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The Description of the Project
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SPECIFICATION DIVISION 23

NUMBER SECTION DESCRIPTION

DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING (HVAC)
SECTION 238413 – STEAM HUMIDIFIERS

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DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING (HVAC)
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

B. Related Sections:

1. Section 018113: Sustainable Design Requirements.
2. Section 019110/019100: Commissioning
3. Section 220500: Common Work Results for Mechanical
4. Section 221113: Piping Materials and Methods
5. Section 220523: Valves
6. Section 220553: Mechanical Identification
7. Section 220719: Mechanical Systems Insulation
8. Section 221119: Domestic Water Piping Specialties
9. Section 232216: Steam and Condensate Piping Specialties
10. Section 230900: Mechanical Systems Controls
11. Division 26: Electrical

1.2 SUMMARY

A. Products specified in this section include the following:

1. Jacketed Steam Humidifiers
2. Steam Injection Dispersion Panels
3. Self-contained Electric Humidifiers
4. Condensate Drain Coolers

1.3 SUBMITTALS

A. Product Data: Include catalog illustrations, model, rated capacities, performance, weights, dimensions, component sizes, rough-in requirements, piping and wiring diagrams and details, materials of construction, accessories, operating and maintenance clearance requirements. Wiring diagrams shall be project specific, and differentiate between factory wiring and field wiring. Include shop drawings and fabrication drawings for equipment indicating piping connections, power and utility requirements, rigging, installation and support details and instructions. Include written sequence of operations for all controls.

B. Provide information for the following:

1. At conditions specific to the project:
   a. Non-wetting (absorption) distance, assuming air downstream of the humidifier is 90% R.H. at 52˚F
   b. Air pressure drop across the humidifier array
   c. For steam injection dispersion panels, required orientation of tubes in the duct.
2. Strainers and steam traps

3. Humidifier actuator and temperature switch
4. Room and duct transmitters and proof of air flow switch
5. Electrode type self-contained Electric humidifiers:
    a. Published cylinder life based on incoming water conductivity
    b. Published replacement pricing
6. Condensate drain cooler
7. Installation, operation, and maintenance manuals

1.4 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. Underwriters Laboratories

1.5 DELIVERY, STORAGE AND HANDLING

A. Ship all components in weather-proof wrap for storage outdoors. Protect control panels, pipe openings, and other sensitive components with heavy plastic or other durable means to ensure cleanliness and prevent damage during shipping and storage. Maintain protection during installation.

1.6 WARRANTY

A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design and model numbers (where provided) are Dri-Steem. Subject to compliance with all requirements and matching the features of the Basis of Design and model numbers, provide products from any of the below manufacturers.

1. Armstrong
2. Neptronics
3. Condair
4. Hermidifier
5. Dri-Steem
6. Pure

2.2 JACKETED STEAM HUMIDIFIERS

A. Steam separator type that discharges dry steam into the air stream through a steam jacketed dispersion tube or manifolded dispersion tubes. Humidifiers shall be complete with Y-type steam supply strainer, modulating steam control valve, condensate temperature switch and steam traps; all provided by the humidifier manufacturer. Provide manifolded multiple dispersion tube type when required to meet the capacity requirements or the conditions at the mounting location, including the indicated non-wetting (absorption) distance. All components shall be rated for a minimum 100 PSIG steam working pressure.

B. The humidifier shall provide absorption characteristics that preclude wetting on any in-duct surfaces within the indicated absorption distance downstream of the humidifier while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 52°F in the duct air stream.

C. Unless indicated otherwise, the air pressure loss across the humidifier array shall not exceed 0.10" W.C. at a duct air velocity of 1200 FPM.

D. Provide type 304 stainless steel dispersion tubes, manifold and separator.

E. Dispersion tubes shall be surrounded by a steam jacket and shall span the width of duct.

F. Provide bronze or stainless steel, fail closed, electric steam control valve for operation with a modulating control signal, minimum 13:1 rangeability and ANSI Class 5 Shutoff.

G. Provide an electric condensate temperature switch for interlocking with control valve. Switch shall be normally closed and shall prevent steam flow to dispersion tubes upon cold start or flooded condensate line.

H. Steam traps shall be per Related Section, sized and provided by the humidifier manufacturer. Provide F & T or thermostatic traps that allow modulating steam control valve service.

I. Provide Type 316 stainless steel dispersion tubes, manifold, separator, and interconnecting piping; and stainless steel strainers, control valve and traps when fed by clean steam (steam generated with RO/DI water).

