solvent at time of delivery. Minimum 8 by 1/2 inch [treated in accordance with AWPA U1 and AWPA T1 with preservatives conforming to AWPA P5 before installation]. Anchoring stakes must be the same material as wood edging, [1/2 by 2] [_____] inches, 12 inches long.~~

~~2.8.2 Recycled Plastic Edging~~

~~100 percent recycled [polyethylene][_____] edging, resistant to insects, termites, boring worms, splintering and rotting, and must not absorb moisture or promote bacterial growth. Minimum [1 by 4][1 by 6][2 by 4][2 by 6][_____] inch, capable of bending a minimum [24][36][_____] radius,~~

~~integrally colored [brown][_____] with [slip joint][_____] connections. Anchors and stakes must be of the same manufacturer and color as the edging.~~

2.8.1 Concrete Edging

~~[Extruded]~~ ~~[~~Cast-in-place~~]~~ ~~[~~6 by 6~~] [_____] by [_____]~~ inch concrete mowstrip. Provide ~~[tooled]~~ ~~[~~saw cut~~]~~ ~~[_____]~~ contraction joints to a depth of ~~[~~3/4~~]~~ ~~[_____]~~ inch after the surface has been finished. Provide joints every ~~[~~5~~]~~ ~~[_____]~~ lineal feet. Provide ~~[~~1/2~~]~~ ~~[_____]~~ inch thick expansion joints at change of direction and where mowstrip abuts rigid pavement. ~~[~~Provide #3~~[#4] [_____]~~ reinforcement bar and other devices necessary to install and secure reinforcement.~~]~~ Provide a floated finish, then finish with a flexible bristle broom. ~~[2500] [_____] psi compressive concrete strength at 28 days as specified under Section 03 30 00 CAST-IN-PLACE CONCRETE.~~

~~[2.9 ANTIDESICCANTS~~

~~Sprayable, water insoluble vinyl-vinledine complex which produce a moisture retarding barrier not removable by rain or snow. Film must form at temperatures commonly encountered out of doors during planting season and have a moisture vapor transmission rate (MVT) of the resultant film of maximum 10 grams per 24 hours at 70 percent humidity.~~

~~]~~[2.9 EROSION CONTROL MATERIALS

Erosion control material must conform to the following:

~~[2.9.1 Erosion Control Blanket~~

~~[100 percent agricultural straw][70 percent agricultural straw/30 percent coconut fiber matrix] stitched with a degradable nettings, designed to degrade within [12 months][18 months].~~

~~]~~[2.9.2 Erosion Control Fabric~~

~~Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.~~

~~]~~[2.9.1 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately one inch square.

~~]~~[2.9.2 Hydrophilic Colloids~~

~~Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.~~

~~]~~2.9.2 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

~~][2.10 ROOT CONTROL BARRIER~~

~~[Flexible and permeable geotextile fabric with permanently attached time-released nodules. Color to be [black] [gray] [_____].] [Pre-formed, [round, tapered cylinder] [linear] barrier with integral vertical root deflecting ribs constructed of ultraviolet resistant polypropylene material. Color to be [black] [_____].~~

~~]]2.11 WATER~~

~~Source of water to be approved by Contracting Officer and suitable quality for irrigation and must not contain elements toxic to plant life.~~

~~[2.12 MYCORRHIZAL FUNGI INOCULUM~~

~~Mycorrhizal fungi inoculum must be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.~~

~~]~~2.10 SOURCE QUALITY CONTROL

The ~~[~~Contracting Officer~~]~~~~[and Landscape Architect of Record]~~ ~~[_____]~~ will inspect plant materials at the ~~[~~project~~]~~ site and approve them. Tag plant materials for size and quality.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide soil preparation, including ~~[~~soil conditioners~~]~~ ~~[~~and~~]~~ ~~[~~soil amendments~~]~~ prior to planting. Provide ~~[~~tree,~~]~~ ~~[shrub,] [vine,] [groundcover,]~~ ~~[~~seed,~~]~~ ~~[~~and~~]~~ ~~[~~sod~~]~~ planting, ~~[~~post-planting fertilizer,~~]~~ ~~[~~edging,~~]~~ ~~[~~staking,~~]~~ ~~[guying,] [~~weed control fabric,~~]~~ ~~[~~ anderosion control material~~,]~~ ~~[root control barrier]~~ installation,~~[_____,]~~ ~~[~~and~~]~~ ~~[~~mulch topdressing~~]~~ of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.2 PREPARATION

3.2.1 Layout

Stake out approved plant material locations and planter bed outlines on the project site before digging plant pits or beds. The Contracting Officer reserves the right to adjust plant material locations to meet field conditions. ~~Do not plant closer than [12] [24] [36] [_____] inches to a [building wall,] [pavement edge,] [fence or wall edge] [and] [other similar structures].~~

3.2.2 Soil Preparation

~~[~~3.2.2.1 pH Adjuster Application Rates

Apply pH adjuster at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

~~[~~ Lime ~~[_____] pounds per acre [_____] pounds per 1000 square feet~~ per manufacturer's recommendation.

]] Sulfur [_____] pounds per acre [_____] pounds per 1000 square feet per manufacturer's recommendation.

]] Iron [_____] pounds per acre [_____] pounds per 1000 square feet per manufacturer's recommendation.

]] Aluminum Sulfate [_____] pounds per acre [_____] pounds per 1000 square feetper manufacturer's recommendation.

]][3.2.2.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Peat [_____] cubic yard per acre [_____] cubic yards per 1000 square feet

]] Sand [_____] cubic yard per acre [_____] cubic yards per 1000 square feet

]] Compost Derivatives [_____] cubic yard per acre [_____] cubic yards per 1000 square feet

]] Gypsum [_____] cubic yard per acre [_____] cubic yards per 1000 square feet

]] Rotted Manure [_____] cubic yard per acre [_____] cubic yards per 1000 square feet

]]3.2.2.2 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Organic granular fertilizer [[_____] pounds per acre] [100[_____] pounds per 1000 square feet].

