**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NAVFAC PTS-D30 (June 2023)  
 ------------------------------  
Preparing Activity: NAVFAC SUPERSEDING PTS-D30 (September 2022)  
  
PERFORMANCE TECHNICAL SPECIFICATION  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

SECTION D30  
  
HVAC  
06/23

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: This section is intended to be used as a guide and contains requirements that are common to many different types of facilities; however, not all requirements and equipment items will be applicable to all projects. In addition, there may be special requirements for a particular project that are not addressed at all. The RFP preparer may have to incorporate additional information to address these special requirements in this PTS and corresponding Part 3 ESR. If the RFP preparer chooses to delete building elements that are not required for the project, do not change the remaining Uniformat paragraph designations (example - A102001). Uniformat designations are unique to the products they are assigned to. However, the subparagraph numerical extensions (example - 1.2 or a,b,c) of the Uniformat designations may change if subparagraphs are deleted.  
  
This guide specification is formatted utilizing Uniformat II, an industry recognized standard, ASTM E 1557. When the RFP preparer chooses to add a paragraph that does not apply to an existing building element already included in the specification, refer to the Uniformat/WBS located on the NAVFAC Design-Build Website for a listing of Uniformat II designations and definitions.  
  
NOTE: The RFP preparer may view or hide the criteria notes in this PTS section by modifying the WORD preferences for "Hidden text". To view the criteria notes, choose "File" then "Option". Click "Display" then check the "Hidden text" box under "Always show these formatting marks on the screen". In the same section, check the box for "Print hidden text" under "Printing options" to print the criteria notes.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: The Table of Contents is intended for navigation purposes only for the RFP writer and should not show up in the printed document.  
  
TABLE OF CONTENTS  
  
D30 GENERAL  
D30 1.1 NARRATIVE  
D30 1.2 MECHANICAL DESIGN GUIDANCE  
D30 1.3 PERFORMANCE VERIFICATION and ACCEPTANCE TESTING  
D30 1.4 HVAC COMMISSIONING  
D30 1.5 DESIGN SUBMITTALS  
D30 1.6 CONSTRUCTION SUBMITTALS  
D3010 ENERGY SUPPLY  
D301001 1.1 OIL SUPPLY SYSTEM  
D301001 1.2 OIL SUPPLY SYSTEM PIPING & EQUIPMENT  
D301002 GAS SUPPLY SYSTEM  
D301002 1.1 NATURAL GAS PIPING  
D301002 1.2 MATERIALS AND EQUIPMENT  
D301002 1.3 PRESSURE TESTS  
D301002 1.4 PROPANE PIPING  
D301002 1.5 PROPANE TANKS  
D301003 STEAM SUPPLY SYSTEM (FROM CENTRAL PLANT)  
D301004 HOT WATER SUPPLY SYSTEM (FROM CENTRAL PLANT)  
D301005 SOLAR ENERGY SUPPLY SYSTEMS  
D3020 HEAT GENERATING SYSTEMS  
D302001 1.1 Boilers  
D302001 1.2 REQUIREMENTS  
D302001 1.3 BOILER BURNER  
D302001 1.4 BOILER TRIM AND CONTROL EQUIPMENT  
D302001 1.5 STEAM BOILERS  
D302001 1.6 BOILER STACK AND ACCESSORIES  
D302001 1.7 BOILER STARTUP AND OPERATIONAL TESTS  
D302002 FURNACES  
D302003 FUEL-FIRED UNIT HEATERS  
D302003 1.1 GAS-FIRED UNIT HEATERS  
D302003 1.2 INFRARED HEATERS  
D302004 AUXILIARY EQUIPMENT  
D302004 1.1 HEAT EXCHANGERS  
D302004 1.2 CONDENSATE RETURN UNITS  
D302005 EQUIPMENT THERMAL INSULATION  
D3030 COOLING GENERATING SYSTEMS  
D303001 CHILLED WATER SYSTEMS  
D303001 1.1 AIR-COOLED CHILLERS  
D303001 1.2 WATER-COOLED CHILLERS  
D303001 1.3 COOLING TOWERS  
D303001 1.4 CLOSED CIRCUIT COOLERS  
D303002 DIRECT EXPANSION SYSTEMS  
D303002 1.1 HEAT PUMPS  
D303002 1.2 CONDENSING UNITS  
D303002 1.3 DX VARIABLE AIR VOLUME (VAV) UNITS  
D303002 1.4 DUCTLESS SPLIT SYSTEM  
D303002 1.5 VARIABLE REFRIGERANT FLOW SYSTEMS  
D3040 DISTRIBUTION SYSTEMS  
D304001 AIR DISTRIBUTION, HEATING & COOLING  
D304001 1.1 DUCTWORK  
D304001 1.2 LOUVERS & HOODS  
D304001 1.3 GRILLES, REGISTERS, & DIFFUSERS  
D304001 1.4 INSULATION  
D304001 1.5 VAV BOXES  
D304001 1.6 VARIABLE AIR VOLUME VAV FAN-POWERED UNITS  
D304002 STEAM DISTRIBUTION SYSTEMS  
D304002 1.1 STEAM PIPING  
D304002 1.2 CONDENSATE RETURN PIPING  
D304002 1.3 STEEL PIPE FITTINGS  
D304002 1.4 INSULATION  
D304002 1.5 STEAM PRESSURE REDUCING STATION  
D304002 1.6 STEAM TRAPS  
D304003 HOT WATER DISTRIBUTION SYSTEMS  
D304003 1.1 HOT WATER PIPING  
D304003 1.2 STEEL PIPE FITTINGS  
D304003 1.3 COPPER FITTINGS  
D304003 1.4 ISOLATION VALVES  
D304003 1.5 INSULATION  
D304003 1.6 VALVES  
D304003 1.7 APPURTENANCES  
D304003 1.8 TEST PORTS  
D304005 GLYCOL DISTRIBUTION SYSTEMS  
D304006 CHILLED / condenser WATER DISTRIBUTION SYSTEMS  
D304006 1.1 ABOVEGROUND CHILLED AND CONDENSER WATER PIPING  
D304006 1.2 STEEL PIPE FITTINGS  
D304006 1.3 COPPER FITTINGS  
D304006 1.4 ISOLATION VALVES  
D304006 1.5 INSULATION  
D304006 1.6 VALVES  
D304006 1.7 TEST PORTS  
D304007 EXHAUST SYSTEMS  
D304007 1.1 FANS  
D304007 1.2 IN-LINE FANS  
D304007 1.3 WALL FANS  
D304007 1.4 ROOFTOP FANS  
D304007 1.5 UTILITY SETS  
D304007 1.6 BATHROOM FANS  
D304007 1.7 RANGE HOODS  
D304008 AIR HANDLING UNITS  
D304008 1.1 CENTRAL STATION AIR HANDLERS  
D304008 1.2 SPLIT SYSTEM AIR HANDLERS  
D304090 OTHER DISTRIBUTION SYSTEMS  
D304090 1.1 PUMPS  
D304090 1.2 VARIABLE FREQUENCY DRIVES (VFD)  
D304090 1.3 CHILLED WATER AND HOT WATER AIR SEPARATORS  
D304090 1.4 SOLIDS SEPARATORS  
D304090 1.5 EXPANSION TANKS  
D304090 1.6 MAKE-UP WATER STATION  
D304090 1.7 GLYCOL MAKE-UP STATION  
D304090 1.8 CONDENSATE DRAIN PIPING  
D304090 1.9 CONDENSATE DRAIN INSULATION  
D304090 1.10 CHEMICAL TREATMENT  
D304090 1.11 PIPING IDENTIFICATION  
D304090 1.12 PIPE SLEEVES  
D304090 1.13 SYSTEM FLUSHING  
D304090 1.14 HEAT TAPE  
D3050 TERMINAL & PACKAGE UNITS  
D305001 UNIT VENTILATORS  
D305002 UNIT HEATERS  
D305002 1.1 STEAM  
D305002 1.2 HOT WATER  
D305002 1.3 CABINET UNIT HEATER  
D305003 FAN COIL UNITS  
D305004 FIN TUBE RADIATION  
D305004 1.1 FIN TUBE RADIATORS and CONVECTORS  
D305005 ELECTRIC HEATING  
D305005 1.1 UNIT HEATERS  
D305005 1.2 BASEBOARD HEATERS  
D305005 1.3 WALL HEATERS  
D305005 1.4 INFRARED HEATERS  
D305006 PACKAGE UNITS  
D305006 1.1 ROOFTOP AIR HANDLERS  
D305006 1.2 DUCT HEATER  
D3060 CONTROLS AND INSTRUMENTATION  
D306001 HVAC CONTROLS  
D306001 1.1 DIRECT DIGITAL CONTROLS  
D306001 1.2 ELECTRONIC CONTROLS  
D3070 SYSTEMS TESTING AND BALANCING  
D3070 1.1 HVAC SYSTEM  
D307001 WATER SIDE TESTING & BALANCING – HEATING & COOLING  
D307002 AIR SIDE TESTING & BALANCING – HEATING, COOLING & EXHAUST  
D3090 OTHER HVAC SYSTEMS AND EQUIPMENT  
D309001 GENERAL CONSTRUCTION ITEMS  
D309001 1.1 SEISMIC DESIGN  
D309002 REFRIGERATION SYSTEMS  
D309090 OTHER SPECIAL MECHANICAL SYSTEMS  
D309090 1.1 ENERGY RECOVERY WHEELS  
D309090 1.2 HEAT PIPES  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