2.3 STEAM INJECTION DISPERSION PANELS

A. Ultra-sorb LV/HV Multi-tube style - TYPE A:

1. Multi-tube non-jacketed style humidifier for use with pressurized or non-pressurized steam and gravity draining of condensate. Each panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Stainless steel construction. Humidifiers shall be complete with Y-type steam supply strainer, modulating steam control valve, condensate temperature switch and steam traps; all provided by the humidifier manufacturer. All components shall be rated for a minimum 100 PSIG steam working pressure.
2. Each steam tube outlet shall contain an orifice sized for its required steam capacity. The humidifier shall provide absorption characteristics that preclude wetting on any in-duct surfaces within the indicated absorption distance downstream of the humidifier while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 52°F in the duct air stream.
3. Unless indicated otherwise, the air pressure loss across the humidifier array shall not exceed 0.10" W.C. at a duct air velocity of 1200 FPM.
4. Provide horizontally or vertically oriented tubes as required for the specific location, considering the steam pressure available at that location.
5. Each packaged humidifier panel assembly of tubes and headers shall be contained within a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple panels in ducts or air handler casings. Provide multiple panels and all related accessories for the panels and installation, in order to achieve the specified capacities.
6. Provide type 304 stainless steel tubes and headers. All joints shall be heli-arc welded.
7. Provide bronze or stainless steel, fail closed, electric steam control valve for operation with a modulating control signal, minimum 13:1 rangeability and ANSI Class 5 Shutoff.
8. Provide Type 316 stainless steel humidifier construction and stainless steel strainer and control valve when fed by clean steam (steam generated with RO/DI water).
9. For steam design loads of 100 lbs/hr or greater, provide high efficiency insulated tubes to substantially reduce dispersion generated condensate and airstream heat gain. Tube insulation shall be 1/8" thick polyvinylidene fluoride insulation (PVDF)in the annulus of double wall tubes or plenum approved insulating material for in-duct single wall tubes and have a maximum conductivity K-factor of 0.28 but in/(hr ft2 F) at a thickness not more than 0.125", for minimal increase in dispersion tube diameter. Insulation shall have a continuous temperature rating of 300F without any loss of material properties. Insulation shall comply with ASTM E84 Test Method for Flame Spread and Smoke Development. Insulation shall comply with UL 181 Test Method for Mold Growth. Insulation shall comply with ASTM G22 for Fungi and Bacterial Resistance.
10. Engineer shall choose steam and condensate connection locations for each project application.

B. Ultra-sorb XV Multi-tube Style - TYPE B:

1. Multi-tube non-jacketed style humidifier for use with pressurized steam, with integral heat exchanger to provide for condensate vaporization back into the steam dispersion tubes or an outside pressurized return condensate tank to provide for condensate lifting. Each panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Stainless steel construction. Humidifiers shall be complete with Y-type steam supply strainer, modulating steam control valve, condensate temperature switch and steam traps; all provided by the humidifier manufacturer. All components shall be rated for a minimum 100 PSIG steam working pressure.
2. Each steam tube outlet shall contain an orifice sized for its required steam capacity. The humidifier shall provide absorption characteristics that preclude wetting on any in-duct surfaces within the indicated absorption distance downstream of the humidifier while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 52˚F in the duct air stream
3. Unless indicated otherwise, air pressure loss across humidifier panel shall not exceed 0.10" W.C. at a duct air velocity of 1200 FPM.
4. Provide horizontally or vertically oriented tubes as required for the specific location, considering available steam pressure at that location.
5. Each packaged humidifier panel assembly of tubes and headers shall be contained within a galvanized metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple panels in ducts or air handler casings. Provide multiple panels and all related accessories for the panels and installation, in order to achieve the specified capacities.
6. Provide type 304 stainless steel tubes and headers. All joints shall be heli-arc welded.
7. Provide bronze or stainless steel, fail closed, electric steam control valve for operation with a modulating control signal, minimum 13:1 rangeability and ANSI Class 5 Shutoff.
8. Provide an electric condensate temperature switch for interlocking with control valve. Switch shall be normally closed and shall prevent steam flow to dispersion tubes upon cold start or flooded condensate line.
9. Provide an integral steam heat exchanger with steam trap arranged to vaporize dispersion-tube-generated steam condensate and return pressurized condensate to a condensate return main.

