1. D3000 GENERAL

This document provides technical guidance to architects and engineers performing mechanical design services for Naval Facilities Engineering Command, Southwest Division. If you have not done work for the government before, you should read this guide carefully prior to beginning work on Southwest Division projects. Military construction requirements often differ from commercial practice and this guide provides a comprehensive listing of the plumbing requirements for military projects. Direct requests for variances and/or suggestions for improvements to this document to Code 03CN.

1.1 SYSTEM DESCRIPTION

Provide heating, ventilating, and air conditioning (HVAC) systems for the facility that attains the following main objectives: Occupant Comfort, Indoor Air Quality, Acceptable Noise Levels, Energy Efficiency, Reliable Operation, and Ease of Maintenance.

Base system selection on the capability of the air conditioning system to maintain the temperature and humidity in conditioned spaces continuously under full load and part load conditions. Consequently, chilled water HVAC systems will be preferred for many facilities.

1.2 SYSTEM REQUIREMENTS

a. HVAC Design Parameters:

Outdoor design conditions shall be in accordance with the Engineering Weather Data, Air Force Hand book (I) 32-1163 and Naval Facilities Engineering Command Publication P-89 dated 1 July 2000 except as detailed in the RFP. Use outdoor design conditions based on the 99% design temperatures for winter and 1% design temperatures for summer as listed in P-89, Engineering Weather Data. Design temperatures listed in this handbook or publications comply with Department of Defense (DOD) standards and may not be as stringent as used on commercial projects. This is intentional to ensure that HVAC equipment is not unnecessarily over-sized. Where specialized design requirements demand the use of more stringent outdoor conditions contact Code 03CN for direction.

Indoor design conditions shall be per given below except as detailed in the RFP. HVAC controls shall be adjustable and may allow selection of temperatures above or below these design values. Specific design criteria are contained in MIL-HDBK-1191 for medical facilities, MIL-HDBK-1027 for training facilities, and MIL-HDBK-1012 for computer and electronics facilities.

b. Summer Indoor Conditions: The indoor design temperature for air-conditioned occupied spaces shall be 15^{o}F (8.3^{o}C) less than the outside dry bulb temperature, but not more than 78^{o}F (25.6^{o}C) or less than 75^{o}F (23.9^{o}C) dry bulb. The design indoor relative humidity shall be 50% maximum. Active humidity control of spaces is not normally required.

c. Winter Indoor Conditions: The winter indoor design temperature for personnel comfort shall be 72^{o}F for administrative, living areas, and working areas and 60^{o}F (15.6^{o}C) for storage areas subject to freezing. Warehouse facilities for the storage of materials not subject to freezing shall not be heated unless routinely occupied by workers.

d. Ventilation:

Ventilation air is outside air provided by forced ventilation or by infiltration. Refer to the latest revision of ASHRAE Standard 62, "Ventilation For Acceptable Air Quality," for required ventilation rates. Pre-condition (i.e.- heat, cool, and dehumidify to room design conditions) all outside air prior to admission into the building.

The following requirements are in addition to the rates recommended by ASHRAE:

Exhaust toilet areas, locker rooms, and janitor closets mechanically with an exhaust rate of not less than 2 cfm/ft^2 (10.2 L/s/m^2) of floor area or 12 air changes, whichever is more stringent. For private toilet rooms with one water closet and one lavatory, exhaust air may be reduced to not less than 1 cfm/ft^2 (5.1 L/s/m^2) or 10 air changes, whichever is more stringent. Provide at least 50 cfm (23.6 L/s) exhaust for bathrooms and janitor closets.

Provide mechanical and electrical equipment rooms with 10 air changes per hour or an exhaust rate to limit room temperature rise to 10^{o}F (5.6^{o}C) above the outdoor summer design dry bulb, whichever is greater. Provide thermostatic control for fans unless otherwise required by code. To ensure that equipment rooms containing combustion burners for boilers, water heaters, or furnaces do not operate as negative pressure areas, use supply fans rather than exhaust fans for ventilation.

Design refrigeration equipment rooms to comply with ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration."

Family Housing: An outside air supply is not required for family housing and shall not be provided.

e. Building Pressurization:

Supply outside air to the return plenum or return mixing box directly at central air conditioning system air handling units Also see paragraph 4.1. Provide adequate outside air to pressurize the building under design wind conditions and building exhaust but never lower than that required by paragraph 3.1. An outside air supply of approximately 115% of the exhaust rate is recommended. Show the supply air quantity, return air quantity, outdoor air quantity, exhaust air quantity, and degree of building pressurization.

f. Filtration:

Provide air filtration for occupied spaces with at least 35% dust spot efficiency and 75% arrestance. Comply with the latest edition of ASHRAE's Systems and Equipment Handbook guidance for selecting and specifying filters.

g. Attic Spaces:

For residential construction, provide a ventilation rate of not less than 1.5 cfm/ft^2 (7.6 L/s/m^2) of floor area for attic spaces. For other buildings, provide sufficient ventilation to limit the temperature rise in the attic to no more than 10 degrees F (5.5 degrees C) above ambient. Provide natural ventilation or mechanical ventilation and thermostatic control for the fan(s) to operate at and above the summer outdoor design dry bulb temperature.

h. Carbon Monoxide Detectors:

In Family Housing containing fuel-fired appliances, provide UL 2034 listed line voltage operated residential carbon monoxide (CO) detectors. Detectors shall feature digital readout and shall be located and installed per the manufacturer's instructions.

i. Occupancy:

Occupancy schedule hours of operation and days of operation during the week shall be as described in the RFP for each individual project. List actual occupancy requirements for the facility in hrs per day and days per week. Insert additional time frames, if occupancy varies during the day.

j. Efficiency:

All mechanical equipment efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.

k. Energy Conservation:

Energy Conservation Compliance: All other projects except family housing, shall demonstrate compliance with ASHRAE Standard 90.1. The design and construction shall meet or exceed the energy efficiency requirements of ASHRAE Energy Standard 90.1 of 1999. An energy analysis must be performed by documenting compliance with the mandatory prescriptive provisions of the standards, and by using an approved computer simulation program to calculate the energy cost budget and design energy cost in the facility.

Family housing projects, shall demonstrate compliance with the “Energy Star” standards. The design and construction of family housing projects shall meet or exceed the requirements of “Energy Star” standards and/or “Energy Star Labeled Home” as described in NAVFACINST 11101.85H Navy Housing Project Standards for guidance.

California Title 24 Compliance: In addition to the above requirements, for projects within COMNAVREGSW AOR (Naval Bases in San Diego, Coronado, Point Loma, Lemoore, El Centro, Seal Beach and Ventura County) and selected projects, the design and construction shall also demonstrate compliance by exceeding the California Title–24 energy standard baseline or custom energy budget by at least 10%. The results of the Title-24 and ASHRAE 90.1 analyses shall be evaluated and compared, and the more rigorous analysis shall be applied to the design and construction of the project of the project. See Southwest Division, Naval Facilities Engineering Command, Energy Related Design Internal Interim Guidance for US Navy MILCON and Special Projects within the CNRSW AOR dated 03 September 2002.

California Title 24 performance approach energy analysis will be required. The analysis shall demonstrate compliance by exceeding the California energy efficiency standard or custom energy budget by at least 10%. The analysis must be accomplished using California Energy Commission approved/certified computer program.

Note that the values for inputs to the energy analysis program such as wall and roof U-values, glass types, HVAC equipment and service water heating system efficiencies, lighting watts/SF and building orientation/layout, must be based on those used in the actual design and construction of the facility.

Submit completed compliance documentations as required in the ASHRAE 90.1 User’s Manual, California Title-24 Energy Efficiency Standards Manual or NAVFACINST 11101.85H.

Computer files and printouts of all input and output data must be submitted, along with the compliance documentations and list of energy-related features included in the design. Input printouts shall include those for any generated wall types, roof types, partition types, etc. Additionally, provide a narrative

report that summarizes the building envelope, lighting system, service water heating and HVAC equipment and systems. Provide the seal and signature of the professional mechanical engineer responsible for the preparation of the energy analysis on the first page of the report.

l. Mechanical Equipment on Roofs:

Minimize the placement of mechanical equipment on roofs. For example, provide split DX systems with condensing units mounted at ground level vice rooftop DX units. This minimizes penetrations through roofs, limits access on roofs, and promotes accessibility of the equipment to encourage proper maintenance.

m. Electric Resistance Heater:

Electric heater shall not be used except where justified for special applications or for heat pumps supplemental heating. Provide a stage of electric heat for each 7-10^{o}F (3.9-5.6^{o}C) differential temperature for all heating coils above approximately 1 kW capacity. For example, for a 15^{o}F (8.3^{o}C) differential temperature coil, provide two steps of heating. Indicate the number of stages provided in the schedule.

n. Air Distribution System for Humid Area:

Consider face and by-pass control for humid areas. Do not use economizer cycles in humid weather areas, as the small reduction in energy usage is more than offset by increased humidity control problems. Dry bulb economizers may be used in humid weather regions.