**D30 GENERAL**

RFP Part 3 including the Engineering System Requirements (ESR) provide project specific requirements. The RFP Part 4, Performance Technical Specifications (PTS) provide generalized technical requirements that apply to multiple facility types and include more requirements than are applicable to any one project. Therefore, only the RFP Part 4 requirements that apply to the project and further define the RFP Part 3 project specific requirements are required.

**D30 1.1 NARRATIVE**

This section includes the construction of interior mechanical systems. This section covers installations inside the facility and out to the five foot line. See Section G30, *Site Civil/Mechanical Utilities*, for continuation of systems beyond the five-foot line.

**D30 1.2 MECHANICAL DESIGN GUIDANCE**

Provide the design and installation in accordance with the following references. This Performance Technical Specification (PTS) adds clarification to the fundamental requirements contained in the following Government Standards. The general requirements of this PTS section are located in PTS Section Z10, *General Performance Technical Specification*.

**D30 1.2.1 Government Standards**

Federal Energy Management Program (FEMP)

UNIFIED FACILITIES CRITERIA (UFC)

|  |  |
| --- | --- |
| UFC 1-200-01 | DoD Building Code (General Building Requirements)(A reference in this PTS section to UFC 1-200-01 requires compliance with the Tri-Service Core UFCs that are listed therein, which includes the following significant UFC(s): UFC 3-401-01, Mechanical Engineering UFC 3-420-01, Plumbing Systems) |
| UFC 1-200-02 | High Performance and Sustainable Building Requirements |
| UFC 3-440-01 | Facility-Scale Renewable Energy Systems |

UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS)

|  |  |
| --- | --- |
| UFGS 01 78 24.00 20 | Facility Data Workbook (FDW) |
| UFGS 23 05 93 | Testing, Adjusting, and Balancing for HVAC |
| UFGS 23 09 00 | Instrumentation and Control for HVAC |
| UFGS 23 09 23.02 | BACnet Direct Digital Control for HVAC and Other Building Control Systems |
| UFGS 23 09 13 | Instrumentation and Control Devices for HVAC |
| UFGS 23 81 23 | Computer Room Air Conditioning Units |

**D30 1.3 PERFORMANCE VERIFICATION AND ACCEPTANCE TESTING**

a. Verification of satisfactory HVAC system performance must be via Performance Verification Testing, as detailed in this section.

b. The Government reserves the right to witness all Acceptance Tests and Inspections, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements.

c. The Qualified Testing Organization must provide the Acceptance Tests and Inspections test plan and perform the acceptance tests and inspections. Perform and evaluate test methods, procedures, and test values in accordance with appropriate standards, and the manufacturer's recommendations. Place equipment in service only after completion of required tests and evaluation of the test results have been completed. 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. Perform acceptance tests and inspections on Computer Room Air Conditioning Units, Direct Digital Control System, and HVAC Testing/Adjusting/Balancing.

**D30 1.4 HVAC COMMISSIONING**

Commission the HVAC systems per the Commissioning Plan as required by Part 2 Section 01 91 00.15, *Building Commissioning*. HVAC system commissioning must coordinate with and incorporate the testing, reporting, training & O&M documentation requirements of UFGS 23 05 93, *Testing, Adjusting, and Balancing for HVAC;* UFGS 23 09 00, *Instrumentation and Control for HVAC*; UFGS 23 09 23.02, *BACnet Direct Digital Control for HVAC and Other Building Control Systems* and UFGS 23 09 13, *Instrumentation and Control Devices for HVAC*.

**D30 1.5 DESIGN SUBMITTALS**

Submit design Submittals in accordance with Z10, *General Performance Technical Specifications*, Part 2 Section 01 33 10.05 20, *Design Submittal Procedures*, FC 1-300-09N, *Navy and Marine Corps Design Procedures*, and UFC 3-401-01, *Mechanical Engineering*.

In addition, UFGS sections listed below or in the body of the PTS text are to be used by the Designer of Record (DOR) as a part of the design submittal. If the UFGS products or systems are applicable to the project, the DOR must edit these referenced UFGS sections and submit them as a part of the design submittal specification. Edit the specification sections in accordance with the limitations stated in PTS section Z10, *General Performance Technical Specifications*.

UFGS 01 78 24.00 20, *Facility Data Workbook (FDW)*

UFGS 23 09 00, *Instrumentation and Control for HVAC*

UFGS 23 09 23.02, *BACnet Direct Digital Control for HVAC and Other Building Control Systems*

UFGS 23 09 13, *Instrumentation and Control Devices for HVAC*

UFGS 23 05 93, *Testing, Adjusting, and Balancing for HVAC*

UFGS 48 14 13.00 20, *Solar Liquid Flat Plate and Evacuated Tube Collectors*

**D30 1.6 CONSTRUCTION SUBMITTALS**

Submit construction submittals in accordance with PTS section Z10, *General Performance Technical Specifications*. In addition to the Z10 requirements, the Designer of Record (DOR) must approve the following construction submittals as a minimum:

Solar hot water heating system fixtures and equipment, and OMSI information for all equipment and fixtures.

**D30 1.7 MOTORS**

High efficiency single-phase fractional-horsepower alternating-current motors, corresponding to the applications listed in NEMA MG 11. Select polyphase motors based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, all polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-10 of NEMA MG 1. Provide controllers for 3-phase motors rated 1 hp (0.75 kW) and above with phase voltage monitors designed to protect motors from phase loss and over/under-voltage. Provide means to prevent automatic restart by a time adjustable restart relay. For packaged equipment, provide controllers including the required monitors and timed restart. Provide reduced voltage starters for all motors 25 hp and larger.

**D3010 ENERGY SUPPLY**

**D301001 OIL SUPPLY SYSTEM**

Conform to requirements of International Mechanical Code for piping. Conform to requirements of NFPA 31 for testing. Provide the complete oil supply system to the facility, including any applications and permits.

**D301001 1.1 OIL SUPPLY SYSTEM PIPING & EQUIPMENT**

ASTM A 53/A 53M or ASTM A 106/A 106M piping with associated ASME fittings or ASTM B 88, type L or M copper tubing with ASME B16.26 flared fittings or compression type fittings. Provide welded fittings on piping below grade. Pumps that are not part of the burner assembly must be positive displacement type. Provide oil filter prior to oil entering appliance or pump. Storage tanks must meet the requirements of NFPA 31.