]

[Fertilizer Tablets for Trees and Shrubs]			
	[Container/Caliper Size]	[Tablet Size]	[No. of Tablets]
[Shrub:]	[[_____]]	[[_____]]	[[_____]]
[Tree:]	[[_____]]	[[_____]]	[[_____]]

[3.2.3 Root Control Barrier

[Install geotextile fabric in the soil in a [vertical] [horizontal] [and] [surrounding] application. Use appropriate holding device to assure fabric position. For vertical or horizontal application, a minimum [2] [_____] inch soil cover is required over the top [surface] [edge]. A minimum [18] [_____] inch extension of fabric beyond the structure area to be protected is required to prevent root growth from growing around fabric edges.][Install [cylindrical] [linear] polypropylene barrier a minimum

~~[1/2] [one] [_____] inch above finish grade to prevent root growth over the barrier. Backfill the outside of the barrier with 3/4 to one gravel a minimum width of [2] [_____] inches. For linear barrier application use appropriate device to connect two pieces.]~~

~~][3.2.4 Subsoil Drainage for Plant Pits and Beds~~

~~Provide as indicated.[Lay perforated drain pipe with perforations down.] Backfill trenches as specified in Section [31 00 00 EARTHWORK][31 23 00.00 20 EXCAVATION AND FILL].~~

~~]~~3.3 PLANT BED PREPARATION

Verify location of underground utilities prior to excavation. ~~Protect existing adjacent turf before excavations are made. Where planting beds occur in existing turf areas, remove turf to a depth that will ensure removal of entire root system.~~ Measure depth of plant pits from finished grade. Depth of plant pit excavation must be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph PLANT INSTALLATION. Do not install trees within 10 feet of any utility lines or building walls.

3.4 PLANT INSTALLATION

3.4.1 Individual Plant Pit Excavation

Excavate pits at least ~~[~~twice as large~~][[16] [_____] inches larger]~~ in diameter as the size of ball or container to depth shown.

3.4.2 Plant Beds with Multiple Plants

Excavate plant beds continuously throughout entire bed as outlined to depth shown.

3.4.3 Handling and Setting

Move plant materials only by supporting the ~~[~~root ball or~~]~~ ~~[~~container~~]~~. ~~[~~ Set plants on hand compacted layer of prepared backfill soil mixture ~~[~~6~~]~~ ~~[_____]~~ inches thick~~][Set plants on native soil]~~ and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Set plant materials, in relation to surrounding finish grade, ~~[~~ ~~[~~one to 2~~]~~ ~~[_____]~~ to ~~[_____]~~ inches above~~]~~ ~~[[_____] inches below]~~ depth at which they were grown in the nursery, collecting field or container. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

Plant material must be set in plant beds according to the drawings. Backfill soil mixture must be placed on previously scarified subsoil to completely surround the root balls, and must be brought to a smooth and even surface, blending to existing areas.

3.4.3.1 Balled and Burlapped Stock

Backfill with ~~[~~prepared soil mixture~~]~~ ~~[topsoil]~~ to approximately half the depth of ball and then tamp and water. Carefully remove or fold back excess burlap and tying materials from the top a minimum 1/3 depth from the top of the rootball. Tamp and complete backfill, place mulch topdressing, and water. Remove wires and non-biodegradable materials from plant pit prior to backfill operations.

~~3.4.3.2 Bare-Root Stock~~

~~Plant so roots are arranged in a natural position. Place roots in water a minimum of 30 minutes prior to planting. Carefully work [prepared soil mixture] [topsoil] among roots. Tamp remainder of backfill, place mulch topdressing and water.~~

3.4.3.2 Container Grown Stock

Remove from container and prevent damage to plant or root system.

~~3.4.3.3 Ground Covers and Vines~~

~~[Plant after placing mulch topdressing. Do not remove plant materials from flats or containers until immediately before planting. Space at intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of [6] [_____] inches without run off or puddling. Smooth planting areas after planting to provide even, smooth finish. [Mulch as indicated.]~~

~~][Smooth planting areas before planting to provide even, smooth finish. Plant after placing weed control fabric and mulch topdressing. Do not remove plant material from flats or containers until immediately before planting. Space at the intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of [6] [_____] inches without run off or puddling. Add mulch topdressing as needed.~~

~~]~~3.4.4 Earth Mounded Watering Basin for Individual Plant Pits

~~[Form with topsoil around each plant by replacing a mound of topsoil around the edge of each plant pit. Watering basins must be 6 inches deep for trees and 4 inches deep for shrubs. Eliminate basins around plants in plant beds containing multiple plants.~~

~~][~~Form with topsoil around each plant by placing a mound of topsoil around the edge of each plant pit. Watering basins must be 6 inches deep for trees and 4 inches deep for shrubs. Construct watering basin in a 4-1/2 foot diameter circle around specimen (not planted in a close group) trees and shrubs.

~~][3.4.5 Weed Control Fabric Installation~~

~~Remove grass and weed vegetation, including roots, from within the area enclosed by edging. Completely cover areas enclosed by edging with specified weed control fabric prior to placing mulch layer. Overlap cut edges [6] [_____] inches.~~

~~][3.4.6 Erosion Control Material~~

~~Install in accordance with manufacturer's instructions.~~

~~]~~3.4.5 Placement of Mulch Topdressing

Place specified mulch topdressing on top of weed control fabric covering total area enclosed by edging. Place mulch topdressing to ~~a~~the depth ~~of~~

~~[3] [_____] inches~~as indicated on the drawings.

3.4.6 Mulch ~~Topdressing~~

Provide mulch topdressing over entire planter bed surfaces and individual plant surfaces including earth mound watering basin around plants to ~~a depth of [3] [_____] inches~~the depth indicated on the plans after completion of plant installation and before watering. Keep mulch out of the crowns of shrubs. Place mulch a minimum 2 to 3 inches~~[_____]~~ away from trunk of shrub ~~or tree.~~. Place on top of any weed control fabric.

~~[~~3.4.7 Installation of Edging

Uniformly edge beds of plants to provide a clear cut division line between planted area and ~~adjacent lawn~~non planted areas. Construct bed shapes as indicated. Install ~~[wood] [plastic] [~~concrete~~]~~ edging material ~~[~~as indicated~~]~~ ~~[and] [as per manufacturer's instructions]~~. ~~[Install edging material in a perfect 4 foot diameter circle inside the 4-1/2 foot watering basin, around individual specimen trees and shrubs not planted in a close group.]~~ Install edging with minimum ~~[~~one inch~~]~~ ~~[_____]~~ left above ground level.

~~]~~3.4.8 Fertilization

3.4.8.1 Fertilizer Tablets

Place fertilizer planting tablets evenly spaced around the plant pits to the manufacturer's recommended depth.

3.4.8.2 Granular Fertilizer

Apply granular fertilizer as a top coat prior to placing mulch layer and water thoroughly.

3.4.9 Watering

Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of ~~[~~12~~]~~ ~~[_____]~~ inches without run off.