For systems using fan coils or thru-the-wall heat pumps, require all outside air to be handled through a separate central station air handler. Air should then be ducted directly into rooms (at room conditions - reheat required) or into the return side of fan coil systems (at room conditions - reheat required at central station air handling unit).

o. Thermal Envelope:

Base the building thermal envelope on architectural and energy standards requirements.

p. Noise Level:

Noise levels shall comply with ASHRAE Applications Handbook, Table 34 “Design Guidelines for HVAC-Related Background Sound in Rooms”. For industrial areas or other areas with special requirements or otherwise not covered by ASHRAE, the designer should review the ASHRAE guidelines (1999 Applications Handbook, Table 34, page 46.45) for suitability and provide different requirements if necessary.

q. Protection of Fire-Rated Partitions:

Use a firestop system in lieu of fire damper where a U.L.-listed through penetration firestop system is available.

r. Zoning:

Zone the HVAC system as described in the RFP for each individual project. The HVAC system shall provide each zone with the choice of heating and cooling year round. Each zone shall have its own control.

s. Access to Equipment:

Provide access to all mechanical equipment and components for system balancing, maintenance and servicing purposes. Provide housekeeping pads and vibration isolators under all floor and roof-mounted equipment. Access to the mechanical equipment on the roof shall be from the inside of the building.

t. Corrosion Protection for Mechanical Equipment:

Mechanical equipment located near the coast or exposed to corrosive environment shall be provide corrosion protection. Condenser coils constructed of aluminum fins and copper tubes shall have a factory or shop-applied anti-corrosion coating. Anti-corrosion coating shall be immersion applied, baked phenolic or other approved coating. Field applied coatings are not acceptable. Provide manufacturer's optional louvered covers or hail guards for outdoor coils to provide protection against vandalism, debris, or hail.

u. Refrigerant Rules to Protect the Ozone Layer:

Refrigerants shall have an Ozone Depletion Factor (ODF) of 0.055 or less. The ODF shall be per the "Montreal Protocol on Substances That Deplete the Ozone Layer", September 1987, sponsored by the United Nations Environment Program.

Rehabilitation Projects- Investigate refrigeration equipment to be demolished under rehab projects to determine the type and quantity of refrigerant contained. For equipment containing a Class 1 Ozone Depleting Substance (ODS) refrigerant, indicate the type and quantity of refrigerant on the drawings. Require the use of refrigerant recovery/reclaim equipment to prevent release of refrigerant to the atmosphere. Class 1 ODS must be reclaimed and turned over to the Government. See NAVFAC guide specification section 02220 for additional requirements.

New construction- Navy regulations prohibit the installation of new equipment containing Class 1 ODS refrigerants. For larger refrigeration equipment (100 tons or larger), provide equipment which uses HFC refrigerants (ODF of 0) vice equipment which uses HCFC refrigerants.

1.3 CRITERIA

HVAC system design and installation shall comply with the latest edition of the following:

a. ASHRAE Handbook, HVAC Systems and Equipment

b. ASHRAE 15, Safety Code for Mechanical Refrigeration

c. ASHRAE 62, Ventilation for Acceptable Indoor Air Quality

d. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings

e. ASHRAE 90.1, User's Manual

f. California Title-24 Energy Efficiency Standards Manual

g. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilation Systems

h. The International Fuel Gas Code

i. The International Mechanical Code

j. The International Plumbing Code

k. SMACNA-HVAC Systems Commissioning Manual

l. SMACNA HVAC Air Duct Leakage Test Manual

m. The Associated Air Balance Council (AABC), AABC MN-1, National Standards

n. The National Environmental Balancing Bureau (NEBB) Procedural Standards for Testing Adjusting Balancing of Environmental Systems

o. Other ASHRAE Standards and Handbooks

p. Other Applicable NFPA Standards

q. Applicable ASME code and Standards

r. Army Corps of Engineers (ACOE) TI-809-04, Seismic Design for Buildings

s. MIL HDBK 1003/1 HVAC and Dehumidification System

t. NAVFACINST 11101.85H Navy Housing Project Standards

Naval Facilities Engineering Command has officially adopted the International Mechanical Code (IPC) as the codes to be used for Naval facilities. These documents are available from International Conference of Building Officials (ICBO). They may be reached via telephone at 800-284-4406. or the Internet homepage at

http://www.icbo.org

MIL-HDBKS referenced in this document can be found on NAVFAC's Corporate Intranet Web page at

http://navfacilitator.navfac.navy.mil/docs/

ACOE TI referenced in this document can be found on Army Corps of Engineers Internet homepage at

http://www.hnd.usace.army.mil/techinfo/ti.htm

Other applicable guidance and criteria. For further guidance and sources of criteria refer to the latest revision of:

a. "Guide For Architect-Engineer Firms, Southwest Division, Naval Facilities Engineering Command."

b. Parametric Cost Estimate (PCE) or EFD 1391 Package

c. Southwest Division, Naval Facilities Engineering Command, Energy Related Design Internal Interim Guidance for US Navy MILCON and Special Projects within the CNRSW AOR dated 03 September 2002

Southwest Division documents and guidance can be found on the SWDIV Internet homepage at

http://www.efdsw.navfac.navy.mil/CapitalImprovements/BusinessLineServices.htm

1.4 COMPLIANCE VERIFICATION

Compliance with the requirements will be determined by a review of the design and construction submittals and by field inspection. See Document 00911, “Design Requirements”, for submittal requirements. See Section 01330, “Submittal Procedures”, for Submittal Descriptions (SD-xx) and requirements.

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

Verification of compliance with ASHRAE 90.1 requirements will be determined by a review of the submitted Compliance Documentation Forms from the ASHRAE 90.1 User's Manual.

1.5 DESIGN SUBMITTALS

Design Analyses, Drawings and Specifications Submittal requirements shall be as described in the RFP for each individual project. See Section 00911 – “Design Requirements”.

The HVAC equipment actually installed on a project may be different from that used as your basis of design. Therefore, mechanical equipment schedules shall reflect actual required equipment capacities as calculated, not capacities provided by manufacturers' catalog data. This helps ensure that the installed equipment is optimally sized for the application.

1.6 CONSTRUCTION SUBMITTALS

Construction Submittal requirements shall be as described in the RFP for each individual project. See Section 01330 – “Submittal Procedures”.

D3010 ENERGY SUPPLY

D3011 OIL SUPPLY SYSTEM

[Use the following as reference: MIL-HDBK 1022, Petroleum Fuel Facility; UFGS 13202, Fuel Storage System; UFGS 15192, Fuel oil Piping.]

D3012 GAS SUPPLY SYSTEM

A. NATURAL GAS PIPING

A. Natural Gas Piping

Conform to requirements of the International Fuel Gas Code. Conform to requirements of 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, pressure regulator, and earthquake valve. Contractor is responsible for providing the complete natural gas system to the facility, including, application or permits and coordination with local utility company.

B. Materials And Equipment

Aboveground Within Buildings: Black steel per ASTM A 53, Schedule 40, threaded ends for sizes [50 mm] [2 inches] and smaller; otherwise, plain end beveled for butt welding. Corrugated stainless steel

tubing with polyethylene jacketing and fittings tested and listed in compliance and construction, installation and performance requirements of ANSI/AGA LC-1.

Underground: Provide Polyethylene (PE) pipe conforming to ASTM D 2513 for 690 kPa (100 PSI) (gage) working pressure. Standard Dimension Ratio shall be 11.5 maximum. Provide detectable aluminum for plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of direct buried piping. Tape shall be detectable by an electronic detection instrument.

Steel Pipe Fittings: Provide ANSI/ASME B16.3, black malleable iron threaded fittings or ASME/ANSI B16.9, butt-welding fittings. Unions shall be ASME/ANSI B16.39, black malleable iron. Flanges and flanged fittings shall be ASME/ANSI B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

Polyethylene Fittings: ASTM D 2683 socket fittings or ASTM D 2513 molded butt-fusion fittings.

Riser: Manufacturer standard anodeless riser, transition from plastic (PE) to steel pipe. Transition fitting shall be with 7-12 mils thick epoxy coating swaged gastight with o-ring seals and metal inserts.

Transition Fittings: Manufacturer's standard fittings. Steel to plastic (PE) with tapping tee or sleeve. Coat or wrap steel pipe with heavy-duty plastic coating.

Below Ground Valves

a. Metallic ball valves: ANSI B16.33 or ANSI/ASME B16.38 corrosion resisting steel with threaded or flanged end.

b. PE ball or plug valves: ANSI/ASME B16.40 and ASTM D 2513 class C material (PE 2306 or PE 3406). SDR matching pipe dimensions and working pressure.

Aboveground Valves

a. Shut-off valves: Bronze or steel threaded end in accordance with ANSI B16.33, or Cast iron or steel flanged end in accordance with ANSI/ASME B16.38, non-lubricated, wedged mechanism or tapered lift plug.

b. Pressure Regulator: ASME B31.8 and AGA service or industrial type, self-contained with spring loaded diaphragm.

c. Earthquake Automatic Shut-off Valve: ANSI Z21.70 and UL or AGA listed.

Gas Meter: ANSI B109.1 or ANSI B109.2 or ANSI B109.3.

Valve Boxes: Street valve box with the word "GAS" cast into the box cover. Heavy-duty cast iron cover for roads and traffic areas, and standard duty concrete cover for other areas.

C. PRESSURE TESTS

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

D3014 STEAM SUPPLY SYSTEM

[For exterior buried Steam Distribution Systems see G3041.] [See D3043.]

D3015 HOT WATER SUPPLY SYSTEM

[For exterior buried Hot Water Distribution Systems see G3043.] [See D3044.]

D3016 SOLAR ENERGY SYSTEM

[Use the following as reference: UFGS 13610N Solar Liquid Flat Plate Collectors.]

D3020 HEAT GENERATING SYSTEMS

D3021 BOILERS

A. HOT WATER BOILER

Boiler Type: The following boiler types are required to be used on all Southwest Division projects. These boiler designs have been selected on the basis of having excellent durability, resistance to abuse, long lives, and reasonable efficiency. Alternative boiler types are not allowed without prior approval of Code 03CN.

a. Below 117 kW (400,000 BTUH) input: Provide cast iron/steel sectional boilers with atmospheric burners.

b. 117 kW – 293 kW (400,000 BTUH - 1,000,000 BTUH) input: Provide steel firetube firebox type with power burners or modified scotch marine type with power burners.

c. Above 293 kW (1,000,000 BTUH) input: Provide modified scotch marine type with power burner up to approximately 3660 kW (12,500,000 BTUH) input. For boilers larger than 3660 kW (12,500,000 BTUH) input, provide packaged steel watertube.