**D301002 GAS SUPPLY SYSTEM**

**D301002 1.1 NATURAL GAS PIPING**

Conform to requirements of the local natural gas utility and ASME B31.8, *Gas Transmission and Distribution Piping Systems*, for exterior piping. Conform to requirements of NFPA 54, *National Fuel Gas Code*, for interior gas piping. Provide meter and pressure regulator in accordance with the requirements of the local utility. Provide earthquake valve where required by code. Provide the complete natural gas system to the facility, including any applications and permits.

**D301002 1.2 MATERIALS AND EQUIPMENT**

**D301002 1.2.1 Aboveground Within Buildings**

Black steel meeting requirements of ASTM A 53/A 53M, Schedule 40, and associated ASME fittings threaded ends for sizes 2 inches (50 mm) and smaller; otherwise, plain end beveled for butt welding.

**D301002 1.3 PRESSURE TESTS**

Pressure test in accordance with NFPA 54 at 1.5 times maximum working pressure, but in no case less than 50 PSI (350 kPa).

**D301002 1.4 PROPANE PIPING**

If required, provide the same as specified for natural gas and comply with NFPA 58.

**D301002 1.4.1 Underground**

Polyethylene (PE) pipe conforming to ASTM D 2513 for 100 PSI (690 kPa) (gage) working pressure. Standard Dimension Ratio must be 11.5 maximum. Provide detectable aluminum plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of direct buried piping. Tape must be detectable by an electronic detection instrument. Warning tape to be color coded with warning and identification of utility type imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (utility type) LINE BELOW" or similar wording. Color to be yellow for gas lines. Polyethylene fittings must be ASTM D 2683 socket fittings or ASTM D 2513 molded butt-fusion fittings.

**D301002 1.5 PROPANE TANKS**

If not provided by the propane provider, the tank material and installation must comply with NFPA 58.

**D301003 STEAM SUPPLY SYSTEM (FROM CENTRAL PLANT)**

Refer to Section G30, *Site Civil/Mechanical Utilities*

**D301004 HOT WATER SUPPLY SYSTEM (FROM CENTRAL PLANT)**

Refer to Section G30, *Site Civil/Mechanical Utilities*

**D301005 SOLAR ENERGY SUPPLY SYSTEM**

Design and build each solar domestic hot water heating system meeting the requirements of UFC 3-440-01 *Facility-Scale Renewable Energy Systems*. Each system must be fully integrated with the building DDC controls system.

Provide complete solar domestic hot water system designed and built by a single contractor who specializes in solar heated water systems. System must be designed, built, and tested by this contractor who is responsible for the provided system to operate as proposed. This design-build contractor must be endorsed in writing, prior to system design, by the manufacturer of the solar plate collectors provided for this solicitation.

The solar domestic hot water system designer must work with the building designers to optimize the roof area, slope and orientation available for solar domestic hot water. Coordinate with other solar systems utilizing the roof area such as photovoltaic systems.

Provide solar liquid flat plate collector systems to comply with the requirements specified in UFGS Section 48 14 13.00 20, *Solar Liquid Flat Plate and Evacuated Tube Collectors.*

**D3020 HEAT GENERATING SYSTEMS**

**D302001 BOILERS**

If required, provide Boiler(s) type for the load capacity of the building as indicated in ESR Section D30. Include all equipment efficiencies on the equipment schedules on the drawings.

**D302001 1.1 REQUIREMENTS**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Due to limited manufacturer and boiler size options for FEMP stated efficiency requirements, this document includes boiler efficiency requirements in conformance with ASHRAE 90.1-2010. ASHRAE 90.1-2010 requires that low and medium pressure boilers used primarily in commercial space heating applications meet the following thermal (Et) or combustion (Ec) efficiencies.  
 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

Design and test boiler in accordance with ASME CSD-1 (Controls and Safety Devices), ASME BPVC SEC IV (Boiler and Pressure Vessel Code), NFPA 54, NFPA 70 and ANSI Z21.13/CSA 4.9. Install boiler in accordance with NBBI NB-23 PART 1. The boiler must meet the requirements of the UL 795, ANSI Z83.3, and ASME CSD. Design oil-fired boiler system in accordance with NFPA 31. Hot water boilers to meet the following thermal (Et) or combustion (Ec) efficiencies: Natural Gas-fired Hot Water rated at 88 - 732 kW (300,000 to 2,500,000 Btuh) capacity, Et = 80 percent; Natural Gas-fired Hot Water rated greater than 732 kW (2,500,000 Btuh) capacity, Ec = 82 percent; #2 Oil-fired Water rated at 88 - 732 kW (300,000 to 2,500,000 Btuh) capacity, Et = 82 percent; #2 Oil-fired Water rated greater than 732 kW (2,500,000 Btuh) capacity, Ec = 84 percent.

**D302001 1.2 BOILER BURNER**

Provide burners of the make, model and type certified and approved by the manufacturer of the boiler being provided. Provide burner controls and flame safety equipment conforming to either ASME CSD-1 or NFPA 58 as dictated by the input.

**D302001 1.3 BOILER TRIM AND CONTROL EQUIPMENT**

**D302001 1.3.1 Boiler Controls**

Mount controls, including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of the control systems, on a single control panel mounted on the burner or separate from the burner. Locate the separate panel at the side of the boiler or in a freestanding control cabinet away from the front of the boiler. When using BACnet communication protocol, use the ASHRAE 135 protocol without gateways to interface with the BACnet Direct Digital Control System in specifications UFGS 23 09 00, UFGS 23 09 23.02 and UFGS 23 09 13.

**D302001 1.3.2 Boiler Trim**

Comply with ASME BPVC SEC IV, ASME CSD-1, and additional appurtenances as specified herein.

**D302001 1.3.3 Pressure Gages**

Provide pressure gages with a scale equivalent to 1.5 times the outlet water pressure on supply water piping and return water piping.

**D302001 1.3.4 Thermometers**

Provide thermometers with a scale equivalent to 1.5 times the outlet water temperature on supply water piping and return water piping.

**D302001 1.3.5 Drain Trapping**

Provide drain valve and piping to a floor drain.

**D302001 1.3.6 Air Vent Valve**

Provide with screwed connection, stainless steel disk, and stainless steel seats to vent entrapped air.

**D302001 1.4 STEAM BOILERS**

Provide steam boilers meeting the requirements of hot water boilers, except as follows. Steam boilers to meet the following thermal (Et) or combustion (Ec) efficiencies: Natural Gas-fired Steam (excluding natural draft) rated at 88 kW (300,000 Btuh) capacity and larger, Et = 79 percent; Natural Draft Steam rated at 88 kW (300,000 Btuh) capacity and larger, Et = 77 percent; #2 Oil-fired Steam rated at 88 kW (300,000 Btuh) capacity and larger, Et = 81 percent.

**D302001 1.4.1 Pressure Gages**

Provide pressure gages with a scale equivalent to 1.5 times the outlet water pressure on boiler feedwater supply piping and condensate return water piping. Provide boiler steam pressure gage with scale equivalent to 1.5 times the boiler rated working pressure.

**D302001 1.4.2 Thermometers**

Provide thermometers with a scale equivalent to 1.5 times the outlet water temperature on boiler feedwater piping and return water piping.

**D302001 1.5 BOILER STACK AND ACCESSORIES**

Provide pre-manufactured, multi-wall stacks complying with NFPA 54 or NFPA 58 and UL-listed. Provide flue gas thermometer and mount in flue gas outlet.