10. For steam design loads of 100 lbs/hr or greater, provide high efficiency insulated tubes to substantially reduce dispersion generated condensate and airstream heat gain. Tube insulation shall be 1/8" thick polyvinylidene fluoride insulation (PVDF)in the annulus of double wall tubes or plenum approved insulating material for in-duct single wall tubes and have a maximum conductivity K-factor of 0.28 but in/(hr ft2 F) at a thickness not more than 0.125", for minimal increase in dispersion tube diameter. Insulation shall have a continuous temperature rating of 300F without any loss of material properties. Insulation shall comply with ASTM E84 Test Method for Flame Spread and Smoke Development. Insulation shall comply with UL 181 Test Method for Mold Growth. Insulation shall comply with ASTM G22 for Fungi and Bacterial Resistance.
11. Engineer shall choose steam and condensate connection locations for each project application.

2.4 SELF-CONTAINED ELECTRIC HUMIDIFIERS

A. Packaged wall mounted self-contained U.L. listed electric humidification unit providing all required steam generation equipment and controls, to provide atmospheric pressure steam generation. Provide either Steam Injection Distribution Panels for steam injection into ducts, or Blower Pack for direct space applications, as indicated.

B. Furnish electrode heating element type humidifier capable of boiling water at the required capacity with a minimum conductivity of 125 umho (micro-mho).

1. Replaceable plastic steam cylinder.
2. Controller shall monitor water conductivity and automatically drain and flush unit to reduce solids build-up and optimize humidifier performance.
3. Published cylinder life based on incoming water conductivity.
4. Published replacement pricing.
5. Pre-notification of automatic shutdown at end of cylinder life
6. Power to the heating elements shall be controlled through the actuation of contactors and solid state relays, to provide a control accuracy of +/- 5% RH or better.

C. Furnish resistance heating element type humidifier capable of boiling water at the required capacity using reverse osmosis or de-ionized water (conductivity of 50 umho (micro-mho)or less).

1. Serviceable stainless steel steam cylinder.
2. Controller shall automatically drain and flush unit to reduce solids build-up and optimize humidifier performance.
3. Corrosion resistant heating elements.
4. Water level control shall be provided by float switch or float valve located in a portion of the tank segregated from the main steam generating portion of the tank.
5. Power to the heating elements shall be controlled through the actuation of contactors and solid state relays, to provide a control accuracy of +/- 3% RH or better.

D. Over temperature safety switch to prevent heating element failure.

E. Water make-up system with inlet strainer, solenoid valve with flow regulator, and fill tee or cup with built-in air gap to prevent back siphoning

F. Solenoid operated automatic drain valve.

G. Bottom drain outlet. Large perforated strainer at drain outlet to prevent blockage of drain valve or drain lines

H. A system on/off switch with power indicator light, external to the humidifier enclosure.

I. Enclosure to be minimum 18 gauge steel and powder-coat painted to prevent against corrosion. The electrical and steam generating compartments shall be separate, but contained within the same cabinet to minimize field wiring. The cylinder access door shall be lockable with a key. A door interlock switch shall prevent humidifier operation when the access door is open.

J. Provide a fan blower pack to disperse steam directly into the room air. Blower pack shall be 120 VAC and shall be capable of being mounted integral to the top of the humidification unit, or remotely via interconnecting piping. Provide an air flow proving switch to prevent humidification when the blower fan is off.

K. Controls

1. Provide a UL listed and labeled microcomputer based controller with the following capabilities:
   a. Control of humidity to within +/- 3% RH (resistance heating element type humidifiers) or +/- 5% RH of set point (electrode heating element type humidifiers).
   b. Proportional/integral/derivative (PID) algorithms for humidifier control.
   c. Integral 24 VDC power supply of adequate size to power controllers and all axillary devices (humidity transmitters, etc.)
   d. LCD or LED display and integral controller keypad to allow adjustment of all humidifier settings, programming of alarms and viewing of alarm history.
   e. High water sensor circuitry to prevent over filling.
   f. Integral drain water tempering feature. Drain water shall be automatically cooled to below 140°F before entering the drain.
      1) If unit cannot provide this feature, provide an external condensate drain cooler.
   g. Automatic drain and flush feature to reduce the concentration of conductive ions in the water and reduce mineral build-up.
   h. Automatic off-season shut-down [user adjustable, factory default set after 3 days of "no call"] to completely drain the tank(s) and automatically restart unit on call for humidity.
   i. External fan control: controller shall have the ability to cycle an external steam dispersion fan on and off in conjunction with a call for humidification.
   j. Fan control off-delay feature. When the humidifier unit controls an external fan, fan “off” is time delayed after steam output stops.