Efficiency: Boilers efficiency shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.

Boiler shall be designed, tested, and installed per ASME CSD-1 (Controls and Safety Devices) and ASME BPVC SEC IV (Boiler and Pressure Vessel Code for Section IV Boilers) or ASME BPVC SEC I (Boiler and Pressure Vessel Code for Section I Boilers.) The boiler shall meet the requirements of the UL 795, NFPA 8501, ANSI Z83.3, ASME CSD, and ASME BPVC SEC IV.

B. BOILER BURNER

Provide a natural gas-fired power burner. Interrupted pilot type ignition system and pilot shall be the electrode-ignited natural gas type. Burners provided shall be the make, model and type certified and approved by the manufacturer of the boiler being provided. Burner controls and safety equipment shall conform to ASME CSD-1. The combustion safeguard system shall have a repetitive self-checking circuit that automatically checks all components of the combustion safeguard system including the flame detector. The combustion control system shall be of the high-low-off type for boilers rated up to 234 kW (800,000 BTUH) input. Full modulation combustion control is required for boilers with capacity ratings greater than 234 kW (800,000 BTUH) input. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner.

C. ADDITIONAL ASME CSD-1 REQUIREMENTS

The safety interlock switches and limit controls required by ASME CSD-1 shall be extended to include the following additions:

1. The safety shutdown caused by loss of combustion air on gas-fired burners with an input greater than 732 kW (2,500,000 BTUH) input shall be extended to include gas-fired burners with an input of 117 kW (400,000 BTUH) input and greater.

2. The safety shutdown caused by high and low pressure in the gas piping of gas-fired burners with an input greater than 732 kW (2,500,000 BTUH) input shall be extended to include gas-fired burners with an input of 117 kW (400,000 BTUH) input and greater.

3. The required fuel gas piping safety shut-off valves for gas-fired burners with an input greater than 732 kW (2,500,000 BTUH) input shall be furnished with all gas-fired burners with an input of 117 kW (400,000 BTUH) input and greater.

D. BOILER TRIM AND CONTROL EQUIPMENT

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 that is not mounted on the burner. Location of the panel shall be at the side of the boiler or in a freestanding control cabinet away from the front of the boiler. Control enclosures conforming to NEMA ICS 6 Type 12. Provide control panel indicating lights as follows:

a. Amber: Ignition on

b. Blue: Draft

c. Green: Main fuel safety shut-off valves open

d. Red (One for each): Safety lockout, flame failure, high temperature, low water pressure, low water level, high gas pressure, low gas pressure.

Each safety interlock requiring a manual reset shall have an individually labeled red indicating light. Non-recycling control interlocks shall have the reset located on control interlock 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 d. above.

2. Combustion Regulator: Provide adjustable temperature, thermostatic immersion type that shall limit boiler water temperature to a maximum of 121 degrees C (250 degrees F). Control shall actuate burner through an electric relay system to maintain boiler water temperature within normal prescribed limits at loads within rated capacity of boiler.

3. High Temperature Limit Switch: Provide immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat shall cause a safety shutdown by closing fuel valves, 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 shall require manual reset before operation can resume and shall prevent recycling of the burner equipment.

4. Low Water Level Cutoff Switch: Provide float-actuated type. Low water level cutoff shall cause a safety shutdown by closing fuel valves, 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 level shall require manual reset before operation can resume and shall prevent recycling of the burner equipment.

5. Boiler Safety Control Circuits: Provide boiler safety control circuits, including control circuits for burner and draft fan. Circuits shall 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 that do not carry current to a grounding conductor.

6. Alarm Bell: Provide alarm bell not less than 100 mm (4 inches) in diameter, electrically operated, with a manual disconnect. Disconnect switch shall 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.

7. Post-Combustion Purge: Ensure operation of draft fan for a period of not less than 15 seconds, or of sufficient duration to provide the appropriate number of air changes in the boiler combustion chamber, (whichever is greater) following shutdown of burner upon satisfaction of heat demand. Upon completion of post-combustion purge period, draft fan shall automatically shutdown until next restart.

8. Emergency Disconnect: Provide and locate an emergency disconnect on wall outside boiler room entrance or just inside door, when boiler room door is on building exterior. Switch shall be red and furnished with a label indicating function of switch.

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

10. Safety Relief Valve: Provide relieving capacity for the full output of boiler. Relief valve piping shall conform to ASTM A 53, schedule 40 steel pipe and be piped full size to floor drain.

11. 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.

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

13. Drain Trapping: Provide drain valve and piping to a floor drain.

14. Air Vent Valve: Provide with screwed connection, stainless steel disk, and stainless steel seats to vent entrapped air.

E. BOILER STACK AND ACCESSORIES

1. Stack: Provide boiler stack constructed of sheet steel having a thickness of not less than 2.47 mm (3/32 inch) and with welded joints. Stack diameter and height shall be in accordance with manufacturer's recommendations and conform to NFPA 211. Manufactured multi-wall stacks may be used.

2. Insulation: Insulate portion of stack located inside the building with 38 mm (1-1/2 inch) of mineral wool conforming to ASTM C 592, Class II - for use up to 649 degrees C (1200 degrees F). Provide insulation with a coat of finishing cement no less than 20 mm (3/4 inch) thick, trowelled to a smooth finish. Insulation is not required for multi-wall stacks.

3. Supports: Provide stack supports, umbrella collar and cap, and flue transition piece.

4. Stack Thermometer: Provide flue gas dial type thermometer with scale calibrated from 66 degrees C to 399 degrees C (150 degrees F to 750 degrees F) and mount in flue gas outlet.

F. BOILER INSTALLATION

1. Location: Install boiler(s) and associated hot water pumps in a mechanical room inside the facility. Do not locate boilers outdoors. Provide ample clearance around boilers to allow access for inspection, maintenance, and repair. Passageways around all sides of boilers shall have an unobstructed width of 36 inches, or the clearances recommended by the boiler manufacturer, whichever is greater.

2. Temperature Requirements: If reset of the supply temperature is desired based on outside air temperature, use a mixing valve to achieve the desired supply temperature. Do not reset the temperature of the water in the boilers unless recommended by the boiler manufacturer.

3. Combustion Air: Provide supply of air for combustion and ventilation. Calculate the amount of combustion air necessary to operate the boiler used as the basis of design. Provide supply fans for ventilation so that boiler rooms are not subjected to negative pressures which may interfere with combustion.

G. BOILER OPERATION

Remote starting and stopping of the boiler is not permitted. Boilers shall be energized manually and locally at the boiler. Energizing the boiler shall also start the hot water pump to minimize thermal shock. Once energized, boilers shall maintain a set temperature by cycling or modulating under factory boiler controls. Maintain hot water boilers at a minimum 85 degrees C (180 degrees F) for hot water supply. Minimum return water temperature shall be 70 degrees C (160 degrees F). Provide reset of the Hot Water supply distribution system temperature based on outside air temperature using a three-way mixing valve to achieve the desired supply temperature. Do not reset the temperature of the water in the boiler.

H. BOILER STARTUP AND OPERATIONAL TESTS

1. Boiler Cleaning: Prior to startup, boil out the boiler for at least 24 hours at a pressure not exceeding 80 kPa (12 PSI) (gage). Boiling solution shall consist of 1 kg (2 pounds) of trisodium phosphate per 380 liters (100 gallons) of water. After cleaning, flush boiler with potable water, drain, and charge with chemically treated water. Professional services are required for the cleaning/treatment process.

2. Operational Tests: As part of Commissioning, furnish the services of an engineer or technician approved by the boiler manufacturer for installation, startup, operational and safety testing. This person shall remain on the job until each boiler has been in successful operation for at least 3 days. Furnish and perform everything required for inspections and tests of the boiler and auxiliary equipment. Test instrumentation shall be calibrated and have full-scale readings 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. Acceptance Operational Test: 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 the manufacturer's recommendations. The Contracting Officer, upon receipt of the notice from the Contractor, shall request a boiler inspection by a Naval Facilities Engineering Service Center Boiler Inspector, Code ESC-231 or by a Base Boiler Inspector if available. Twenty-one days advance notice is required for scheduling the inspector to conduct the acceptance operational test. An engineer or technician approved by the boiler manufacturer shall be present to perform the acceptance operational test.

D3022 BOILER ROOM PIPING AND SPECIALTIES

See 3045.

D3023 AUXILIARY EQUIPMENT

A. STEAM TO HOT WATER CONVERTER

1. FS WW-H-191. Provide steam to hot water converter as required for the application. Reset hot water supply temperature based on outside air temperature.

2. Provide a 1/3 and 2/3 capacity control valve arrangement at each converter. Low-pressure steam supply to the converters shall be provided with a 100% bypass valve.

B. CONDENSATE RETURN UNITS

MIL-P-17749, with hexahedral floor-mounted receiver or horizontal cylindrical stand mounted receiver or vertical cylindrical underground receiver as required. Provide duplex pump units.

C. FIN TUBE RADIATORS

FS A-A 50545, Fin tube radiators shall be provided with copper tubes and aluminum fins with adjustable damper. Provide normally open, spring return control valves.

D. STEAM METER

Rotary axial turbine totalizing type designed for mounting directly in the steam line or in a bypass piping arrangement with orifice plate in the main line. Bypass meter shall be furnished for horizontal or vertical upward flow or vertical down ward flow.