**D302001 1.6 BOILER STARTUP AND OPERATIONAL TESTS**

**D302001 1.6.1 Boiler Cleaning**

Prior to startup, clean boiler(s) in accordance with ASME *Boiler and Pressure Vessel Code*and manufacturer's recommendations.

**D302001 1.6.2 Operational Tests**

Furnish the services of an engineer or technician approved by the boiler manufacturer for installation, startup, operational and safety testing. Demonstrate proper operability of combustion control, flame safeguard control, and safety interlocks.

**D302002 FURNACES**

Provide manufacturer's standard, self-contained, indirect, forced-air type. Furnace and furnace components to be completely factory-assembled and consist of a heat exchanger; burner; centrifugal blower, a sheet metal cabinet-type casing with provisions for duct, vibration isolators, and all required operating, limit, and safety controls. Furnace casing to be factory insulated and compatible with the operating temperatures. Furnace to be provided with removable service panels which allow access to all internal components requiring cleaning, servicing, or adjustment. Provide a 24 volt control transformers, high temperature limit, and fan time delay relay. Design to supply heated air through a ducted system. If required in ESR D30, provide cooling evaporator coil module with cabinet suitable for use with furnace.

**D302002 1.1 GAS-FIRED FURNACES**

Furnace conforming to ANSI Z21.47/CSA 2.3. Furnace design to be certified by the AMERICAN GAS ASSOCIATION LABORATORIES (AGA). If a conventional type furnace is required in ESR D30, and the capacity is less than 65.9 kW (225,000 Btuh), the furnace must have a minimum AFUE of 78 percent. FEMP requires gas-fired warm air furnaces with a capacity greater than 65.9 kW (225,000 Btuh) have a minimum thermal efficiency of 80 percent at the maximum rated capacity. For residential applications, Energy Star requires warm air furnaces with capacity less than 65.9 kW (225,000 Btuh) have a minimum AFUE of 90 percent for US South applications, and a minimum AFUE of 95 percent for US North applications. Refer to Energy Star "Furnaces Key Product Criteria" for identification of US North and US South applications.

**D302002 1.1.1 Gas-Burning Components**

Gas-burning equipment to include the gas burners, ignition equipment, gas-control valve, gas piping, gas-pressure regulating valve, when applicable, and accessories necessary for a fully automatic system that is listed in CSA Directory. Gas-fired units equipped with programming controls to be furnished both with high and with low gas supply pressure switches in the fuel supply piping.

**D302002 1.1.2 Ignition System**

Ignition systems to be automatic electric ignition with electrically-ignited proven pilots. Continuous pilots are not permitted. Burner to be designed in accordance with NFPA 54 and located so that parts are protected against overheating. Provisions to be made in the burner housing for inspection of the pilot flame.

**D302002 1.2 OIL-FIRED FURNACES**

Furnace conforming to UL 727. Oil-fired furnaces with a capacity less than 65.9 kW (225,000 Btuh) require a minimum AFUE of 78 percent. FEMP requires oil-fired warm air furnaces with a capacity greater than 65.9 kW (225,000 Btuh) have a minimum thermal efficiency of 81 percent at the maximum rated capacity. For residential applications, Energy Star requires oil-fired warm air furnaces with capacity less than 62.9 kW 225,000 Btuh have a minimum AFUE of 85 percent.

**D302002 1.2.1 Oil-Burning Components**

The equipment to include the oil burner motor, ignition equipment safety devices, and accessories necessary for a full automatic system that conforms to UL 296. Oil-fired units equipped with programming controls to be furnished with low oil-pressure switches in the fuel supply piping. Oil-fired units not equipped with programming controls to be equipped with a delayed opening oil shutoff valve. The valve must automatically delay delivery of oil to the burner until such time as the combustion air fan and, when applicable, the induced draft fan is operating at rated speed.

**D302002 1.2.2 Ignition System**

Ignition systems for oil-fired units to be of the direct-electrical spark type or interrupted type in accordance with UL 296.

**D302003 FUEL-FIRED UNIT HEATERS**

**D302003 1.1 GAS-FIRED UNIT HEATERS**

ANSI Z83.8 and AGA label. Equip each heater with individually adjustable package discharge louver. Provide with thermostat.

**D302003 1.2 INFRARED HEATERS**

ANSI Z83.8 and AGA label.

**D302004 AUXILIARY EQUIPMENT**

**D302004 1.1 HEAT EXCHANGERS**

Steam to hot water converter as required for the application. Provide factory assembled, u-tube units constructed in accordance with ASME BPVC for steam or hot water. Factory assembled, plate type heat exchangers may be provided for hot water.

**D302004 1.2 CONDENSATE RETURN UNITS**

Floor-mounted receiver and duplex pump unit.

**D302005 EQUIPMENT THERMAL INSULATION**

Insulate hot water pumps and equipment as suitable for the temperature and service in rigid block, semi-rigid board, or flexible unicellular insulation to fit as closely as possible to equipment.

**D3030 COOLING GENERATING SYSTEMS**

If coatings are indicated in ESR Section D30, provide with copper tube/copper fin construction or immersion applied, baked phenolic or other approved coating that passes the 3000 hour salt spray resistance test using the ASTM B117 procedure. Field applied coatings are not acceptable.

**D303001 CHILLED WATER SYSTEMS**

**D303001 1.1 AIR-COOLED CHILLERS**

Provide air-cooled chillers of type indicated in Project Program and meet the requirements of AHRI 550/590. For electric air cooled chillers use minimum full load and part load efficiency ratings specified by ASHRAE 90.1-2013 Table 6.8.1-3. Provide control panel with the manufacturers' standard controls and protection circuits. If DDC system is required in project, provide a control interface for remote monitoring of the chiller's operating parameters, functions and alarms from the DDC control system central workstation. When using BACnet communication protocol, use the ASHRAE 135 protocol without gateways to interface with the BACnet DDC system in specifications UFGS 23 09 00, UFGS 23 09 23.02, and UFGS 23 09 13.

**D303001 1.1.1 Stages**

Provide continuous variable speed compressor adjustment to match actual load, or minimum of four stages of unloading at 25 percent per stage minimum for reciprocating, centrifugal, and scroll chillers. Provide reciprocating units with hot gas bypass.

**D303001 1.1.2 Pressure Control**

Provide head pressure control for cold temperature operation. Provide freeze protection for chiller and piping.

**D303001 1.1.3 Coil Construction**

Provide copper tube, aluminum fins for condenser coils. Provide manufacturer's optional louvered covers or hail guards for condenser coils to provide protection against vandalism, debris, or hail.

**D303001 1.2 WATER-COOLED CHILLERS**

Self-contained chiller meeting the requirements of AHRI 550/590. For electric water cooled positive displacement chillers less than 300 tons use minimum full load and part load efficiency ratings specified by ASHRAE 90.1-2013 Table 6.8.1-3. For electric water cooled positive displacement chillers greater than 300 tons and electric water cooled centrifugal chillers, use minimum full load and part load efficiency ratings specified by FEMP, which is located at the following DOE FEMP webpage: <http://energy.gov/eere/femp/covered-product-category-water-cooled-electric-chillers> . Provide control panel with the manufacturers' standard controls and protection circuits. If DDC system is required in project, provide a control interface for remote monitoring of the chiller's operating parameters, functions and alarms from the DDC control system central workstation. Provide automatic capacity-reduction system for stable operation from 100 to 10 percent of full load capacity. When using BACnet protocol, use the ASHRAE 135 protocol without gateways to interface with the BACnet DDC system in specifications 23 09 00, 23 09 23.02, and 23 09 13.