3.4.10 Staking ~~and Guying~~

3.4.10.1 Staking

Stake plants with the number of stakes indicated and ~~complete with [double strand of 12 gage guy wire] [_____]~~ as detailed in drawings. ~~Attach [guy wire] [_____] half the tree height but not more than 5 feet high. Drive stakes to a depth of [2-1/2 to 3] [_____] feet into the ground outside the plant pit. Do not injure the root ball.[Use hose chafer guards where guy wire comes in contact with tree trunk.]~~

~~3.4.10.2 Guying~~

~~Guy plants as indicated. Attach [two strands of guying wire] [guying cable] around the tree trunk at an angle of 45 degrees at approximately 1/2 of the trunk height [_____]. Protect tree trunks with chafing guards where guying [wire] [cable] contacts the tree trunk. Anchor guys to [deadmen wood blocks] [wood ground stakes] [malleable iron anchors] [steel screw anchors]. Fasten flags to each guying [wire] [cable] approximately~~

~~2/3 of the distance up from ground level.[Provide turnbuckles as indicated.]~~

~~3.4.10.3 Chafing Guards~~

~~Use hose chafing guards, as specified where guy [wire] [cable] will contact the plant.~~

~~[3.4.10.4 Deadmen~~

~~Place deadmen minimum 18 inches below ground surface. Place equal distance from tree trunk and around the plant pit.~~

~~][3.4.10.5 Wood Ground Stakes~~

~~Drive wood ground stakes into firm ground outside of plant pit with top of stake flush with ground. Place equal distance from tree trunk and around the plant pit.~~

~~][3.4.10.6 Iron Anchors~~

~~Drive malleable iron anchors into firm ground outside of plant pit a minimum 30 inches below finish grade. Place equal distance from tree trunk and around the plant pit.~~

~~][3.4.10.7 Steel Screw Anchors~~

~~Insert steel screw anchors as recommended in manufacturer's data. Place equal distance from tree trunk and around the plant pit.~~

~~][3.4.10.8 Flags~~

~~Securely fasten flags on each guy [wire] [and][cable] [approximately two-thirds of the distance up from ground level].~~

~~]~~3.4.11 Pruning

Prune in accordance with safety requirement of TCIA Z133.

3.4.11.1 Trees ~~and Shrubs~~

Remove dead and broken branches. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. ~~Do not cut central leader on trees.~~ Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars must remain in place. Pruning must be accomplished by trained and experienced personnel and must be accordance with TCIA A300P1.

~~3.4.11.2 Wound Dressing~~

~~Do not apply tree wound dressing to cuts.~~

3.5 RESTORATION AND CLEAN UP

3.5.1 Restoration

~~Turf areas, p~~Pavements and facilities that have been damaged from the planting operation must be restored to original condition at the Contractor's expense.

3.5.2 Clean Up

Excess and waste material must be removed from the installed area and must be ~~[~~disposed offsite at an approved landfill, recycling center, or composting center~~][composted on site]~~. ~~Separate and recycle or reuse the following landscape waste materials: [nylon straps,] [wire,] [ball wrap,] [burlap,] [wood stakes,] [_____].~~ Adjacent paved areas must be cleared.

-- End of Section --

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SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)
06/17

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D709	(2016) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017) National Electrical Safety Code

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-87-640	(2016) Optical Fiber Outside Plant Communications Cable; 4th Edition
ICEA S-98-688	(2012) Broadband Twisted Pair Telecommunication Cable, Aircore, Polyolefin Insulated, Copper Conductors Technical Requirements
ICEA S-99-689	(2012) Broadband Twisted Pair Telecommunication Cable Filled, Polyolefin Insulated, Copper Conductors Technical Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C62.61	(1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-107	(1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set
TIA-455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
TIA-455-78-B	(2002) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-472D000	(2007b) Fiber Optic Communications Cable for Outside Plant Use
TIA-492AAAA	(2009b) 62.5-um Core Diameter/125-um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers
TIA-492CAAA	(1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA-492E000	(1996; R 2002) Sectional Specification for Class IVd Nonzero-Dispersion Single-Mode Optical Fibers for the 1550 nm Window
TIA-526-14	(2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-526-7	(2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-568-C.2	(2009; Errata 2010; Add 2 2014; Add 1 2016) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568-C.3	(2008; Add 1 2011) Optical Fiber Cabling Components Standard
TIA-569	(2015d) Commercial Building Standard for Telecommunications Pathways and Spaces
TIA-590	(1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant

TIA-606	(2012b; Add 1 2015) Administration Standard for the Telecommunications Infrastructure
TIA-607	(2011b) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-758	(2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard
TIA/EIA-455	(1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
TIA/EIA-455-204	(2000) Standard for Measurement of Bandwidth on Multimode Fiber
TIA/EIA-598	(2014d) Optical Fiber Cable Color Coding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755	Telecommunications Standards and Specifications for Materials, Equipment and Construction
RUS Bull 1751F-630	(1996) Design of Aerial Plant
RUS Bull 1751F-640	(1995) Design of Buried Plant, Physical Considerations
RUS Bull 1751F-643	(2002) Underground Plant Design
RUS Bull 1751F-815	(1979) Electrical Protection of Outside Plant
RUS Bull 1753F-201	(1997) Acceptance Tests of Telecommunications Plant (PC-4)
RUS Bull 1753F-401	(1995) Splicing Copper and Fiber Optic Cables (PC-2)
RUS Bull 345-50	(1979) Trunk Carrier Systems (PE-60)
RUS Bull 345-65	(1985) Shield Bonding Connectors (PE-65)
RUS Bull 345-72	(1985) Filled Splice Closures (PE-74)
RUS Bull 345-83	(1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)

UNDERWRITERS LABORATORIES (UL)

UL 497	(2001; Reprint Jul 2013) Protectors for Paired Conductor Communication Circuits
UL 510	(2005; Reprint Jul 2013) Polyvinyl

	Chloride, Polyethylene and Rubber Insulating Tape
UL 83	(2014) Thermoplastic-Insulated Wires and Cables

1.2 RELATED REQUIREMENTS

Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM, Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, TIA-606, and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect - (MC).) On Camp Lejeune the main cross-connect is established in Area Distribution Nodes (ADN), network operation centers (NOC), or telephone central office serving predesignated areas of the base. Designers should not design any new main cross-connects without approval from TSD (Telecommunications Support Division aka Base Telephone). The campus backbone is outside plant (OSP) back to TSD and a network operations center.

1.3.2 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including antennae, CATV, CCTV, IDS) including the entrance point at the building wall and continuing to the entrance room or space.

1.3.3 Entrance Room (ER) (Telecommunications)

A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity but could be combined within the communications room if additional space needed is allotted.