Spring loaded variable orifice principle type steam meter, density compensated, to ensure accuracy within plus or minus 2 percent of actual flow rate independent of line pressure changes. Provide computer to display totalized flow rate, temperature, pressure time and date.

Steam meter shall be interfaced with building energy monitoring system.

D3024 INSULATION

Insulate hot water 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. Provide vapor barrier as required for the application.

D3030 COOLING GENERATING SYSTEMS

D3031 CHILLED WATER SYSTEMS

A. SYSTEM REQUIREMENTS

1. Maximum supply chilled water temperature shall be 7 degrees C (45 degrees F) in the chilled water distribution loop at all times. Chilled water reset is not allowed.

2. Total system chilled water volume contained in the piping, valves, pumps, cooling coils, and chiller barrel(s) shall be a minimum of 7.5 liters per kW (7 gallons per ton) of cooling. If necessary, provide an insulated storage tank in the chilled water piping to achieve the required chilled water capacity. Install the chilled water storage tank downstream of the chiller and upstream of the cooling coils.

Provide calculations to demonstrate compliance with this requirement. Volumes for components may be estimated where manufacturer's information is not available. This requirement is intended to prevent short-cycling of the chiller(s) to promote long chiller life and good chilled water temperature control, especially in smaller chilled water systems.

3. Provide a rationale with back-up calculations in support of the decision to use one or multiple chillers. Maintain constant flow through each chiller when multiple chillers are used. The combined capacity of the two chillers shall not exceed the total requirement, including diversity, unless there is a specific requirement for redundancy. Consult chiller manufacturers for recommendations for sizing each chiller in multiple chiller plants to provide the lowest energy usage.

4. Part-load efficiency of the chillers often has the greatest effect on operating costs because chillers spend most of their time operating at less than full load. Therefore, selection of the chiller capacity shall consider part load operating hours. Provide hot gas bypass as required for capacity reduction to 15% of maximum rated capacity.

5. For a central plant when more than one chiller is provided or when the tonnage is more than 200 tons, provide hydraulically decoupled piping/pumping (primary/secondary arrangement) chilled water loop arrangement. Provide a dedicated primary pump and condenser water pump for each chiller. Provide piping and valve configuration that allows each chiller to operate with any primary pump and with any condenser water pump. Total system capacity shall be available through back-up or stand-by pump with any one pump out of service. Provide adjustable frequency drives on secondary pumps. Or provide variable primary flow chilled water pumping system with adjustable frequency drives on primary pumps.

6. HVAC equipment with multiple compressors shall have independent refrigerant circuits to provide redundancy and multiple steps of capacity control.

7. Provide backup (100% capacity) chilled/hot water pumps to minimize outages for repairs or maintenance.

8. Mechanical equipment rooms shall comply with ASHRAE 15, Safety Code for Mechanical Refrigeration.

9. Provide foundations and clearances per manufacturer's recommendations.

B. AIR-COOLED CHILLERS

1. Air-cooled chillers shall be rotary screw, slide valve modulation, scroll, or reciprocating type per ARI 550/590-98 as specified in the RFP.

2 . Provide control panel with indication of discharge pressure and suction pressure, separate high pressure cutout with manual reset, separate low pressure cutout, low water temperature cutout with manual reset, compressor operating control and manual off-auto switch. Provide signal lights or other visual "failed" indications for high pressure, low pressure, and oil pressure protection devices. Provide a minimum two-minute time delay to prevent compressors from short cycling whenever stopped by safeties. Provide a control interface for remote monitoring of the chiller's operating parameters, functions and alarms from the DDC control system central workstation.

C. WATER-COOLED CHILLERS

1. Centrifugal or rotary screw, slide valve modulation, self-contained, ARI 550/590-98 as specified in the RFP. Chiller efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.

2. Provide automatic capacity-reduction system for stable operation from 100 to 10 percent of full load capacity.

3. Provide control panel with indication of evaporator pressure, condenser pressure, oil pump pressure, and elapsed running time meter. In addition, provide protection devices with manual reset for low oil temperature, low refrigerant temperature, low temperature chilled water, high pressure, low oil pressure or flow, high oil or bearing temperature, high motor winding temperature, compressor motor overload, low chilled water flow, low condenser water flow. Provide signal lights or other visual "failed" indications for specified protective devices. Provide a control interface for remote monitoring of the chiller's operating parameters, functions and alarms from the DDC control system's central workstation. Provide a central plant controller supplied by the chiller manufacturer to coordinate staging of the chillers and overall plant operation.

D. CHILLED WATER EQUIPMENT INSULATION

Insulate chilled water equipment as suitable for the temperature and service in cellular glass or flexible unicellular insulation to fit as closely as possible to equipment. Provide vapor barrier as required for the application.

E. CHILLER START-UP AND OPERATIONAL TESTS

1. Prior to chiller start-up, flush piping systems per D3045 and place water treatment systems in operation.

2. Place the chillers in operation under the direction of a manufacturer's representative. Record manufacturer's recommended readings hourly for a period of not less than 3 days. Provide a detailed description of chiller start-up and operational tests in the Commissioning Plan.

F. COOLING TOWERS

Over-size cooling towers to ensure adequate performance under adverse conditions and for future operational flexibility. Select cooling towers for 25% extra capacity but operate at design capacity. For example:

Design (Calculated) capacity = 1000 GPM (63.1 L/s)
Scheduled (Selected) capacity = 1000 GPM (63.1 L/s) X 1.25 = 1250 GPM (78.9 L/s)

Provide a note on the cooling tower schedule to indicate that the equipment is selected for 1250 GPM but will operate at 1000 GPM.
Size condenser water flow to chiller for the design flow rate, not the oversized tower flow rate.

1. Factory assembled, conforming to NFPA 214. Fire hazard rating for plastic impregnated materials shall not exceed 25. Provide Cooling Technology Institute 201 certification of tower capability and performance. Cooling Tower performance shall meet or exceed that listed in ASHRAE 90.1.

2. Constructed of galvanized steel with stainless steel basin or stainless steel or fiberglass with fill material of PVC formed sheets as specified in the RFP. Provide stainless steel hardware.

3. Provide vibration cutout switch interlocked with the fan motor.

4. Provide 2-speed or adjustable frequency drive fan motors or as specified in the RFP.

5. Meet OSHA safety requirements for stairs and handrails. Provide work platform(s) at all locations in the tower that require periodic maintenance.

6. Provide an automatic bypass valve arrangement to divert condenser water directly to the tower basin in the event condenser water temperatures fall too low for proper chiller operation. Provide basin heaters as required.

D3032 DIRECT EXPANSION SYSTEMS

A. DIRECT EXPANSION OUTDOOR EQUIPMENT

Provide Direct Expansion equipment shall be with air cooled or water cooled condenser as specified in the RFP. Direct Expansion equipment efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.

D3040 DISTRIBUTION SYSTEMS

D3041 AIR DISTRIBUTION SYSTEMS

AIR HANDLING EQUIPMENT

Provide AMCA 210 certified fans with AMCA seal. Fan bearings shall have a minimum average life of 200,000 hours at design operating conditions. Provide nominal 2 mesh, 1.60 mm (1/16 inch) wire diameter bird screens for outdoor inlets and outlets.

Provide auxiliary drain pans under all cooling coils or units containing cooling coils located in attic spaces, above suspended ceilings, furred spaces, or any other space where condensation overflow from the cooling coils may result in damage to surrounding materials. Provide a separate drain line for the auxiliary pan and extend to a conspicuous point to signal that the regular drain is restricted, or provide a sensor switch to de-energize the equipment if condensate enters the auxiliary drain pan

1. CENTRAL STATION AIR HANDLERS

Provide modular construction, double wall air handling units. Provide ARI 430 certified fans and ARI 410 certified coils. Unit shall be rated as an entire assembly. Sound rating shall conform to ANSI/ASHRAE 68. Provide a minimum of 50 mm (2 inch) thick insulation, 24 kg/cu. m (1.5 lb/cu. ft.) density sandwiched between two sheets of solid galvanized steel, except that plug fan sections and discharge plenums shall be insulated with minimum 100 mm (4 inch) thick, 24 kg/cu. m (1.5 lb/cu. ft.) density insulation. Coils shall be copper tube, aluminum fin type provided by the air handling unit manufacturer. Provide positive-draining, stainless steel drain pans. Provide an economizer cycle for each air-handling unit. For 100% outside air units provide capability for cooling, heating, dehumidification and reheat.

Provide fan motors with adjustable frequency drives (AFDs) for variable air volume distribution. See D3069.

Ultraviolet Disinfection System

For central station air handling units provide a UVC (ultra violet c-band) 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 shall be of the lowest possible reflected and shadowed losses. Energy Efficiency - Power supplies shall be of the high efficiency electronic type and matched to the emitter. Intensity - The minimal UVC energy striking the leading edge of all the coil

fins shall not be less than 820 μW/cm2 at the closest point and through placement, not less than 60% 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 - emitters and fixtures shall be installed 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. One complete set of spare bulbs will be supplied.

2. FAN-COIL UNITS

Provide factory assembled and tested horizontal or vertical type fan coils, ARI 440 and UL 883 certified with ARI and UL seal with the following factory fabricated and assembled items:

a. Insulated drain pan.

b. Type L copper drain pan piping.

c. Single point electrical connection and disconnect. Motors shall have thermal overload protection.

d. Condensate pumps, as required.

e. Unit enclosure shall be internally lined with sound and thermal insulation.

f. Fan coil units shall have 4-pipe coil arrangement with separate heating and cooling coils, unless specified 2-pipe in the RFP. Provide copper coils with aluminum fins.

g. Provide fan control, heat-cool switch and temperature adjustment for each fan coil unit wall-mounted within each zone.

h. Provide factory mounted and tested DDC temperature control module.

i. Provide for DDC system for control and monitoring of temperatures within each zone at the central workstation.

j. Provide filtration as recommended by ASHRAE for the specific application.

k. Provide outside air ventilation through the return duct of the fan coil unit or by a separate pre-conditioned outside air system.