**D303001 1.3 COOLING TOWERS**

Factory assembled, conforming to NFPA 214. Fire hazard rating for plastic impregnated materials must not exceed 25. Provide Cooling Technology Institute 201 certification of tower capability and performance. Cooling Tower performance must meet or exceed that listed in ASHRAE 90.1. Construct as indicated in ESR Section D30 with fill material of PVC formed sheets. Provide stainless steel hardware. Provide vibration cutout switch interlocked with the fan motor. Provide 2-speed or adjustable frequency drive fan motors. Provide work platform(s) at all locations in the tower that require periodic maintenance. For multi-cell installations, provide isolation valves on inlets and outlets of each cell. Provide eliminators in the tower outlet to limit drift loss to not over 0.002 percent of the circulating water rate for counterflow towers, or 0.005 percent of the circulating water rate for cross-flow towers. Eliminators to be constructed of not less than 3/8 inch (10 mm) lumber or polyvinyl chloride (PVC).

**D303001 1.4 CLOSED CIRCUIT COOLERS**

Factory assembled, conforming to NFPA 214. Fire hazard rating for plastic impregnated materials must not exceed 25. Provide Cooling Technology Institute 201 certification of tower capability and performance. Cooler performance must meet or exceed that listed in ASHRAE 90.1. Provide stainless steel hardware. Provide vibration cutout switch interlocked with the fan motor. Provide 2-speed or adjustable frequency drive fan motors. Meet OSHA safety requirements for stairs and handrails.

**D303002 DIRECT EXPANSION SYSTEMS**

If coatings are indicated in ESR Section D30, provide with copper tube/copper fin construction or immersion applied, baked phenolic or other approved coating that passes the 3000 hour salt spray resistance test using the ASTM B117 procedure. Field applied coatings are not acceptable.

**D303002 1.1 HEAT PUMPS**

**D303002 1.1.1 Air to Air**

Air-cooled, split system heat pumps with ducted air distribution. Provide units factory assembled, designed, tested, and rated in accordance with AHRI 210/240 or AHRI 340/360. Equipment to be Energy Star Qualified, and heat pumps must include the Energy Star label affixed to the equipment. For small (less than 65,000 Btuh) air-cooled heat pumps, Energy Star requires a minimum 14 SEER, 11 EER, and 8.0 HSPF. For medium (65,000 to 135,000 Btuh) air-cooled heat pumps, Energy Star requires a minimum 11.3 EER, 11.4 IEER, and 3.35 COP. For large (136,000 to 240,000 Btuh) air-cooled heat pumps, Energy Star requires a minimum 10.9 EER, 11 IEER, and 3.35 COP. Provide manufacturer's minimum recommended clearance around condensing units. Size refrigerant piping in accordance with the manufacturer's recommendations. Insulate refrigerant piping suction lines and condensate drain.

**D303002 1.1.2 Water Source**

Factory assembled, designed, tested, and rated in accordance with AHRI/ISO 13256-1 or AHRI/ISO 13256-2. Unit must be AHRI/ISO 13256-1 or AHRI/ISO 13256-2 certified, or listed in the AHRI/ISO 13256-1 or AHRI/ISO 13256-2 directory. In compliance with FEMP/Energy Star requirements, water-to-air closed loop units to have a minimum EER of 17.1 and COP of 3.6. Water-to-air open loop units to have minimum EER of 21.1 and COP of 4.1. Water-to-water closed loop units to have a minimum EER of 16.1 and minimum heating performance COP of 3.1; water-to-water open loop units to have a minimum EER of 20.1 and a minimum heating performance COP of 3.5.

**D303002 1.1.3 Ground-Coupled**

Factory assembled, designed, tested, and rated in accordance with AHRI/ISO 13256-1 or AHRI/ISO 13256-2. Unit must be AHRI/ISO 13256-1 or AHRI/ISO 13256-2 certified, or listed in the AHRI/ISO 13256-1 or AHRI/ISO 13256-2 directory. Ground-coupled heat pumps must be connected to the heat exchanger by a closed loop ground source vertical well field. In compliance with FEMP/Energy Star requirements, water-to-air closed loop units to have a minimum EER of 17.1 and minimum heating performance COP of 3.6. Water-to-water closed loop units to have a minimum EER of 16.1 and minimum heating performance COP of 3.1. Design and install each well field in accordance with IGSHPA and ASHRAE Standards.

**D303002 1.2 CONDENSING UNITS**

Air-cooled, split system air conditioner with ducted air distribution. Provide units factory assembled, designed, tested, and rated in accordance with AHRI 210/240 or AHRI 340/360. Condensing units with capacities greater than or equal to 135,000 Btuh to meet the minimum efficiency requirements specified by ASHRAE 90.1-2013 Table 6.8.1-1 "Electrically Operated Unitary Air Conditioners and Condensing Units". Provide manufacturer's minimum recommended clearance around condensing units. Size refrigerant piping in accordance with the manufacturer's recommendations.

**D303002 1.3 DX VARIABLE AIR VOLUME (VAV) UNITS**

Direct expansion equipment to be specifically designed and manufactured for VAV applications. Central air handling units, VAV boxes/zone dampers and zone controls are to be provided by the same manufacturer.

**D303002 1.3.1 Changeover-Bypass VAV Units**

Provide the changeover-bypass VAV system with a constant-volume supply fan, and duct mounted zone control damper units with integral control boxes, designed for use with DX VAV packaged systems. A bypass duct and bypass damper diverts (bypasses) supply air not required by the zones back to the return duct by modulating the bypass damper to maintain the supply duct static pressure setpoint. Airflow through the evaporator coil must not be modulated.

**D303002 1.3.2 Variable Air Volume Units**

Provide the variable air volume (VAV) system with a variable speed supply fan, variable speed compressors, and pressure independent zone VAV boxes/units. The supply fan varies speed to modulate the supply airflow to maintain the supply duct static pressure setpoint, while the variable speed compressors modulate to maintain discharge air temperature setpoints as the airflow through the evaporator coil is modulated.

**D303002 1.4 DUCTLESS SPLIT SYSTEM**

Air-cooled, ductless split system. Provide units factory assembled, designed, tested, and rated in accordance with ARI 210/240. Provide manufacturer's minimum recommended clearance around heat pump or condensing units. Size refrigerant piping in accordance with the manufacturer's recommendations. Insulate refrigerant piping suction lines and condensate drain.

**D303002 1.4.1 Light Commercial Air Conditioner, Three-Phase, Ductless Split Systems**

In order to meet Energy Star requirements, ductless split system air conditioners smaller than 65,000 Btuh require a minimum SEER of 14 and EER of 12; ductless split system air conditioners that have an electric resistance heating section (or no heating) and are sized from 65,000 Btuh up to 240,000 Btuh to have an EER of 11.7 and an IEER of 11.8; all other air conditioners sized from 65,000 Btuh up to 240,000 Btuh to have an EER of 11.5 and IEER of 11.6.

**D303002 1.4.2 Light Commercial Heat Pump, Three-Phase, Ductless Split Systems**

In order to meet Energy Star requirements, ductless split system heat pumps smaller than 65,000 Btuh require a minimum SEER of 14, EER of 11, and HSPF of 8.2; ductless split system heat pumps that have an electric resistance heating section (or none) and are sized from 65,000 Btuh up to 135,000 Btuh to have an EER of 11.3, an IEER of 11.4, and a COP of 3.35 (rated at 47 deg F); ductless split system heat pumps that have an electric resistance heating section (or none) and are sized from 135,000 Btuh up to 240,000 Btuh to have an EER of 10.9, an IEER of 11, and a COP of 3.25 (rated at 47 deg F).

**D303002 1.5 VARIABLE REFRIGERANT FLOW SYSTEMS**

Provide a complete system consisting of VRF heat pump units, branch circuit controllers, VRF fan coil units, and associated controls. Provide inverter driven heat pump units that utilize R410A refrigerant. In order to meet Energy Star requirements, heat pumps smaller than 65,000 Btuh require a minimum SEER of 14, EER of 11, and HSPF of 8.2; heat pumps that have an electric resistance heating section (or none) and are sized from 65,000 Btuh up to 135,000 Btuh to have an EER of 11.3, an IEER of 11.4, and a COP of 3.35 (rated at 47 deg F); heat pumps that have an electric resistance heating section (or none) and are sized from 135,000 Btuh up to 240,000 Btuh to have an EER of 10.9, an IEER of 11, and a COP of 3.25 (rated at 47 deg F). On the branch circuit controllers, include multiple branch connections allowing for simultaneous heating and cooling utilizing hot gas refrigerant or sub-cooled liquid. The total capacity of the branch controllers must be between 50 and 150 percent of the rated capacity.