1.3.4 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect - (IC).)

1.3.5 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The telecommunications outside plant consists of cable, conduit, manholes, splices, protection, riser points, load coils, etc. required to provide

signal paths from the closest point of presence (demarcation) to the new facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning and surge protection modules at one or both ends of the cable, installed from the entrance facility in building to designated demarcation point. The work consists of providing, testing and making operational cabling, interconnecting hardware and lightning and surge protection necessary to form a complete outside plant telecommunications system for continuous use. The telecommunications contractor must coordinate with TSD concerning layout and configuration of the EF telecommunications and OSP. The telecommunications contractor may be required to coordinate work effort for access to the EF telecommunications and OSP with TSD.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

a. Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph "Regulatory Requirements" and as required for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

b. Commercial off-the-shelf manuals shall be provided for operation, installation, configuration, and maintenance of products provided as a part of the communications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs "Telecommunications Outside Plant Shop Drawings" and "Telecommunications Entrance Facility Drawings".

SD-02 Shop Drawings

Telecommunications Outside Plant; G

Telecommunications Entrance Facility Drawings; G

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Wire and cable; G

Cable splices, and connectors; G

Closures; G

Building protector assemblies; G

Protector modules; G

Cross-connect terminal cabinets; G

Spare Parts; G

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Pre-installation tests; G

Acceptance tests; G

Outside Plant Test Plan; G

SD-07 Certificates

Telecommunications Contractor Qualifications; G

Key Personnel Qualifications; G

Minimum Manufacturer's Qualifications; G

SD-08 Manufacturer's Instructions

Building protector assembly installation; G

Cable tensions; G

Fiber Optic Splices; G

Submit instructions prior to installation.

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G

SD-10 Operation and Maintenance Data

Telecommunications outside plant (OSP), Data Package 5; G

Commercial off-the-shelf manuals shall be provided for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS OUTSIDE PLANT SHOP DRAWINGS and TELECOMMUNICATIONS ENTRANCE FACILITY DRAWINGS.

SD-11 Closeout Submittals

Record Documentation; G

In addition to other requirements, provide in accordance with paragraph RECORD DOCUMENTATION.

1.5.1 ADDITIONAL SUBMITTAL REQUIREMENTS

All submittals of material, equipment and design must be approved by the TSD Office prior to installing any telecommunications cabling and equipment.

1.6 QUALITY ASSURANCE

Ensure compliance with Section 01 45 00.00 20 QUALITY CONTROL.

1.6.1 Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Outside Plant Shop Drawings

Provide Outside Plant Design in accordance with TIA-758, RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643 for underground duct system design and for direct buried system design. Provide T0 shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA-606. Drawings shall include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, load coils, fiber pair count and type, pathway duct and innerduct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified in specification and drawings. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the telecommunications outside plant. Update existing telecommunication Outside Plant T0 drawings to include information modified, deleted or added as a result of this installation in accordance with TIA-606. The telecommunications outside plant (OSP) shop drawings shall be included in the operation and maintenance manuals.

1.6.1.2 Telecommunications Entrance Facility Drawings

Provide T3 drawings for EF Telecommunications in accordance with TIA-606 that include telecommunications entrance facility plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical

layout, and cabinet, rack, backboard and wall elevations. Drawings shall show layout of applicable equipment including incoming cable connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings. Provide T3 drawings for EF Telecommunications as specified in the paragraph TELECOMMUNICATIONS SPACE DRAWINGS of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS. The telecommunications entrance facility shop drawings shall be included in the operation and maintenance manuals.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor Qualifications

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years.

1.6.2.2 Key Personnel Qualifications

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Cable splicing and terminating personnel assigned to the installation of this system or any of its components shall have training in the proper techniques, shall be Building Industry Consulting Services International (BICSI) Certified Cabling Installation Technicians, Installer Level 2, or have a minimum of 3 years current consecutive experience in the installation of the specified copper and fiber optic cable and components for products used.

Supervisors and installers assigned to the installation of this system or any of its components shall have factory or factory approved certification

from each equipment manufacturer indicating that they are qualified to install and test the provided products.

Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from the Contracting Officer.

1.6.2.3 Minimum Manufacturer's Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with, TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. In addition, cabling manufacturers shall have a minimum of 3 years experience in the manufacturing and factory testing of cabling which comply with ICEA S-87-640, ICEA S-98-688, and ICEA S-99-689.

1.6.3 Outside Plant Test Plan

Prepare and provide a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the copper conductor and optical fiber cables, components, and accessories for approval by Telecommunications Support Division (aka Base Telephone) via the Contracting Officer. Include a cut-over plan with procedures and schedules for relocation of facility station numbers without interrupting service to any active location. Submit the plan at least 30 days prior to tests for Contracting Officer approval. Provide outside plant testing and performance measurement criteria in accordance with TIA-568-C.1 and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link performance criteria.

1.6.4 Standard Products

Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and shall be the manufacturer's latest standard design that has been in satisfactory commercial or industrial use for at least 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section. Product submission must be approved for use by TSD via Contracting Officer prior to install.

1.6.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

1.6.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the TSD via the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated by references or AHJ. Because references are living documents use of most current version shall be enforced.

1.6.5.1 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.7 DELIVERY, STORAGE, AND HANDLING

Ship cable on reels in 5000 feet length with a minimum overage of 10 percent for 25, 50 or 100 pair configuration and 1250 feet length for larger cables. Radius of the reel drum shall not be smaller than the

minimum bend radius of the cable. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at both ends of the cable shall be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

1.8 MAINTENANCE

1.8.1 Record Documentation

Provide the activity responsible for telecommunications system maintenance and administration (TSD via the Contracting Officer) a single complete and accurate set of record documentation for the entire telecommunications system for each structure with respect to this project.

Provide record documentation as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided in both hard copy format and on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, shall be provided. Update existing record documentation to reflect campus distribution T0 drawings and T3 drawing schedule information modified, deleted or added as a result of this installation. Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA-606. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility for the soft copy in accordance with TIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - Provide a record of installed patch panels, cross-connect points, campus distributor and terminating block arrangements and type in accordance with TIA-606. Documentation shall include the required data fields as a minimum in accordance with TIA-606.

Provide record documentation as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

1.8.2 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts

recommended for stocking. Spare parts shall be provided no later than the start of field testing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems. All product data must be supplied in the submittal process and no product can be used without approval from TSD via the Contracting Officer.