3. VARIABLE AIR VOLUME (VAV) UNITS

Provide pressure-independent type variable air volume units rated per ARI 880. The flow sensor in the inlet duct shall be center averaging and shall sample total velocity pressure at no less than four separate radius points in no less than two planes. Boxes shall not be allowed to fully shut-off. Provide each box with a hot water coil unless an electric heating coil is specified in the RFP. Insulation shall be per NFPA 90A and UL 181 with minimum 13 mm (1/2 inch) thick, 24 kg/cubic meter (1.5 pounds/cubic foot) density glass fiber. Provide insulation on all areas of box that are subject to sweating, including inlet and outlet connections and heating coil casings.

4. DX VARIABLE AIR VOLUME (VAV) UNITS

Direct expansion equipment shall be specifically designed and manufactured for VAV applications. The same manufacturer shall provide central air handling units, VAV boxes/zone dampers and zone

controls. Airflow through the evaporator coils shall not be modulated. Provide duct mounted zone control damper units with integral control box, designed for use with DX VAV packaged systems. Self-modulating air diffusers will not be allowed. Provide duct mounted hot water coil or electric heating coil for each zone. Equipment efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.]

5. VARIABLE AIR VOLUME VAV FAN-POWERED UNITS

Provide pressure-independent parallel flow VAV fan-powered units rated per ARI 880 and UL listed. The flow sensor in the inlet duct shall be center-averaging and shall sample total velocity pressure at no less than four separate radius points in no less than two planes. VAV boxes shall not be allowed to fully shut off. The fan assembly shall include a backdraft damper with a field adjustable stop at the fan discharge to prevent backflow of primary air into the fan casing. A fan speed controller shall also be provided. Provide each box with a hot water coil or an electric heating coil. Insulation shall be per NFPA 90A and UL 181 with minimum 13 mm (1/2 inch) thick, 24 kg/cubic meter (1.5 pounds/cubic foot) density glass fiber.

B. DUCTWORK AND ACCESSORIES

Ductwork: Provide round ductwork where space permits. Fibrous glass duct is prohibited. Piping, conduit, etc. penetrations into HVAC ductwork are prohibited

Low Pressure System Design: For low pressure rectangular duct systems designed using the equal friction method, use 45 degree entries into branches from the main supply duct. Spin-in fittings and conical taps are allowed for round take-offs from rectangular duct. Provide manual volume dampers in each branch take-off after leaving the main duct to control branch air quantity. Do not use splitter dampers for air balancing.

Variable Air Volume (VAV) System Design: Use the static regain method for duct design. Provide round or flat oval ductwork for VAV systems. Provide minimum stops on VAV systems to ensure adequate outside air ventilation at all loads. Provide a constant supply of outside air to the central air handler to meet ASHRAE ventilation requirements.

Ductwork drawings: Always show inside dimensions of ductwork. Increase duct dimensions to compensate for duct liner when specified. Include note on the drawings "All Ductwork Sizes Shown Are Inside Dimensions.

DUCTWORK

a. Rigid Ductwork: Except as specified herein, provide galvanized steel ductwork constructed per SMACNA DCS standards.

b. Flexible Ductwork and Connectors: Use insulated flexible duct only for connections to air distribution devices to adapt to minor offsets. Flexible duct shall be UL 181 listed and per SMACNA DCS with a minimum R value of 4. Provide the minimum length required to make connections, but not greater than 1.8 meters (6 feet). Bends shall be at a minimum radius-to-diameter ratio of 1.5. Provide flexible connectors between fans and ducts. Detail flexible duct connections on plans..

c. Provide acoustical duct lining for the first 10 feet of run of supply and return ductwork on each side of Air Handling Units. Duct lining shall meet ASTM C 1071.

d. Ductwork is prohibited in unventilated crawlspaces and beneath or in concrete slabs on grade. Ductwork in ventilated crawlspaces shall not be in contact with the ground.

2. DUCTWORK ACCESSORIES

a. Air Distribution Devices: Provide factory-finished grilles, registers, and diffusers constructed of aluminum. Exterior and exposed edges shall be rolled, or otherwise stiffened and rounded. Provide factory-fabricated volume dampers for all registers and diffusers.

b. Dampers: For low-pressure rectangular duct systems, use 45-degree entries into branches from the main duct. Provide manual volume dampers in each branch take-off from the main duct to control air quantity. Dampers shall conform to SMACNA DCS.

c. Fire Dampers: Provide per UL 555. Fire dampers shall be dynamic type rated for closure against a moving airstream. Provide fire dampers with damper blade section that does not intrude into the air stream when in the open position.

d. Smoke dampers: Smoke dampers shall be rated per UL 555S.

e. Louvers: Provide outdoor air intake and exhaust louvers of powder-coated aluminum or stainless steel designed to prevent the entry of rain or snow. Intakes shall be a minimum of 7.6 meters (25 feet) from the nearest exhaust outlet and exterior mechanical equipment. Provide birdscreens at all louvers, except for clothes dryer exhausts.

f. Provide filtration as recommended by ASHRAE “Systems and Equipment Handbook”, Chapter 24, Table 2.

3. DUCTWORK INSULATION

a. Provide external thermal insulation for all ductwork. Insulate ductwork in concealed spaces with 12 kg per cubic meter (0.75 pounds per cubic foot), blanket flexible mineral fiber insulation conforming to ASTM C 553, Type 1, Class B-3. Insulate ductwork in Mechanical Rooms and exposed locations with 48 kg per cubic meter (3 pounds per cubic foot), rigid mineral fiber insulation conforming to ASTM C 612, Class 2. Provide insulation with factory applied all-purpose jacket with integral vapor barrier. In exposed locations, provide a jacket with white surface suitable for painting. Seal all joints and seams with glass fabric and mastic. (Note- Hugh to verify UL listing, asbestos-free certification, etc.) Tape is not acceptable. Flame spread/smoke developed rating for all insulation shall not exceed 25/50. Acoustically lined ductwork shall also be externally insulated. Minimum insulation thickness shall be 50 mm (2 inch) thick for flexible blanket insulation and 37.5 mm (1.5 inch) for rigid insulation but neither shall be less that the minimum thickness required by ASHRAE 90.1.

b. Insulate the backs of all supply air diffusers with a minimum of 50 mm (2 inch) thick, 12 kg per cubic meter (0.75 pounds per cubic foot), blanket flexible mineral fiber insulation.

D3042 EXHAUST VENTILATION SYSTEMS

A. DUCTWORK AND ACCESSORIES

Same as D3041.

B. EXHAUST FANS

Fans shall be AMCA 210 certified, with AMCA seal. Fan bearings shall have a minimum average life of 200,000 hours at design operating conditions. Provide nominal 2 mesh, 1.60 mm (1/16 inch) wire

diameter bird screens for outdoor inlets and outlets. Coordinate technical and aesthetic requirements and location of building exhaust or attic cooling fans with architectural requirements. As far as practicable, locate fans such that they are readily accessible for maintenance. Fans located in attics, on roofs, or in other areas where access is limited shall be direct-drive type with means for verifying operation via the building DDC system to eliminate belt maintenance.

D3043 STEAM DISTRIBUTION SYSTEMS

[For Exterior Buried Steam systems see G3041.]

B. Steam piping over 105 kPa (15 PSI) shall be ASTM A106 or A53 Grade B, Schedule 40, black steel, electric-resistance welded or seamless. Steam piping under 105 kPa (15 PSI) shall be ASTM A 53, Schedule 40, black steel, electric-resistance welded or seamless.

C. Condensate return piping shall be ASTM A 106 or ASTM A 53, Grade B, Schedule 80, black steel, electric-resistance welded or seamless. At pressures less than 105 kPa (15 PSI), ASTM B 88, Type K, copper tubing may be used.

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

E. Insulate steam and condensate return piping with mineral fiber or cellular glass insulation with all-purpose jacket. Thickness shall meet or exceed that recommended by the insulation manufacturer for this application or the minimum thickness listed in ASHRAE 90.1, whichever is greatest.

F. Piping Identification: Stencil names or code letters for piping systems in clearly visible locations using 13 mm (1/2 inch) high (minimum) letters. Stencil arrow-shaped markings to indicate direction of flow.]

G. Provide pipe sleeves at each wall and floor penetration. The sleeve shall be of a material suitable to protect the carrier pipe (two pipe sizes larger) and sealed with an appropriate flexible material.

A. VALVES AND RELATED EQUIPMENT

1. Provide appropriately sized valves as necessary to balance water flows and/or isolate equipment for service and repairs, or as otherwise required by building codes.

    d. For each building, provide steam pressure reducing stations with two regulator valves in parallel sized for 1/3 and 2/3 of total required capacity.

    e. Provide appropriately sized FS WW- T-696 steam traps and air trap, flask tank and other accessories where required. Provide flask tank with vent and drain valve.

    f. Pressure gages and thermometers are to be provided and located such that they can be read from a standing position on the floor and such that they can be removed for maintenance or replacement without disturbing adjacent piping or equipment. Install gages and thermometers on the inlet and discharge side and other locations where required by code or good engineering practice.

    g. Provide FS WW-S 2739, Strainer Style Y for class 125 and 250 piping in sizes 15 to 200 mm (1/2 to 8 inches). Cast iron is prohibited.

D3044 HOT WATER DISTRIBUTION

Same as D3045. [For exterior buried Hot Water Distribution Systems see G3043.]