Size and install refrigerant piping in strict compliance with the manufacturer's requirements. Refrigerant piping must be clean, dry, and leak free. Prior to installation all refrigerant pipes must remain sealed. During installation and prior to filling, use nitrogen to maintain cleanliness and prevent oxidation and scaling while brazing. Install each system to provide proper oil return. Refrigerant piping must be copper, ACR type, ASTM B280. All joints must be sil-brazed. All thicknesses of piping must remain the same throughout the system. Individually pressure test and commission each refrigerant circuit. Perform pressure testing using nitrogen at 1-1/2 times the system operating pressure. Design each system to meet Refrigerant Piping and Heat Transfer Components ASME B31.9, Building Services Piping Code and design to allow for expansion and contraction.

**D3040 DISTRIBUTION SYSTEMS**

**D304001 AIR DISTRIBUTION, HEATING & COOLING**

**D304001 1.1 DUCTWORK**

Except as specified herein, provide ductwork constructed, braced, reinforced, installed, supported, and sealed in accordance with SMACNA standards.

**D304001 1.1.1 Flexible Ducts**

Use insulated flexible duct only for connections to air distribution devices to adapt to minor offsets. Flexible duct must be UL 181 listed and in conformance with SMACNA 1966 duct construction standards with a minimum R value of 4. Limit flexible ductwork to maximum of 5 feet (1.5 meters) in length.

**D304001 1.1.2 Flexible Connections**

Provide flexible connectors between fans and ducts.

**D304001 1.1.3 Volume Dampers**

Provide manual volume dampers in each branch take-off from the main duct to control air quantity except for primary supply ductwork on VAV systems. Dampers must conform to SMACNA 1966 duct construction standards and must be seal class "A" construction.

**D304001 1.1.4 Fire Dampers**

Fire dampers must be rated in accordance with UL 555. Fire dampers must be dynamic type rated for closure against a moving airstream. Provide fire dampers that do not intrude into the air stream when in the open position.

**D304001 1.1.5 Smoke Dampers**

Smoke dampers must be rated in accordance with UL 555S.

**D304001 1.1.6 Sound Attenuators**

Fabricated attenuators that will reduce the rated sound pressure level of the fan down to at least 65 decibels in the 250 Hz (third octave band) center frequency by using a reference sound source calibrated in decibels of sound power at 10 to 12 watts. Maximum permissible pressure drop must not exceed 0.63 inch of water (157 Pa).

**D304001 1.2 LOUVERS & HOODS**

**D304001 1.2.1 Louvers**

Louvers must bear AMCA ratings seal for air performance and water penetration in accordance with AMCA 500L and AMCA 511. Louvers must be constructed of anodized aluminum alloy or stainless steel. Provide birdscreens.

**D304001 1.2.2 Hoods**

Hoods must be constructed of anodized aluminum alloy or stainless steel. Provide with birdscreens.

**D304001 1.3 GRILLES, REGISTERS, & DIFFUSERS**

Factory-finished grilles, registers, and diffusers. Exterior and exposed edges must be rolled, or otherwise stiffened and rounded.

**D304001 1.4 INSULATION**

Provide external thermal insulation for all ductwork. Insulate ductwork in concealed spaces with blanket flexible mineral fiber. Insulate ductwork in Mechanical Rooms and exposed locations with rigid mineral fiber insulation.

Provide insulation with factory applied all-purpose jacket with integral vapor retarder. In exposed locations, provide a jacket with white surface suitable for painting. Flame spread/smoke developed rating for all insulation must not exceed 25/50. Minimum insulation thickness must be the minimum thickness required by ASHRAE 90.1. Insulate the backs of all supply air diffusers with blanket flexible mineral fiber insulation.

**D304001 1.5 VAV BOXES**

Pressure-independent type variable air volume units rated in accordance with AHRI 880. Boxes must not be allowed to fully shut-off. Provide each box with a heating coil unless not required by space reheat or heating. Provide electronic controls.

**D304001 1.6 VARIABLE AIR VOLUME VAV FAN-POWERED UNITS**

Pressure-independent, fan powered, VAV units rated in accordance with AHRI 880 and UL listed. Provide each box with a heating coil. Provide electronic controls with speed controller, discharge volume control damper(s), and return/recirculation air frame and filter. If discharge dampers are not provided with the unit, coordinate installation with the sheet metal contractor. Insulate in accordance with ASHRAE 90.1.

**D304002 STEAM DISTRIBUTION SYSTEMS**

**D304002 1.1 STEAM PIPING**

ASTM A 106/A 106M or ASTM A 53/A 53M Grade B, Schedule 40, black steel, electric-resistance welded or seamless.

**D304002 1.2 CONDENSATE RETURN PIPING**

ASTM A 106/A 106M or ASTM A 53/A 53M, Grade B, Schedule 80, black steel, electric-resistance welded or seamless.

**D304002 1.3 STEEL PIPE FITTINGS**

For piping 2 inch (50 mm) and smaller, provide ASME B16.3 malleable iron screwed fittings or ASME B16.11 socket welding (Class 3000) or threaded type (Class 2000). Provide ASME B16.9 butt-welding fittings or ASME B16.5 flanged type for piping 2-1/2 inch (63 mm) and larger.

**D304002 1.4 INSULATION**

Insulate steam and condensate return piping with mineral fiber or cellular glass insulation with all-purpose jacket.

**D304002 1.5 STEAM PRESSURE REDUCING STATION**

For each building, provide steam pressure reducing station(s).

**D304002 1.6 STEAM TRAPS**

Provide steam traps and accessories in accordance with UFC 3-401-01.

**D304003 HOT WATER DISTRIBUTION SYSTEMS**

**D304003 1.1 HOT WATER PIPING**

Electric resistance welded or seamless Schedule 40 black steel pipe conforming to ASTM A 53/A 53M. Piping 4 inch (100 mm) and smaller may be ASTM B 88 Type K or L copper.

**D304003 1.2 STEEL PIPE FITTINGS**

For piping 2 inch (50 mm) and smaller, provide ASME B16.3 malleable iron screwed fittings or ASME B16.11 socket welding (Class 3000) or threaded type (Class 2000). Provide ASME B16.9 butt-welding fittings or ASME B16.5 flanged type for piping 2-1/2 inch (63 mm) and larger.

**D304003 1.3 COPPER FITTINGS**

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type.

**D304003 1.4 ISOLATION VALVES**

Provide isolation valves on supply and return lines at take-offs for service to each building(s). Locate valves in valve boxes.

**D304003 1.5 INSULATION**

Insulate hot water piping with mineral fiber insulation with factory-applied all-purpose jacket. Provide aluminum metal wrap over insulation for all exterior piping.

**D304003 1.6 VALVES**

Provide shut off valves, appropriately sized relief valves, and appropriately sized balancing valves as necessary to balance water flows, protect components and isolate equipment for service and repairs.

**D304003 1.7 APPURTENANCES**

Provide appurtenances such as air separators, expansion tanks, suction diffusers, strainers, and other required features to allow for proper operation of hot water systems.

**D304003 1.8 TEST PORTS**

Provide test ports in piping at inlet and outlet of all major system components including boilers, pumps, and other equipment as required.

**D304005 GLYCOL DISTRIBUTION SYSTEMS**

Provide as specified for Chilled Water Distribution Systems see D304006.