2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

2.2.1 Building Protector Assemblies

Building protector assembly (BEP) shall be self-contained and have interconnecting hardware (710 input and 66 output) for connection to all Outside Plant rated cabling at full capacity. Provide and follow manufacturers instructions for building protector assembly installation. If Multiple BEPs are used, arrange and connect with lowest count high and to left and highest to bottom right. Provide copper cable interconnecting hardware as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. There will be no service loops or splicing of copper cable outside of the building protector assembly within the telecommunications room (pigtail BEPs are not authorized).

2.2.2 Protector Modules

Provide in accordance with UL 497 three-electrode gas tube type, 5 pin, rated for the application. Provide gas tube protection modules in accordance with RUS Bull 345-83 and shall be heavy duty, A>10kA, B>400, C>65A where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current in accordance with ANSI C62.61. The gas modules shall shunt high voltage to ground, fail short, and be equipped with an external spark gap and heat coils in accordance with UL 497. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly. Recommend 4B1E type.

2.2.3 Fiber Optic Terminations

Provide fiber optic cable terminations as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Ensure terminations within the Fiber Distribution Center (FDC) are logical left to right and top to bottom (OSP SM/Backbone SM then MM/Row to Row SM then MM).

2.2.4 Pathways

Underground applications for single buildings: provide a minimum of (3) four inch ducts (copper, fiber, maintenance duct... in that order), one of which (fiber)contains (2)- three cell fabric inner duct. The (3) four

inch ducts shall enter the Main Communications Room (entrance facility) to the far left of the communications backboard (longest farthest wall from the door) and shall be 3-6 inches above floor and 3-6 inches away from wall, aligned parallel to the communications backboard wall. The underground ducts must have 3" concrete encasing, with 24 inches minimum backfill below grade from the Communications Entrance Facility to the maintenance hole that will be providing service to the building (Demarcation point).

For campus distribution between maintenance holes, ducts may need to be 5" to support larger cables, also there will be no less than 4, and up to xx ducts as needed for distribution to the area serviced. All new ducts will include bell ends and terminators flush with MH walls sealed water tight. Both ends of new duct shall be plugged with compression plugs or duct seal around cables (no expanding foam). All new pathway shall be visibly marked and provided on area map with GPS coordinates. All ducts shall be installed as straight through runs between holes and shall not cross each other allowing a straight pull through. All duct banks where fiber cables are installed shall include fabric innerduct to maximize the pathway.

For direct buried applications (only in remote areas where there is no manhole duct systems and none is in project contract), provide a minimum of three (3) four inch ducts from the Communications Entrance Facility to outside the bldg foot print past any obstructions, footers, or sidewalks by at least 5 feet into clear soil/entryway, 24 inches below grade. The ducts will be plugged at both ends and clearly marked on outside end. For distribution to demarcation, between handholes, and riser points cables need to be 36" below grade with metal locating tape at 24" below grade. Cables need to be in HDDPE direct bored, HDDPE direct buried, concrete encased in conduit, or concrete encased split duct under all roadways and pavement. All new cables need to be provided on area map with GPS coordinates for riser points or hand holes. Handholes and maintenance holes shall be traffic rated (MIN tier 22). Handhole size min 4'x4'x4'. Maintenance hole size 6'x7'x8'and all penetrations should be splayed.

If utility pathway conflicts necessitate placement of a manhole below the typical/normal depth (6-12 inches), the roof of the manhole shall be placed at normal depth and riser extensions shall be used to increase the depth of the manhole. If a deep collar is unavoidable and the depth of the collar will exceed 24 inches, the Designer shall obtain written permission from TSD (Base Telephone) and ensure that the collar is equipped with permanent galvanized steps (rungs). Also do not drill hole in bottom of maintenance/handhole for grounding rod, use grounding ribbon built into the concrete structure itself that is in full contact with the ground.

2.3 CLOSURES

2.3.1 Copper Conductor Closures

2.3.1.1 Aerial Cable Closures

Provide cable closure assembly consisting of a frame with clamps, a lift-off polyethylene cover, cable nozzles, and drop wire rings. Closure shall be suitable for use on Figure 8 cables. Closures shall be free breathing and suitable for housing either straight-through type or branch type splices of non-pressurized communications cables and shall be sized as indicated. The closure shall be constructed with ultraviolet resistant PVC.

NOTE: The installation of aerial cabling aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized.

2.3.1.2 Underground Cable Closures

a. Aboveground: Provide aboveground closures constructed of not less than 14 gauge steel and acceptable for pole or stake mounting in accordance with RUS 1755.910. Closures shall be sized and contain a marker as indicated. Covers shall be secured to prevent unauthorized entry. PVC type closures are to be used in beach areas. All pedestals shall contain a minimum 4 foot x 3/8 inch pigtailed ground rod.

b. Direct burial: Provide buried closure suitable for enclosing a straight, butt, and branch splice in a container into which can be poured an encapsulating compound. Closure shall have adequate strength to protect the splice and maintain cable shield electrical continuity in the buried environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

NOTE: The installation of a direct buried closure aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized; all closures shall be in a riser point, handhole, or manhole.

c. In vault or manhole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which air can be pumped for flash testing. Closure shall be of suitable thermoplastic or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Heat shrinkable type closures shall not be used. Provide filled splice cases in accordance with RUS Bull 345-72.

2.3.2 Fiber Optic Closures

2.3.2.1 Aerial

Provide aerial closure that is free breathing and suitable for housing splice organizer of non-pressurized cables. Closure shall be constructed from heavy PVC with ultraviolet resistance.

NOTE: The installation of new aerial cabling aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized.

2.3.2.2 Direct Burial

Provide buried closure suitable to house splice organizer in protective housing into which can be poured an encapsulating compound. Closure shall have adequate strength to protect the splice and maintain cable shield electrical continuity, when metallic, in buried environment. Encapsulating compound shall be reenterable and shall not alter chemical stability of the closure.

NOTE: The installation of a direct buried closure aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized; all closures shall be in a riser point, handhold, or manhole.

2.3.2.3 In Vault or Manhole

Provide underground closure suitable to house splice organizer in a protective housing into which air can be pumped for flash testing. Closure shall be of thermoplastic material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Provide 60' slack coils on fiber in every 3rd manhole/handhole or in any which a turn is made.

2.4 PAD MOUNTED CROSS-CONNECT TERMINAL CABINETS

Provide in accordance with RUS 1755.910 and the following:

a. Constructed of 14 gauge steel.

b. Equipped with a double set of hinged doors with closed-cell foam weatherstripping. Doors shall be locked and contain a marker as indicated.

c. Equipped with spool spindle bracket, mounting frames, binding post log, jumpering instruction label, and load coil mounting provisions.

d. Complete with cross connect modules to terminate number of pairs as indicated.

e. Sized as indicated.