D3045 CHILLED WATER DISTRIBUTION

B. PUMPS

Provide centrifugal circulating pumps with motor, motor starter, and motor enclosure conforming to the appropriate NEMA standards. Provide suction diffusers on base-mounted pumps. Pump motor efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.

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 pump motors with adjustable frequency drives (AFDs) for variable pumping. See D3069.

C. PIPING

1. Aboveground Piping: Electric resistance welded or seamless Schedule 40 black steel pipe conforming to ASTM A 53. Piping 100 mm (4 inch) and smaller may be Type K or L copper, depending on design pressure and temperature, per ASTM B 88,

2. Underground Chilled Water Piping: See G3051. Underground Hot Water Piping: See G3043.

h. Aboveground Condenser Water Piping: Electric resistance welded or seamless Schedule 40 black steel pipe conforming to ASTM A 53. Piping 100 mm (4 inch) and smaller may be Type K or L copper, depending on design pressure and temperature, per ASTM B 88.

i. Piping Identification: Stencil names or code letters for piping systems in clearly visible locations using 13 mm (1/2 inch) high (minimum) letters. Stencil arrow-shaped markings to indicate direction of flow.

j. Provide pipe sleeves at each wall and floor penetration. The sleeve shall be of a material suitable to protect the carrier pipe (two pipe sizes larger) and sealed with an appropriate flexible material.

D. FITTINGS

1. Steel Pipe Fittings: For piping 50 mm (2 inch) and smaller, provide ANSI/ASME B16.3 malleable iron screwed fittings or ASME B16.11 socket welding (Class 3000) or threaded type (Class 2000). Provide ASME/ANSI B16.9 butt-welding fittings or ASME/ANSI B16.5 flanged type for piping 63 mm (2-1/2 inch) and larger. Grooved joint pipe coupling systems of appropriate pressure rating are acceptable in lieu of welded or screwed fittings if specified in the RFP..

k. Copper Fittings: Provide ANSI B16.18 cast bronze solder joint type or ASME/ANSI B16.22 wrought copper solder joint type.

l. Dielectric Fittings: Provide between different materials.

E. PIPING AND EQUIPMENT INSULATION

1. Below ground piping shall be factory fabricated, pre-insulated.

2. Insulate above ground chilled water piping with cellular glass, ASTM C552, Type II, Grade 2. No substitutes are allowed. Insulation shall be a minimum of 38 mm (1.5 inches) thick for piping 50 mm (2 inches) and smaller, 50 mm (2 inches) thick for pipe sizes 63 mm (2.5 inches) to 100 mm (4 inches), and 75 mm (3 inches) thick for piping 150 mm (6 inches) and larger. Provide all-purpose jacket.

    m. Insulate hot water piping with mineral fiber, ASTM C547, Class I, with factory-applied all-purpose jacket. Thickness shall meet or exceed manufacturer recommended thickness for this application, 38 mm (1.5 inches), or the thickness listed in ASHRAE 90.1, whichever is greatest.

    n. For hydronic piping located outside the building, increase minimum required insulation thickness by 25 mm (1 inch) and provide an aluminum or stainless steel jacket as specified in the RFP.

    o. Provide mineral fiber insulation with vapor barrier on all aboveground condenser water piping for cooling towers.

    p. Insulate pumps used for hot service with 50 mm (2 inch) thick preformed mineral fiber insulation and pumps used for chilled water service with 50 mm (2 inch) thick flexible unicellular insulation. Insulate pumps by forming a box around pump housing, drive shaft, and piping. Apply insulation to inside surfaces of 20-gage galvanized sheet metal boxes having openings for drive shaft and pipes. Construct box to be easily disassembled to facilitate pump maintenance.

F. VALVES AND RELATED EQUIPMENT

    a. Provide appropriately sized valves as necessary to balance water flows and/or isolate equipment for service and repairs, or as otherwise required by building codes.

    b. Provide appurtenances such as air separators, expansion tanks, suction diffusers, strainers, etc. for chilled and hot water systems.

    c. Provide test ports in piping at inlet and outlet of all major system components including chillers, pumps, etc.). Test ports shall accept 3mm (1/8 inch) probe. Test ports shall have brass body, EPDM or neoprene seal, and a protective cap.

    d. Pressure gages and thermometers are to be provided and located such that they can be read from a standing position on the floor and such that they can be removed for maintenance or replacement without disturbing adjacent piping or equipment. Install gages and thermometers on the inlet and discharge side of central station air handler coils, pumps, chillers, and other locations where required by code or good engineering practice.

    e. Provide duplex basket strainer with cast steel, bronze, or cast iron body and quick open top. Strainer baskets may be removed one at a time without disrupting system flow. The stainless steel strainer basket shall have a mesh size of 60 minimum or as recommended by the refrigeration or cooling tower equipment supplier. Pressure drop shall not exceed 20 kPa(3 PSI) clean. Provide a piston type direct reading differential pressure gage on the strainer.

G. AIR CONTROL AND CHEMICAL TREATMENT

1. Air Separators: Provide ASME rated separators for use with pressures up to 900 kPa (130 PSI) (gage).

    q. Expansion Tanks: Provide ASME rated tanks for use with pressures up to 900 kPa (130 PSI) (gage).

    r. Chemical Treatment: Provide chilled and hot water systems with chemical treatment for the control of pH, scale formation, and corrosion inhibition. Provide shot-type feeders for manual chemical feed. Feeders shall be rated for use with pressures up to 900 kPa (130 PSI) (gage). Mount the top of the feeder no higher than 1.2 meters (4 feet) above finished floor. Provide condenser water systems with automatic chemical treatment systems that monitor conductivity, pH, etc. and provide for water metering and bleed-off.

    s. Makeup Water Station: Provide a water pressure-reducing valve, 100 mm (4 inch) diameter pressure gage, filter and relief valve in the make-up water line to the chilled and hot water systems to maintain the operating pressure. Provide a 20 mm (3/4 inch) globe valve by-pass around this pressure reducing station. Provide reduced pressure backflow preventer upstream of the by-pass.

    t. Glycol Makeup Station: Provide a [automatic] glycol makeup system to maintain system proper operating mixture if required in the RFP.

H. SYSTEM FLUSHING

Thoroughly flush hydronic systems prior to system startup. Install temporary strainers to protect air handlers, boilers, cooling towers and chillers. Remove control valves during flushing. Install temporary 40 mesh cone strainers ahead of each pump during flushing. System shall be free of gross contamination and visible debris in the strainer basket prior to system startup. Clean the strainers and repeat the process as necessary to obtain clean hydronic systems prior to placing the systems in service.

D3050 TERMINAL AND PACKAGE UNITS

D3051 TERMINAL SELF-CONTAINED UNITS

A. Air-To-Air Heat Pumps

Unit shall be in accordance with ARI 310/380 and UL 1995. Heat pump efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest. Unit shall include auxiliary electric heat and operate under the standard unit controls. Units shall be designed to allow ease of maintenance. The units shall operate with low sound levels to meet the requirements of the RFP. Unit wall sleeves shall be provided by the heat pump manufacturer specifically for the heat pump to be installed and shall be airtight and water tight. Condensate shall drain to the sanitary sewer. Units shall have internal condensate removal (condensate shall not be externally drained). The units shall also have as a minimum: reverse cycle defrost system, permanently lubricated fan motors, microprocessor controls, rotary compressors, automatic compressor restart delay, concealed manual vent control, staged heating, automatic emergency heat, and electronic temperature limiting.

D3052 PACKAGE UNITS

A. Split System Air-To-Air Heat Pumps

Provide air-cooled, split system heat pumps with ducted air distribution for each space or room module. Heat pump efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as

listed in ASHRAE 90.1, whichever is greatest. Provide supplemental electric heat strips in air handlers. Match the cooling capacity for each system as closely as practicable to the calculated cooling load to maximize humidity control capability. Provide manufacturer's minimum recommended clearance around condensing units. Refrigerant piping material, length, size, and routing shall be per the manufacturer's recommendations. Insulate refrigerant piping suction lines with flexible cellular insulation per ASTM C 534. Thickness shall be 12.5 mm (1/2 inch) m. Insulate condensate drain piping with flexible cellular insulation, ASTM C 534, Type I, with vapor barrier. Thickness shall be 25 mm (1 inch) minimum.

B. Closed Loop Ground Coupled Heat Pumps

Each air-conditioned zone shall have the same type of system. Unit efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest In order to establish this rating, the Air Conditioning Refrigeration Institute publication “Directory of Certified Applied Air Conditioning Products”, latest edition, shall be the sole determination and only information for units coded HSP-GS shall be used. Refrigerant shall have an Ozone Depletion Factor of 0.055 or less. Pipe condensate drains to the sanitary sewer. Heat pumps shall be provided with supplementary electric resistance heaters in accordance with manufacturer's recommendations. Electric resistance heaters in excess of 5 KW shall be staged with an outdoor thermostat and installed and operated in accordance with the manufacturer's recommendations.

Ground coupled piping shall be PE 3408 (High Density Polyethylene) with minimum cell classification 355434C per ASTM D 3350. The piping shall experience zero failures (Fo) after 5000 hours under condition "C" when tested per ASTM D 1693. The pipe manufacturer must provide a written 50-year limited warranty. U-type fittings shall be shop fabricated under quality-controlled conditions of the same material designation. Joining shall be by the butt-fusion on saddle (sidewall) fusion method per the manufacturer's heat fusion qualification guide. Polyethylene Fittings shall be ASTM D 2683 socket fittings or ASTM D 2513 molded butt-fusion fittings.]