**D304006 CHILLED / CONDENSER WATER DISTRIBUTION SYSTEMS**

**D304006 1.1 ABOVEGROUND CHILLED AND CONDENSER WATER PIPING**

Aboveground chilled water piping must be electric resistance welded or seamless Schedule 40 black steel pipe conforming to ASTM A 53/A 53M. Piping 4 inch (100 mm) and smaller may be ASTM B 88 Type K or L copper.

**D304006 1.2 STEEL PIPE FITTINGS**

For piping 2 inch (50 mm) and smaller, provide ASME B16.3 malleable iron screwed fittings or ASME B16.11 socket welding (Class 3000) or threaded type (Class 2000). Provide ASME B16.9 butt-welding fittings or ASME B16.5 flanged type for piping 2-1/2 inch (63 mm) and larger.

**D304006 1.3 COPPER FITTINGS**

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type.

**D304006 1.4 ISOLATION VALVES**

Provide isolation valves on supply and return lines at take-offs for service to each building(s). Locate valves in valve boxes.

**D304006 1.5 INSULATION**

Insulate chilled water pumps and accessories for the temperature and service in rigid block, semi-rigid board, or flexible unicellular insulation to fit as closely as possible to equipment. Insulate above ground chilled water piping with cellular glass insulation (ASTM C 552, Type II, and Type III). Flexible unicellular insulation may be used on small piping runouts. Insulate condenser water piping with mineral fiber insulation. Provide all-purpose jacket with vapor retarder. Provide aluminum metal wrap over insulation for all exterior piping.

**D304006 1.6 VALVES**

Provide shut off valves, appropriately sized relief valves, and appropriately sized balancing valves as necessary to balance water flows, protect components and isolate equipment for service and repairs.

**D304006 1.7 TEST PORTS**

Provide test ports in piping at inlet and outlet of all major system components including chillers, pumps, and other equipment as required.

**D304007 EXHAUST SYSTEMS**

**D304007 1.1 FANS**

AMCA 210 certified, with AMCA seal. Fan bearings must have a minimum average life of 200,000 hours at design operating conditions. Provide bird screens for outdoor inlets and outlets. Provide direct-drive type fans with means for verifying operation via the building DDC system or with speed controllers

**D304007 1.2 IN-LINE FANS**

UL-Listed centrifugal fans.

**D304007 1.3 WALL FANS**

Propeller fans with fan guards. Provide centrifugal fans with backdraft dampers and wall bracket.

**D304007 1.4 ROOFTOP FANS**

UL-Listed centrifugal fans with roof curb.

**D304007 1.5 UTILITY SETS**

AMCA 210 with AMCA seal.

**D304007 1.6 BATHROOM FANS**

UL 507 and UL-listed, Home Ventilating Institute (HVI) certified and with AMCA seal for ceiling installation.

**D304007 1.7 RANGE HOODS**

UL 507 and UL-listed, with AMCA seal, range hood with light over stove. Minimum fan capacity must be 160 cfm with maximum sound level of 5.6 sones.

**D304008 AIR HANDLING UNITS**

AMCA 210 certified fans with AMCA seal. Fan bearings must have a minimum average life of 200,000 hours at design operating conditions. Provide bird screens for outdoor inlets and outlets.

**D304008 1.1 CENTRAL STATION AIR HANDLERS**

Modular construction, double wall air handling units with minimum of 1 inch (25 mm) casing insulation. Provide AHRI 430 certified fans and AHRI certified coils. Provide stainless steel, positive draining condensate drain pan. For 100 percent outside air units provide capability for cooling, heating, dehumidification and reheat.

**D304008 1.1.1 Ultraviolet Disinfection System**

For central station air handling units provide an ultra violet c-band (UVC) disinfection system for mold, bacteria and odor control in each air handler that has a chilled water or DX cooling coil. Irradiation-emitters and fixtures are to be installed in sufficient quantity and in such an arrangement so as to provide an equal distribution of UVC energy on the coil and in the drain pan. To maintain energy efficiency, the UVC energy produced must be of the lowest possible reflected and shadowed losses. Energy Efficiency - high efficiency electronic type power supplies matched to the emitter. Intensity - The minimal UVC energy striking the leading edge (if installed upstream) or trailing edge (if installed downstream) of all the coil fins must not be less than 820 ÂµW/cm2 at the closest point and through placement, not less than 60 percent of that value at the farthest point. Equal amounts are to strike the drain pan, either directly or indirectly through reflection. The foregoing sets the placement and minimum quantity of fixtures to be installed. Installation - install emitters and fixtures at right angles to the conforming lines of the coil fins, such that through incident angle reflection, UVC energy bathes all surfaces of the coil and drain pan as well as all of the available line of sight airstream. Provide one complete set of spare bulbs.

**D304008 1.1.2 Dedicated Outside Air System (DOAS)**

Provide package or modular air handling unit specifically designed for conditioning 100% outside air. Provide controls and hardware necessary for controlling ventilation air to the point of use at a specific dry bulb temperature and relative humidity. Provide with supply and exhaust/return fan with heat recovery element if called for. Provide with DX or chilled water cooling/dehumidification coil. Provide with modulating hot refrigerant gas or hot water reheat coil.

**D304090 OTHER DISTRIBUTION SYSTEMS**

**D304090 1.1 PUMPS**

Centrifugal circulating pumps with motor, motor starter, and motor enclosure conforming to the appropriate NEMA standards. Provide suction diffusers on base-mounted pumps. Insulate pumps used for hot service and chilled water service.

**D304090 1.1.1 In-Line Pumps**

Pumps constructed of manufacturer's standard materials suitable for chilled, condenser, and hot water heating systems.

**D304090 1.1.2 Base Mounted Pumps**

Single stage end suction pumps suitable for chilled, condenser, and hot water heating systems.

**D304090 1.2 VARIABLE FREQUENCY DRIVES (VFD)**

Factory-assembled variable frequency drive control systems for variable speed control. Provide all air handling unit and pump VFD's from the same manufacturer. Each VFD must include motor starter, motor disconnects and controls as required for a complete system. Units must be UL-listed and comply with the National Electric Code.

Provide the following accessories:

Disconnect switch

Control circuit transformer, with primary and secondary fuses

Manual bypass

System hand-off-auto switch with provisions for remote start/stop of the system.

System initialized light

Run light

Failure alarm

LCD digital display with numeric keypad

Provide a control interface for remote monitoring of VFD functions and alarms from the DDC control system computer.

**D304090 1.3 AIR SEPARATORS**

ASME rated air separators with tangential inlet and outlet connections and automatic air vent.

**D304090 1.4 SOLIDS SEPARATORS**

Provide centrifugal solids separator with automatic drain in open systems.

**D304090 1.5 EXPANSION TANKS**

ASME rated expansion tanks with polypropylene or butyl diaphragm or compression tanks as indicated in UFC 3-401-01.

**D304090 1.6 MAKE-UP WATER STATION**

Provide station consisting of a water pressure-reducing valve and a relief valve in the make-up water line to the chilled and hot water systems to maintain the operating pressure. Provide a 3/4 inch (20 mm) globe valve by-pass around this pressure reducing station. Provide reduced pressure backflow preventer upstream of the by-pass.

**D304090 1.7 GLYCOL MAKE-UP STATION**

If required, provide a glycol makeup system to maintain system proper operating mixture.

**D304090 1.8 CONDENSATE DRAIN PIPING**

ASTM B 88, Type M or L, hard drawn copper.

**D304090 1.9 CONDENSATE DRAIN INSULATION**

Insulate condensate drain piping with flexible cellular insulation.

**D304090 1.10 CHEMICAL TREATMENT**

If required, Provide chilled and hot water systems with automatic chemical treatment system for the control of pH, scale formation, and corrosion inhibition. Provide shot-type feeders for manual chemical feed. Feeders must be rated for use with pressures up to 130 PSI (900 kPa) (gage). Provide condenser water systems with automatic chemical treatment systems that monitor conductivity, and pH, and provide for water metering and bleed-off. Provide chemicals in accordance with EPA and equipment manufacturer’s recommendations.