2.5 CABLE SPLICES, AND CONNECTORS

2.5.1 Copper Cable Splices

In vaults or manholes or entrance protectors provide multi-pair, in-line fold back to maximize length of accessible conductors for maintenance or single pair, in-line splices of a moisture resistant, three-wire insulation displacement connector held rigidly in place to assure maximum continuity in accordance with RUS Bull 1753F-401. Cables greater than 25 pairs shall be spliced using multipair splicing connectors, which accommodate 25 pairs of conductors at a time (typical 710). Provide correct connector size to accommodate the cable gauge of the supplied cable. Provide enough cable slack suitable for splicing operations to maximize length of accessible conductors for maintenance operations. In above ground splices use three wire insulation displacement single pair connectors no matter what size the cable. In longer runs of copper provide proper load coils to balance the load as needed to ensure line quality in accordance with RUS Bull 1753F-201.

2.5.2 Copper Cable Splice Connector

Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector shall accommodate 19 to 26 AWG solid wire with a maximum insulation diameter of 0.065 inch and shall only be installed with manufacturer recommended crimp/cut tool. Fill connector with sealant grease to make a moisture resistant connection, in accordance with RUS Bull 1753F-401.

2.5.3 Fiber Optic Cable Splices

Provide fiber optic cable splices and splicing materials for fusion

methods at locations shown on the construction drawings. The splice insertion loss shall be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Splices shall be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107. Physically protect each fiber optic splice by a splice kit specially designed for the splice. Provide enough cable slack suitable for splicing operations, but in no case less than 30 feet at each end.

2.5.4 Fiber Optic Splice Organizer

Provide splice organizer suitable for housing fiber optic splices in a neat and orderly logical fashion. Splice organizer shall allow for a minimum of 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer shall accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

2.5.5 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.6 CONDUIT

Provide conduit as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 PLASTIC INSULATING TAPE

Tape shall be premium quality, heavy-duty, weather-resistant designed for use on electrical and telecommunications applications and UL 510 compliant.

2.8 WIRE AND CABLE

2.8.1 Copper Conductor Cable

Solid copper conductors, covered with an extruded solid insulating compound. Insulated conductors shall be twisted into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, the cable core shall be separated into compartments. Cable shall be completed by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor shall verify distances between splice points, slack required, and pair count required prior to ordering cable. Gauge of conductor shall be determined by the distance from the central office. In all cases the installed cable shall be of the same gauge as the cable it is being spliced into at the Demarcation point. The cable range available is; numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs). **26 AWG is not used on Camp Lejeune** Copper conductors shall conform to the following: All outside plant copper conductor cable available in PE-39 type shall be used; PE-89 is only approved for large pair counts when PE-39 is not manufactured due to large count.

2.8.1.1 Underground

Provide filled cable (type PE-39/89) meeting the requirements of ICEA S-99-689, RUS 1755.390, and RUS 1755.890. Provide enough cable slack suitable for splicing operations, but in no case less than 10 feet.

2.8.1.2 Aerial

Provide filled cable meeting the requirements of ICEA S-99-689, ICEA S-98-688, and RUS 1755.390 except that it shall be suitable for aerial installation and shall be Figure 8 distribution wire with 6,000 pound Class A galvanized steel or 6,000 pound aluminum-clad steel strand.

2.8.1.3 Screen

Provide screen-compartmental core cable filled cable meeting the requirements of ICEA S-99-689 and RUS 1755.390.

2.8.2 Fiber Optic Cable

Provide single-mode, 8/125-um, 0.10 aperture 1310 nm fiber optic cable in accordance with TIA-492CAAA, and single-mode, 8/125-um, 0.10 aperture 1550 nm fiber optic cable in accordance with TIA-492E000 and multimode 62.5/125-um, 0.275 aperture fiber optic cable in accordance with TIA-492AAAA, TIA-472D000, and ICEA S-87-640 including any special requirements made necessary by a specialized design. Provide a minimum of 24 optical fibers or more as indicated by drawings but never less without a waiver from local authority having jurisdiction. Fiber optic cable shall be specifically designed for outside use with preferred double jacket (if buried), single armor, loose buffer construction, and must be shielded. Provide fiber optic color code in accordance with TIA/EIA-598. Provide minimum 60' slack coil in every 3rd MH or any one where a turn is made.

NOTE: The installation of Multi-mode OSP Fiber Optic cables aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized; except as Backbone Underground Cabling between Communications Rooms within the same building, which is allowed, but not recommended.

2.8.2.1 Strength Members

Provide central/non-central, non-metallic/metallic strength members with sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements in accordance with ICEA S-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and shall not serve as a pulling strength member.

2.8.2.2 Shielding or Other Metallic Covering

Provide continuous, conductive or locatable, single tape covering and shield in accordance with ICEA S-87-640 on all cables.

2.8.2.3 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

2.8.3 Grounding and Bonding Conductors

Provide grounding and bonding conductors in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B1 for sizes No. 8 AWG and smaller and stranded bare copper wire meeting the requirements of ASTM B8, for sizes No. 6 AWG and larger. Conductors should be installed so as not to exceed minimum bend radius and shall be attached to most suitable bond available at location. Do not install field modified ground rods in maintenance holes that already have factory grounding. Insulated conductors shall have 600-volt, Type TW insulation meeting the requirements of UL 83.

2.9 T-SPAN LINE TREATMENT REPEATERS

Provide as indicated. Repeaters shall be pedestal mounted with pressurized housings, sized as indicated and shall meet the requirements of RUS Bull 345-50.

2.10 POLES AND HARDWARE

Provide poles and hardware as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

2.11 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide tags for each telecommunications cable or wire located in manholes, handholes, and vaults. Cable tags shall be stainless steel or polyethylene and labeled in accordance with TIA-606. Coordinate actual cable tag information with TSD. Handwritten labeling is unacceptable.

2.11.1 Stainless Steel

Provide stainless steel, cable tags 1 5/8 inches in diameter 1/16 inch thick minimum, and circular in shape. Tags shall be die stamped with numbers, letters, and symbols not less than 0.25 inch high and approximately 0.015 inch deep in normal block style.

2.11.2 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags orientation.

2.12 BURIED WARNING AND IDENTIFICATION TAPE

Provide fiber optic media marking and protection in accordance with TIA-590. Provide color, type and depth of tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 23 00.00 20 EXCAVATION AND FILL.