C. Computer Room Air Conditioning Units

Computer room air conditioning units shall consist of computer room air handling units with direct expansion cooling coils and remote air-cooled condensers, or chilled water coils and hot water coils or electric resistance heating coils as specified in the RFP. System shall provide for precision environmental control of temperature and humidity to meet the conditions specified in the RFP. Computer room air handling units shall be capable of heating, cooling, humidifying, and dehumidifying. Air handling units and remote condensers shall have matched capacities and shall be shipped fully charged with refrigerant. Air handling units shall be factory fabricated, fully assembled, and shall include all components as required to maintain room conditions. Each computer room air handling unit and its components shall be performance tested for conformance to the manufacturer’s ratings and per ASHRAE 07 and ASHRAE 51. Ratings shall comply with ARI 430. Control system shall be microprocessor based and shall control all functions locally. A control interface shall be provided to allow for remote monitoring of the unit functions, alarms and room conditions from the DDC control system’s central workstation. Provide Type K or L copper tubing refrigerant piping per ASTM B 88.

D. 100% Outside Air Makeup Air Units

Provide factory packaged combination heating and cooling units, specifically designed to condition (cool, dehumidify, and/or heat) 100% outdoor air at the conditions indicated. Provide units suitable for outdoor installation. Units shall have a minimum EER of 9.8 when tested per ARI 210/240 or ARI 360 as applicable. Provide a coil guard to protect condenser and fan from damage. Provide short-cycle protection device that requires a minimum of 5 minutes between compressor operating cycles. Provide hot gas reheat to maintain specified room conditions of temperature and humidity with 100% outdoor air.

E. Gas-Fired Unit Heater

ANSI Z83.8 and AGA label. Equip each heater with individually adjustable package discharge louver. Louvers may be substituted by discharge cones or diffusers. Provide thermostats. Furnish circuit breaker disconnect switch.

1. Heat Exchanger-Minimum 20 gage all-welded steel construction with corrosion-resistant aluminum finish.

2. Burners-Die-formed, slot ports, and steel construction with aluminum paint.

3. 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.

4. Controls-Consisting of a combination pressure regulator, 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.

5. Unit heater efficiencies shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.

6. Flue Vent-Use UL 441 flue vents and gas-vent roof jacks, of galvanized steel, aluminum or stainless steel.

F. Hot Water Unit Heaters

ASHRAE 33 tested for heating coils; UL listed for motor and controls.

1. Casing-Minimum 20 gage steel with removable access panels or means to remove, service, and maintain major components.

2. Coil-Fin-and-tube coil constructed of copper tubes and copper or aluminum fins.

3. Hot water piping- Same as D3045

D3060 CONTROLS AND INSTRUMENTATION

General

Keep it simple! Provide the simplest HVAC controls that will accomplish the intended function.

Drawings

Show system control schematics and written sequence of controls on the drawings for each mechanical system. For direct digital control (DDC) systems, include an input/output points list and a system architecture schematic.

Control Valves

Provide schedules on the plans for automatic control valves showing the allowable flow coefficient (C_v). Select control valve C_v ratings so that maximum pressure drops are used within constraints of available pressures, pipe velocities, economy of design, and noise criteria.

Selection Of Temperature Control Zones

Group temperature control zones to have similar load profiles based on the intended usage throughout the day, month, and year. Place spaces that have widely fluctuating loads on separate zones. The following paragraphs provide additional guidance.

1. Provide a separate zone for each classroom.

2. Provide a separate zone for each conference room.

3. Where possible, provide one terminal unit for large single room zones to prevent multiple units from "fighting" each other. Where two terminal units are required to cool a single zone, provide a single thermostat.

4. Show location of all thermostats on the drawings.

Electric Heat Control

Provide Silicon Control Rectifiers (SCRs) when precise control is required.

Direct Digital Control System:

a. Provide a direct digital control (DDC) system. DDC system communication protocol shall be match existing Base-wide system as indicated in the RFP. Notwithstanding any other provisions of this contract, no other product will be acceptable. Digital controllers shall link in a flat line communications network without any sub network or gateways. Conventional control devices (pneumatic or electronic) such as receiver-controllers, and logic units are not allowed.

b. Central control will be provided via a workstation computer a Desktop or Laptop as required in the RFP. Provide the workstation in a location as directed by the Contracting Officer. The workstation shall meet or exceed the minimum requirements of the DDC software manufacturer.

c. Provide a 475 mm (19 inch) diagonal measurement monitor, a keyboard, a mouse, a laser or inkjet printer capable of printing 600 dpi, and a 110-volt terminal strip with surge protection for both power and phone connections.

d. Workstation software shall permit monitoring and troubleshooting of the DDC system. Workstation software shall also allow modification to setpoints, operational schedules, control graphics, and control programs. The software shall be graphic-based to provide an ergonomic interface to the DDC system. Software shall provide representation of the building, the building's mechanical systems, and the DDC systems control panels. The current value and point name of every input/output point shall be shown on at least one graphic in its appropriate physical location relative to the mechanical system.

1. Graphics shall follow the style of the control project drawings in representing mechanical systems, sensors, controlled devices, and point names.

2. Graphics shall have an identifying title visible when the graphic is being viewed.

3. Point data shall update dynamically on the graphic images.

4. Provide graphic penetration or menu penetration for selection of individual graphics to give the same hierarchical affect provided by graphic penetration.

5. Provide building exterior graphic showing exterior architecture, major landmarks, and the building number.

6. Show stacked floors in section graphic with appropriate floor name on each floor.

7. Provide a single graphic for each floor. Each heating or cooling zone within a floor plan shall have a zone name and its current temperature displayed within the zone outline. Show each controlled variable in the zone. Provide visual indication for each point that is in alarm.

8. Provide two-dimensional drawings to symbolize mechanical equipment; do not use line drawings. Each graphic shall consist of a single mechanical system or component; examples are a graphic for a fan-coil unit, a chiller system. Place sensors and controlled devices associated with mechanical equipment in their appropriate locations. Place point name and point value adjacent to sensor or controlled device. Provide visual indication of each point in alarm. Conditions, such as zone temperature, associated with the mechanical system shall be shown on the graphic.

9. Provide editing capacity for creating, deleting, and modifying graphics and text.

10. DDC software shall allow modification to setpoints, deadband limits and spans, reset schedules, time, timed local override time, occupancy schedules, alarm points, trend points, runtime accumulation and passwords.

e. Provide panel mounted displays and keypads connected to each digital controller to communicate/program with the digital controllers.

f. Mount room sensing elements and controllers on the interior walls of individual zones. Coordinate locations of sensors and controllers with systems furniture and testing equipment.

g. Equipment status and actuator positions indicated at workstation shall be based on sensors at equipment and position feedback devices on actuators and not on output signals from controllers.

D3061 HEATING GENERATING SYSTEMS CONTROLS

A. BOILER

Boiler shall be energized manually and locally at the boiler. Once enabled, boiler shall maintain its set temperature by cycling under factory boiler controls.

At a minimum, the DDC system shall monitor and control the following points associated with hot water heating systems:

-Hot water pump status
-Hot water supply temperature
-Hot water return temperature
-Hot water flow rate
-Hot water mixing valve position
-Differential pressure across pump
-Boiler status
-Alarms

D3062 COOLING GENERATING SYSTEMS CONTROLS

A. CHILLER

Enabling and disabling of the chiller by the central control system is the only operational feature allowed. All other control required to maintain chilled water supply temperature shall be through the chiller's control panel. Provide means to ensure that the chiller will not operate unless chilled water pumps are operating and chilled water flow is proven. A master chiller control panel provided by the chiller manufacturer shall control multiple chillers. DDC interface with the chillers shall be via this master panel to optimize the interface of chiller operation with building DDC system.

B. CHILLER INPUT/OUTPUT POINTS

Provide control interface for each chiller to allow the DDC system to monitor setpoints, operating points, alarms, and all other control parameters associated with each piece of equipment. This is to include all points that can be read at the local control panel provided with each system component. All set points are to be adjustable. Provide alarm notices at the workstation for all failures. The central control system shall monitor the chiller's entering and leaving water temperatures and chilled water flow. Provide monitoring alarms uploaded from the chiller's control panel to signal emergency/safety situations. The central control system shall monitor all of the chiller's functions, alarms and operating parameters through the control interface provided with the chillers.

At a minimum, the DDC system shall monitor and control the following points associated with the chilled water system:

-Chiller enable/disable
-Chiller status
-Entering and leaving water temperatures at each chiller
-Chilled water flow rates for each chiller
-Secondary loop chilled water flow rate
-Chilled water supply and return temperatures for the central plant
-Water temperature in the common piping of the primary/secondary loop
-Chilled water system differential pressure at central chilled water plant
-Chilled water system differential pressured used for control of secondary pumps
-Primary chilled water pump start/stop
-Primary chilled water pump status
-Outside air temperature
-Outside air relative humidity
-Cooling tower fan status [(high-low-off)]
-Cooling tower fans - Adjustable frequency drive functions and alarms
-Condenser water supply and return temperature
-Cooling tower bypass valve position

D3063 HEATING/COOLING AIR HANDLING UNITS CONTROLS

A. AIR DISTRIBUTION SYSTEM INPUT/OUTPUT POINTS

For air distribution systems, the DDC central control system shall be provided with start/stop capability and status indication for each air handling unit and exhaust fan. All setpoints shall be adjustable.