**D304090 1.11 PIPING IDENTIFICATION**

Provide piping identification labels or Stencil names or code letters for piping systems in clearly visible letters and symbols. Provide arrow-shaped markings to indicate direction of flow.

**D304090 1.12 PIPE SLEEVES**

Provide pipe sleeves at each wall and floor penetration. The sleeve must be of a material suitable to protect the carrier pipe (two pipe sizes larger) and sealed with an appropriate flexible material. Provide fire stopping in fire rated walls in accordance with IBC.

**D304090 1.13 SYSTEM FLUSHING**

Thoroughly flush hydronic systems prior to system startup. Isolate coils during initial flushing until water is clear.

**D304090 1.14 HEAT TAPE**

UL-Listed, self-regulating, heat tape on piping subject to freezing.

**D3050 TERMINAL & PACKAGE UNITS**

**D305002 UNIT HEATERS**

See D302004 for gas fired unit heaters.

**D305002 1.1 STEAM**

UL-Listed, factory assembled, unit heaters.

**D305002 1.2 HOT WATER**

UL-Listed, factory assembled, unit heaters.

**D305002 1.3 CABINET UNIT HEATER**

UL-Listed, factory assembled, heaters.

**D305003 FAN COIL UNITS**

UL-Listed, factory assembled and tested fan coils, AHRI 440 and AHRI certified.

**D305004 FIN TUBE RADIATION**

**D305004 1.1 FIN TUBE RADIATORS AND CONVECTORS**

Provide fin tube radiators and convectors with copper tubes and aluminum fins. Provide normally open, spring return control valves.

**D305005 ELECTRIC HEATING**

**D305005 1.1 UNIT HEATERS**

Factory assembled, UL-1025, unit heaters.

**D305005 1.2 BASEBOARD HEATERS**

Factory assembled, UL-1042, heaters.

**D305005 1.3 WALL HEATERS**

Factory assembled, UL-1025, cabinet heaters.

**D305005 1.4 INFRARED HEATERS**

Factory assembled, UL-Listed and labeled heaters.

**D305006 PACKAGE UNITS**

**D305006 1.1 ROOFTOP AIR HANDLERS**

Factory packaged units in accordance with AHRI 430 and suitable for outdoor installation. Provide with manufacturer's roof curb.

**D305006 1.2 DUCT HEATER**

Factory assembled, UL-listed heaters. Provide control cabinet and heating coil.

**D3060 CONTROLS AND INSTRUMENTATION**

**D306001 HVAC CONTROLS**

**D306001 1.1 DIRECT DIGITAL CONTROLS**

Provide one of the following as directed in ESR Section D30.

a. Provide Direct Digital Controls (DDC) to comply with the requirements specified in UFGS Sections 23 09 00, *Instrumentation and Control for HVAC*, 23 09 23.02, *BACnet Direct Digital Control for HVAC and Other Building Control Systems*, and 23 09 13, *Instrumentation and Control Devices for HVAC*.

b. Provide a partial direct digital control (DDC) system that will communicate with the existing DDC system. If using BACnet protocol, comply with the requirements specified in UFGS Sections 23 09 00, *Instrumentation and Control for HVAC*, 23 09 23.02, *BACnet Direct Digital Control for HVAC and Other Building Control Systems*, and 23 09 13, *Instrumentation and Control Devices for HVAC*. Notwithstanding any other provisions of this Contract, no other product will be acceptable other than that indicated in ESR Section D30. Provide a distributed control system. Integrate all new DDC points on the existing server providing a seamless logical flow from the existing facilities to the new integrated facility.

c. Provide and integrate Direct Digital Controls (DDC) in accordance with Part 3 Chapter 6 D306001 1.1 DIRECT DIGITAL CONTROLS in compliance with requirements specified in UFGS Sections 23 09 00, *Instrumentation and Control for HVAC*, 23 09 23.02, *BACnet Direct Digital Control for HVAC and Other Building Control Systems*, 23 09 13, *Instrumentation and Control Devices for HVAC*, and UFGS 25 10 10, *Utility Monitoring and Control System (UMCS) Front End and Integration*.

The Designer of Record must use UFGS Sections 23 09 00, 23 09 23.02, and 23 09 13 if using BACnet protocol, and submit the edited specification sections as a part of the project design submittal.

Design requirements must be in accordance with all specification notes and the BAS Owner must be identified and designated early in the design documentation.

System must include stand alone digital controllers, a communication network, and a workstation computer with control software. Provide stand-alone control routines that operate without connection to the network during a loss of communication. Provide trending, scheduling and alarm tables (may be included with the sequence of operation). Provide reset routines (based on outdoor air temperature or zone demand) for hot water loop temperature setpoints and supply air static pressure control. Use alarming and trending services during performance testing or commissioning. Alarm every sequence routine when out-of-limits or control/response failure occurs. Display all graphic floor plans, equipment graphics, DDC ladder diagrams, and sequence of operations graphic pages.

All 120-volt wiring must comply with NFPA 70. All 24-volt wiring must comply with the IMC and terminal device manufacturer’s recommendations.

Provide training on the installed system according to the maximum training days in UFGS 23 09 00, UFGS 23 09 23.02, and UFGS 23 09 13. Demonstrate all operator workstation functions requiring BACnet services, i.e., navigating through the graphic displays, trending, alarming and monitoring of the new controls system from the existing operator workstation using only the existing application software and without the need to launch other applications or logon to other vendor applications.

**D306001 1.2 ELECTRONIC CONTROLS**

If required, provide programmable thermostats with built in keypads for scheduling of day and night temperatures with two setback periods per day. Provide independent summer and winter programs. Thermostats must have temporary and manual override of schedule and battery backup.

**D3070 SYSTEMS TESTING AND BALANCING**

**D3070 1.1 HVAC SYSTEM**

Provide HVAC systems testing and balancing that complies with the requirements specified in UFGS Specification Section 23 05 93, *Testing, Adjusting, and Balancing for HVAC*. The Designer of Record must prepare UFGS Specification Section 23 05 93, as a part of the project specification and include the prepared specification section in the design submittal for the project.

**D3090 OTHER HVAC SYSTEMS AND EQUIPMENT**

**D309001 GENERAL CONSTRUCTION ITEMS**

**D309001 1.1 SEISMIC DESIGN**

Provide in accordance with UFC 3-401-01, *Mechanical Engineering*.

**D309002 REFRIGERATION SYSTEMS**

**D309090 OTHER SPECIAL MECHANICAL SYSTEMS**

**D309090 1.1 ENERGY RECOVERY WHEELS**

Total energy (enthalpy) type energy recovery wheels (heat wheels). Media must be aluminum or a lightweight polymer coated with a corrosion-resistant finish. Etched or oxidized surfaces are not acceptable. Heat transfer surfaces must be coated with a non-migrating (permanently bonded) absorbent specifically developed for the selective transfer of water vapor. Equal sensible and latent recovery efficiencies must be documented through a certification program conducted in accordance with ASHRAE 84 and AHRI 1060. The energy recovery wheel must have an insulated housing of double wall construction, rotor seals that are specifically designed to limit cross-contamination, and a rotation detector. Should rotation stop, the rotation detector must alarm the HVAC control system. Filter sections must be readily accessible for maintenance.

**D309090 1.2 HEAT PIPES**

Factory fabricated, assembled and tested heat pipes with counter-flow arrangement. Provide hermitically sealed, seamless aluminum tube cores with extended surfaces. Heat exchanger frame must be constructed of not less than 16-gage 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. A refrigerant must be used as the working fluid. Type I refrigerants are not allowed.

-- End of Section --