2.13 GROUNDING BRAID

Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755.200. Braid shall be made from flat tin-plated copper properly attached to factory ground in maintenance/handhole, TMGB, building steel, electrical bus, or approved grounding rods in riser points.

2.14 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.15 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates in accordance with ASTM D709 for each patch panel, protector assembly, rack, cabinet and other equipment or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.16 TESTS, INSPECTIONS, AND VERIFICATIONS

2.16.1 Factory Reel Test Data

Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568-C.1 and TIA-568-C.3. Use TIA-526-7 for single mode fiber and TIA-526-14 Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), shall meet the requirements of ICEA S-99-689. Enhanced performance air core OSP copper cables shall meet the requirements of ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

PART 3 EXECUTION

3.1 INSTALLATION

Install all system components and appurtenances in accordance with manufacturer's instructions, IEEE C2, NFPA 70, and as indicated. Provide all necessary interconnections, services, and adjustments required for a complete and operable telecommunications system from designated demarcation point to building entrance facility, to include lightning protection terminations at one or both ends of the cable as required per paragraph: SYSTEM DESCRIPTION.

3.1.1 Contractor Damage

Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a nonindicated line or system, such notice

shall provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify Base Telephone via the Contracting Officer of damage.

3.1.2 Cable Inspection and Repair

Handle cable and wire provided in the construction of this project with care. Inspect cable reels for cuts, nicks or other damage. Damaged cable shall be replaced or repaired to the satisfaction of the Contracting Officer. Reel wraps shall remain intact on the reel until the cable is ready for placement.

3.1.3 Direct Burial System

Installation shall be in accordance with RUS Bull 1751F-640. Under railroad tracks, paved areas, and roadways install cable in conduit encased in concrete. Slope ducts to drain. Excavate trenches by hand or mechanical trenching equipment after proper locates and pothole methods are used. Provide a minimum cable cover of 36 inches below finished grade for both fiber and copper cable. Trenches shall be not less than 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches shall have a radius of not less than 36 inches. Where two or more cables are laid parallel in the same trench, space laterally at least 3 inches apart. When rock is encountered, remove it to a depth of at least 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position. Provide color, type and depth of warning tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 23 00.00 20 EXCAVATION AND FILL. Fiber optic cable will not be direct buried, it will be installed in a smooth wall HDPE type duct.

3.1.3.1 Cable Placement

a. Prior to design and installation of any copper or optical fiber cable systems, cable routes and pathways must be approved by the Base Telephone via Contracting Officer. Manhole layouts (butterflies) shall be provided for review and approval. Cable route shall include which conduits are to be used for which cables using a logical bottom up and straight run approach.

b. Separate cables crossing other cables or metal piping from the other cables or pipe by not less than 3 inches of well tamped earth. Do not install circuits for communications under or above traffic signal loops.

c. Cables shall be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

d. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

e. Leave a horizontal slack of approximately 10 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought aboveground. Where cable is brought aboveground, leave additional slack to make necessary connections. (For fiber, provide a minimum of 30 feet at each end.)

3.1.3.2 Identification Slabs (Markers)

Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers shall be of concrete, approximately 20 inches square by 6 inches thick.

3.1.3.3 Backfill for Rocky Soil

When placing cable in a trench in rocky soil, the cable shall be cushioned by a fill of sand or selected soil at least 2 inches thick on the floor of the trench before placing the cable or wire. The backfill for at least 4 inches above the wire or cable shall be free from stones, rocks, or other hard or sharp materials which might damage the cable or wire. If the buried cable is placed less than 24 inches in depth, a protective cover of concrete shall be used.

3.1.4 Cable Protection

Provide direct burial cable protection in accordance with NFPA 70 and as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Galvanized conduits which penetrate concrete (slabs, pavement, and walls) shall be PVC coated and shall extend from the first coupling or fitting outside either side of the concrete minimum of 6 inches per 12 inches burial depth beyond the edge of the surface where cable protection is required; all conduits shall be sealed on each end. Where additional protection is required, cable may be placed in galvanized iron pipe (GIP) sized on a maximum fill of 40 percent of cross-sectional area, or in concrete encased 4 inches PVC pipe. Conduit may be installed by jacking or trenching. Trenches shall be backfilled with earth and mechanically tamped at 6 inches lift so that the earth is restored to the same density, grade and vegetation as adjacent undisturbed material.

3.1.4.1 Cable End Caps

Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.1.5 Underground Duct

Provide underground duct and connections (terminators and bell ends) to existing manholes or handholes, as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION with any additional requirements as specified herein. Minimum size of ducts shall be 4 inch and minimum number will be three (3) into any building.

3.1.6 Reconditioning of Surfaces

Provide reconditioning of surfaces as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.1.7 Penetrations

Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.8 Cable Pulling

Test duct lines with a mandrel (SHALL BE WITNESSED BY GOVERNMENT) and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the manhole. Do not place cables in ducts other than those shown without prior written approval of Base Telephone via the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the manhole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling shall also be stopped when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

3.1.8.1 Cable Tensions

Obtain from the cable manufacturer and provide to the Contracting Officer, the maximum allowable pulling tension. This tension shall not be exceeded.

3.1.8.2 Pulling Eyes

Equip cables 1.25 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller than 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping shall not be beaten into the cable sheath. Use a swivel of 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.8.3 Installation of Cables in Manholes, Handholes, and Vaults

Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Do not install slack coils in copper unless approved or requested by AHJ. Fiber slack coils should be min 60' in every 3rd MH or any MH where a turn is made. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 4 feet. Install cable or cables in corresponding ducts entering and exiting the manholes in straight lines, do not cross ducts or manhole. In existing manholes, handholes, and vaults where new ducts are

to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables. Identify each cable with corrosion-resistant embossed metal tags. All fiber optic cables will be installed in fabric innerduct measuring min 1 inch (or larger) with min of three cells (but should maximize pathways).

3.1.9 Aerial Cable Installation

Pole installation shall be as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Where physical obstructions make it necessary to pull distribution wire along the line from a stationary reel, use cable stringing blocks to support wire during placing and tensioning operations. Do not place ladders, cable coils, and other equipment on or against the distribution wire. Wire shall be sagged in accordance with the data shown. Protect cable installed outside of building less than 8 feet above finished grade against physical damage.

NOTE: The installation of aerial cabling aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized.

3.1.9.1 Figure 8 Distribution Wire

Perform spiraling of the wire within 24 hours of the tensioning operation. Perform spiraling operations at alternate poles with the approximate length of the spiral being 15 feet. Do not remove insulation from support members except at bonding and grounding points and at points where ends of support members are terminated in splicing and dead-end devices. Ground support wire at poles to the pole ground.