k. A dry contact rated 10 amps at 24 VDC, which can be programmed to energize when any humidifier alarm condition occurs.
l. Password protection. Controller adjustment shall only be enabled after a password is entered. It shall be possible to disable the password protection feature.
m. For duct mounted humidifiers, controller shall limit duct humidity downstream of the humidifier to a user adjustable set point by modulating humidifier output, and prevent humidifier operation if duct air flow is not present.
n. For space mounted humidifiers, controller shall prevent humidifier operation if air flow is not present at the blower pack fan.
o. The controller shall monitor and display the following conditions, minimum:
    1) Space relative humidity
    2) Space relative humidity set point
    3) Space dew point
    4) Space dew point set point
    5) Duct relative humidity
    6) Duct high relative humidity limit set point
    7) Air flow status
    8) Tank temperature
    9) Tank level
    10) All units shall be displayed in inch-pounds.

2. Controller shall accept two wire 4-20mA input signals for space humidity, duct humidity, and room temperature.
3. Provide the following auxiliary devices for use with the humidifier controller:
    a. 4-20 mA room humidity transmitter
    b. 4-20 mA duct relative humidity transmitter (duct mounted humidifiers only)
    c. Air flow proving switch
    d. Auxiliary devices shall comply with Related Section Mechanical Systems Control, and be compatible with the humidifier controller.
4. Controller shall be capable of operation in ambient conditions of 32°F to 140°F and a humidity range of 5% to 95%, non-condensing.
5. The controller shall hold its software in non-volatile memory. On-line field modified data entries shall be stored in flash memory to prevent accidental loss of data due to power loss, voltage surge or spike. In the event of a complete power outage, all field and factory settings shall remain stored and shall automatically be restored when power is restored
6. Provide humidifier set point reset based on window glass temperature, to prevent condensation on windows. Provide control algorithm and 4-20 mA temperature transmitter with a RTD designed to be mounted on a window surface.Interoperability shall allow communication with building automation systems via Modbus, BACnet, or LonTalk protocols.

2.5 CONDENSATE DRAIN COOLER

A. Provide a stainless steel drain cooler for condensate water being discharged. Provide a unit of size and volume adequate for handling the expected discharge from the humidification system.

B. Drain cooler shall include a self-actuated thermostatically controlled water valve to control mixing.

C. Drain cooler shall be capable of metering a sufficient amount of cold water into the mixing chamber to temper 212˚F (100˚C) water to a 140˚F (60˚C) max. discharge temperature

D. Cooler dimensions must allow gravity flow of condensate to the waste discharge point based on the height of the humidifier's condensate discharge connection.

E. Provide all mounting components and hardware required to properly support the drain cooler, independent of the humidifier unit.

F. Provide a vacuum breaker in the unit to prevent backflow into the potable water systems.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Store units protected from weather, dirt, water, and construction debris.

B. Examine roughing-in for equipment support, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting equipment performance, maintenance, and operations. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in strict compliance with manufacturer's installation instructions and Related Sections. Maintain manufacturer's recommended clearances for service and maintenance.

B. Route steam line to humidifier by connecting to top of steam main (either straight up or at 45 degrees (preferred)). Provide a steam trap upstream of the humidifier if the top of steam main could not be tapped or if the distance between the steam main and the humidifier exceeds ten feet.

C. Install separate devices furnished by manufacturer and not factory installed, including but not limited to control valve, steam traps, and temperature switch.

D. Provide and install any manufacturer's accessory devices necessary or recommended to meet the particular needs of the humidifier installation.

E. Install condensate drain coolers where indicated or required.

F. Install to provide a minimum of ten feet of straight, unobstructed (no filters, turning vanes, etc.) duct downstream from the humidifier, unless a shorter non-wetting (absorption) distance upstream of such obstructions is indicated on the reviewed/approved submittal.

G. Direction of steam injection relative to air flow is dependent on humidifier features and duct orientation. Review manufacturer's installation instructions carefully and install accordingly.

H. Seal all duct penetrations made as a result of humidifier installation. Use sealant appropriate for service.

I. Jacketed Steam Humidifiers

1. Install the humidifier's discharge steam trap to allow the condensate piping to drain by gravity. Do not lift condensate piping downstream of this steam trap.