3.1.9.2 Suspension Strand

Place suspension strand as indicated. Tension in accordance with the data indicated. When tensioning strand, loosen cable suspension clamps enough to allow free movement of the strand. Place suspension strand on the road side of the pole line. In tangent construction, point the lip of the suspension strand clamp toward the pole. At angles in the line, point the suspension strand clamp lip away from the load. In level construction place the suspension strand clamp in such a manner that it will hold the strand below the through-bolt. At points where there is an up-pull on the strand, place clamp so that it will support strand above the through-bolt. Make suspension strand electrically continuous throughout its entire length, bond to other bare cables suspension strands and connect to pole ground at each pole.

3.1.9.3 Aerial Cable

Keep cable ends sealed at all times using cable end caps. Take cable from reel only as it is placed. During placing operations, do not bend cables in a radius less than 10 times the outside diameter of cable. Place temporary supports sufficiently close together and properly tension the cable where necessary to prevent excessive bending. In those instances where spiraling of cabling is involved, accomplish mounting of enclosures for purposes of loading, splicing, and distribution after the spiraling operation has been completed.

NOTE: The installation of aerial cabling aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized.

3.1.10 Cable Splicing

3.1.10.1 Copper Conductor Splices

Perform splicing in accordance with manufacturer, best known practices, and requirements of RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are not allowed. Exception does not apply for pairs assigned for carrier application.

3.1.10.2 Fiber Optic Splices

Fiber optic splicing shall be in accordance with manufacturer's recommendation and shall exhibit an insertion loss not greater than 0.2 dB for fusion splices.

NOTE: The installation of Mechanical Fiber Optic Splices aboard Marine Corps Base, Camp Lejeune and Marine Corps Air Station, New River is not authorized.

3.1.11 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection (710 input/66 output) installed at each end which meet the requirements of RUS Bull 1751F-815.

3.1.12 Grounding

Provide grounding and bonding in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Ground exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.

3.1.12.1 Telecommunications Master Ground Bar (TMGB)

The TMGB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment. Establish a TMGB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. The TMGB will at a minimum be 4 inches by 10 inches by 1/4 inch as shown in TIA-607.

3.1.12.2 Incoming Cable Shields

Shields shall not be bonded across the splice to the cable stubs at the main distribution frame. Ground shields of incoming cables in the EF Telecommunications to the TMGB.

3.1.12.3 Campus Distributor Grounding

a. Protection assemblies: Mount CD protector assemblies directly on the telecommunications backboard. Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to TMGB.

b. TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.01 ohms.

3.1.13 Cut-Over

All necessary transfers and cut-overs, shall be accomplished by the telecommunications contractor except government owned cables with active service which must be done by TSD.

3.2 LABELING

3.2.1 Labels

Provide labeling for new cabling and termination hardware located within the facility in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for cable and termination hardware shall be provided using either thermal ink transfer process or laser printer. Actual information on labels shall be obtained from TSD via contracting office.

3.2.2 Cable Tag Installation

Install cable tags for each telecommunications cable or wire located in manholes, handholes, and vaults including each splice. Tag new wire and cable provided under this contract and existing wire and cable which are indicated to have splices and terminations provided by this contract. The labeling of telecommunications cable tag identifiers shall be in accordance with TIA-606. Tag legend shall be as indicated. Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

3.2.3 Termination Hardware

Label patch panels, distribution panels, connector blocks and protection modules using color coded labels with identifiers in accordance with TIA-606.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FIELD QUALITY CONTROL

Provide the Contracting Officer 10 working days notice prior to each test. Provide labor, equipment, and incidentals required for testing. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed. Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

3.4.1 Pre-Installation Tests

Perform the following tests on cable at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests shall be performed at the factory and certified test results shall accompany the cable.

3.4.1.1 Cable Capacitance

Perform capacitance tests on all pairs within a cable to determine if cable capacitance is within the limits specified.

3.4.1.2 Loop Resistance

Perform DC-loop resistance on all of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's calculated resistance.

3.4.1.3 Pre-Installation Test Results

Provide results of pre-installation tests to the Contracting Officer at least 5 working days before installation is to start. Results shall indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable from the job site.

3.4.2 Acceptance Tests

Perform acceptance testing in accordance with RUS Bull 1753F-201 and as further specified in this section. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any test unless specified otherwise. Testing shall not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested. Provide test reports to TSD via Contracting officer in soft and hard copy in .pdf or .xls form showing all field tests performed, upon completion and testing of the installed system. Measurements shall be tabulated on a pair by pair or strand by strand basis. Blank forms can be provided from Base Telephone upon request.

3.4.2.1 Copper Conductor Cable

Perform the following acceptance tests in accordance with TIA-758:

a. Wire map (pin to pin continuity)

b. Continuity to remote end

c. Crossed pairs

d. Reversed pairs

e. Split pairs

f. Shorts between two or more conductors

g. Grounded pairs.

3.4.2.2 Fiber Optic Cable

Test fiber optic cable in accordance with TIA/EIA-455 and as further specified in this section. Two optical tests shall be performed on all

optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. These tests shall be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, outside plant field un-terminated at demarcation point, and the far-end pre-connectorized single fiber cable assembly.

a. OTDR Test: The OTDR test shall be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. Hard copy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 1000 feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7 for single-mode fiber and TIA-526-14 for multimode fiber. Splice losses shall not exceed 0.2 db.

b. Attenuation Test: End-to-end attenuation measurements shall be made on all fibers, in both directions, using a 850 & 1300 for 62.5 multi-mode fiber and 1310 & 1550 for single mode nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with TIA-455-46A for multimode and TIA-526-7 for single-mode fiber optic cables. The measurement method shall be in accordance with TIA-455-78-B. Attenuation losses shall not exceed 0.5 db/km at 1310 nm and 1550 nm for single-mode fiber. Attenuation losses shall not exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multimode fiber.

c. Bandwidth Test: The end-to-end bandwidth of all multimode fiber span links shall be measured by the frequency domain method. The bandwidth shall be measured in both directions on all fibers. The bandwidth measurements shall be in accordance with TIA/EIA-455-204.

3.4.3 Soil Density Tests

a. Determine soil-density relationships for compaction of backfill material in accordance with ASTM D1557, Method D.

b. Determine soil-density relationships as specified for soil tests in Section 31 23 00.00 20 EXCAVATION AND FILL.

-- End of Section --