J. Steam Injection Dispersion Panels

1. Dispersion panels are typically designed for a specific duct orientation (either horizontal or vertically oriented duct). Verify that the dispersion panel supplied is the correct model for the duct orientation at the humidifier mounting location.
2. Rotate tubes to the correct orientation to inject steam into the air stream, typically perpendicular to the air stream. Follow manufacturer's installation instructions for injection orientation.
3. Install all required p-traps. Do not lift condensate discharging from p-traps

K. Self-Contained Electric Humidifiers

1. Mount humidifier and accessories at locations indicated on the drawings, maintaining manufacturers recommended service clearances.
2. Connect power to the humidifier. Comply with Division 26 requirements.
3. Install water supply and drain piping to each unit in compliance with manufacturer's recommendations, including pipe sizes.
   a. Install an isolation valve, water hammer arrestor, and a strainer in the supply piping to the humidifier. Install the strainer between the isolation valve and the humidifier.
   b. When plastic pipe is used for water supply piping, provide a minimum of 3 feet of stainless steel tubing for the last 3 feet of the supply piping before connecting to the unit.
   c. Install unions at each supply and drain connection.
   d. Install traps in supply and drain piping as recommended by the unit manufacturer.
   e. All drain piping shall be type L copper pipe. When humidifiers are not installed in mechanical rooms or similar spaces that are typically inaccessible to occupants, insulate the tank/flush drain with ½" thick insulation per Related Section. Overflow drains do not require insulation.
4. Connect drain piping via an air gap fitting to the building drain. Prior to connecting to building drain, install a condensate drain cooler for units that are not equipped with an integral drain water tempering feature.
5. Install steam vapor hose or piping, as indicated, between steam dispersion device and humidifier.
   a. Piping material shall be per Related Section.
   b. When piping is used, install a union at the humidifier to allow humidifier removal.
   c. Electrically ground the piping. Bond the ground to the humidifier cabinet ground.
   d. When hose is used, use approved hose, fittings, and clamps obtained from the humidifier manufacturer.

e. Pitch steam vapor hose or piping to allow condensate to drain back into the humidifier. Follow manufacturer's instructions for all piping slopes between steam generator and dispersion tubes. Some may recommend sloping towards the dispersion tubes.
f. Install steam condensate drains where required. Route such drains back to the humidifier tank fill connection in lieu of to a building drain where possible and when permitted by humidifier manufacturer.
1) Where routed to building drains, provide condensate cooler and route drain through cooler before connection to building drain.
g. Insulate hose/piping per Related Section.

6. Install steam dispersion devices.
7. Install the fan blower pack when utilized.
a. Mount blower pack to prevent the discharged steam from condensing on nearby surfaces.
b. Install power to blower pack in compliance with Division 26 requirements.
c. When mounted remote from the humidifier, install steam vapor hose or piping between humidifier and blower pack, pitched to allow condensate to drain back to humidifier. Install drain piping, complying with the same requirements indicated above for the humidifier drain piping.
8. Install separate devices furnished by manufacturer and not factory installed, including but not limited to, room humidity transmitter, proof of air flow switch, duct high limit humidity transmitter, and control wiring between fan blower pack and humidifier.
a. Install wiring in conformance with Related Section (Mechanical Systems Controls), utilizing approved contractors listed in that section.
9. Program the humidifier controller.

3.3 STARTUP

A. Adhere to manufacturer’s start-up instructions.

B. Assure that actuators operate freely, close off steam tightly (no leaking steam discharges into the duct or space), and that the stem packing is not leaking. Verify proper steam trap operation.

C. For dispersion panel types, check dispersion tubes for leaks at slip couplings while steam is being injected into the duct or space; repair any leaks.

D. When provided as part of the humidifier package, verify that the air flow proving switch and duct high limit humidistat operate properly. Prime any p-traps and verify he operation of temperature switches, float switches, and similar devices specified or provided, prior to putting humidifier into operation.

E. For self-contained electric humidifiers, adjust all control parameters as directed by the Commissioner and as appropriate for the project, and place into service. For projects without a Commissioner, consult the project engineer for direction regarding control parameter settings. Record all settings and include in the O&M manual.

3.4 COMMISSIONING

A. Perform Commissioning activities per Related Sections above.

3.5 TRAINING

A. Provide a qualified service technician from the Manufacturer's staff to provide training.

B. Train Owner's maintenance personnel on equipment operation, start-up and shutdown, trouble-shooting, servicing and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities.

1. Provide 2 hours of training minimum.

END OF SECTION 238413