At a minimum, the DDC system shall monitor and control the following points associated with each air distribution system:

-Supply air temperature
-Supply air static pressure
-Supply airflow rate
-Outside air temperature

-Return air temperature
-Mixed air temperature
-Discharge temperature from each heating or cooling coil
-Filter status
-Supply/return damper positions
-Outside air damper positions
-Chilled water valve positions
-Hot water valve positions
-Electric heater status (on/off and number of stages energized or % power)
-Freezestat
-Smoke detector
-Supply fan start/stop
-Supply fan speed control
-Supply fan run status
-Supply fan fault status
-Bathroom exhaust fan run status
-Attic exhaust fan run status

For VAV systems, the DDC system shall monitor and control the following points associated with the VAV systems:

-VAV box inlet velocity pressure
-Airflow rate at discharge of each VAV box
-Fan control start/stop
-Air valve actuator
-VAV box damper position
-Discharge air temperature at each VAV box
-VAV box hot water valve position
-Electric reheat control valve (on/off and number of stages)
-Space temperature for each zone with set point adjustment

D3067 ENERGY MONITORING & CONTROL

Central DDC system shall be capable of recording, trending and graphing data of HVAC system including system flow rates, temperature rise/drop of chilled water and hot water systems, and calculated energy consumption or input.

D3069 OTHER CONTROLS & INSTRUMENTATION

Adjustable Frequency Drives (AFDs)

Provide factory-assembled adjustable frequency drive control systems for variable speed control. All air handling motor AFDs and all pump motor AFDs shall be from the same manufacturer. Each AFD shall include motor starter, motor disconnects and controls as required for a complete system. Operation of adjustable frequency control variable speed system shall not cause RFI/EMI radiated and conducted interference or power surging/spiking in excess of 5% total harmonic current distortion or 5% voltage distortion. Provide harmonic filters, and/or other means of filtering and muffling as necessary to negate such problems.

Provide the following accessories:

a. Disconnect switch

b. Control circuit transformer, with primary and secondary fuses

c. Manual bypass

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

e. System initialized light

f. Run light

g. Failure alarm

h. LCD digital display with numeric keypad

i. A control interface provided for remote monitoring of AFD functions and alarms from the DDC control system front-end computer.

D3070 SYSTEMS TESTING AND BALANCING

D3071 PIPING SYSTEM TESTING & BALANCING

Same as D3072.

D3072 AIR SYSTEMS TESTING & BALANCING

Provide balancing valves, manual dampers, gages and temperature/pressure test ports, etc. in proper locations to ensure that water and air systems can be balanced. Provide manual balance dampers at all duct branch connections to air devices in supply and exhaust systems. Provide manual balance dampers in both the return and outside air ducts.

When an existing system is modified, provide all information required for re-balancing in the construction documents.

Variable speed drives on pumps or fans shall not be adjusted to achieve system balance. Balance systems with variable speed drives operating at between 55 and 60 Hz so that maximum operational flexibility is maintained. Replace fan drive pulleys as necessary to achieve air system balance. Throttle pump discharges to achieve system balance on water systems. Consider trimming pump impellers to achieve system balance on larger systems to achieve optimum operating efficiency.

A. TESTING AND TRAINING

Accomplish testing of HVAC systems and their controls and training of personnel. At a minimum, personnel are to be trained in the function and maintenance of each HVAC system component and control device, operation of the provided DDC system, and the overall sequence of operation for the HVAC system.

B. TRAINING

Provide a training course schedule, syllabus, and materials 45 days prior to the start of training. Furnish a qualified instructor to conduct courses for designated personnel in the maintenance and operation of the HVAC and DDC system. Orient training to the specific system being installed under this contract. Use DDC training manual, and operation and maintenance manuals as the primary instructional aids. Manuals shall be delivered for each trainee with two additional sets delivered for archiving to the ROICC. Training manuals shall include an agenda, defined objectives and a detailed description of the subject matter for each lesson. Furnish audio-visual equipment and all other training

materials and supplies. For guidance, the Contractor should assume the attendees have a high school education and are familiar with HVAC systems.

C. HVAC SYSTEMS TESTING, ADJUSTING, AND BALANCING

1. Perform duct air leakage testing for ducts of pressure class 0.75 kPa (3.0 inches water gage) and greater in accordance with the SMACNA HVAC Air Duct Leakage Test Manual.

2. The Test and Balance (TAB) Agency supervisor shall review project specifications and drawings to verify that the air and water systems are designed so that the TAB engineer can accomplish the work. He shall 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. Submit a report to the Contracting Officer indicating the results of the TAB supervisor's review. The report shall also describe the method of approach to the TAB fieldwork from start to finish, [including the methodology for accomplishing each seasonal TAB field work session.]

3. Before calling the Test and Balance Agency to the site, completely check out and correct any deficiencies noted in HVAC equipment, ductwork, and controls. This includes searching for and eliminating malfunctioning elements in the HVAC system installation, and verifying all adjustable devices are functioning as designed.

4. Contractor shall provide the technical personnel, such as factory representatives, equipment mechanics or HVAC controls installer, which are required by the TAB field team to support [DALT and] field measurement work. Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

5. 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, the Contractor shall ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

6. Noise levels shall comply with the requirements for in the ASHRAE Applications Handbook (1999), Chapter 46, Table 34, “Design Guidelines for HVAC-Related Background Sound in Rooms” and the following requirements:

a. The L *eq* sound levels shall be measured in each octave band.

b. The sound levels shall be measured based on a space average of not less than 10 readings taken throughout each room or space.

c. Measure sound levels with a sound meter complying with ANSI S1.4 (ASA 47), Type 1 or 2, and an octave band filter set complying with ANSI S1.11 (ASA 65).

d. Sound level meters shall be field-calibrated immediately before and after each measurement session per the manufacturer’s instructions using a portable acoustic calibrator.

e. Measured sound levels shall be compared to the criteria in ASHRAE Applications Handbook (1999), Chapter 46, Table 34 for hotels and motels. HVAC system shall be adjusted or modified until requirements are met.

7. All fans and Air Handling units with Adjustable Frequency Drives (AFDs) shall be balanced by performing sheave changes or adjustments so that the AHU provides design airflow with AFD output no less than 55 Hz. All pumps with AFDs shall be balanced by setting the discharge valve to provide

design flow with AFD output no less than 55 Hz. If pump discharge valve must be closed more than 50% or flow noise results from closing discharge valve to achieve 55 Hz output from AFD, trim the pump impeller as needed.

D. PERFORMANCE TEST

Upon completion of the installation and field testing, noise test, performance test and balance all systems to provide the air volume and water flow quantities indicated and maximum sound levels allowed. Accomplish all work per AABC National Standards Manual and NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems. Correct any air, noise and water system performance deficiencies uncovered during testing and balancing of the systems.

E. AGENCY QUALIFICATIONS

The Contractor, as part of this contract, shall obtain the services of a qualified testing organization to perform the testing and balancing work as herein specified. Prior to commencing work under this section of the specifications, the testing organization shall have been approved by the Contracting Officer. The criteria for determining qualifications shall be membership in the AABC, or certification by the NEBB. The testing organization shall be independent of the installing contractors or equipment suppliers for this project.

F. CERTIFIED REPORTS

1. Submit three copies of the test and balance report, covering air and water system performance, and sound pressure levels to the Contracting Officer prior to final inspection.

2. Include types, serial numbers, and dates of calibration for all instruments.

3. Reports shall identify items not in conformance with design criteria. Correct any noted deficiencies.

4. An independent Registered Mechanical Engineer who is versed in the field of air and water balancing and who is not affiliated with any firm involved in the design or construction phases of this project shall certify all reports. Certification shall include checking of calculations, procedures, and evaluation of final summaries.

G. QUALITY ASSURANCE FOR FIELD TAB WORK

Conduct tests to demonstrate that capacities and general performance of air and water systems comply with the contract requirements. Upon satisfactory completion of the quality assurance test, permanently mark settings of HVAC adjustment devices so that adjustment can be restored if disturbed at any time. Mark and identify the location points of duct test ports. Show the location of all test ports on the as-built drawings.

H. HVAC SYSTEM PERFORMANCE VERIFICATION TEST

Conduct performance verification tests in the presence of a representative of the Contracting Officer to demonstrate maintenance of setpoints, the execution of operational sequences, and control loop stability and accuracy. Conduct performance verification tests during one week of continuous HVAC and DDC systems operation. Tests shall not be conducted until all mechanical systems and control components are fully operational. Notify the Contracting Officer 15 days prior to scheduled start date of testing. The Contracting Officer will select up to 25 percent of the total number of reported data entries tabulated in the Certified TAB Report for recheck. Failure of the components or the control system during testing will result in another test being performed after corrective action is taken. The

Performance Verification Test Plan must be approved by the Contracting Officer. Coordinate the Performance Verification Test with the project Commissioning Agent. See D3073.

D3073 HVAC COMMISSIONING

A. Commission the HVAC systems per the Commissioning Plan of this section. Commissioning will include testing, adjusting, and modifying of the HVAC systems as well as training of personnel as required to ensure that the HVAC systems operation conforms to the requirements of this section.

B. After acceptance by the Contracting Officer, modify OMSI manuals as required, including providing all Commissioning Reports, and submit the Final OMSI manuals per the requirements of Section 01782, "Operation and Maintenance Data".

C. Develop and submit a [Level 1] or [Level 2] or [Level 3] Commissioning Plan specified in the RFP per the SMACNA HVAC Commissioning Manual to define the on-site activities for commissioning the HVAC systems. The Commissioning Plan shall incorporate all requirements of this section of the RFP and include the following:

1. The commissioning agent will be appointed by the HVAC contractor and the commissioning authority will be the Mechanical Engineer of record for the project.

2. Provide a schedule of inspections during construction that includes periodic inspections by the system designer. [Specify a minimum of 3 inspections. One of the visits shall coincide with item 3 below.]

3. Provide a schedule for verification and functional performance tests. System designer shall be present for the functional performance tests.

4. Provide a schedule detailing training sessions for Government personnel. Training sessions are to address maintenance and operation of HVAC equipment, control system components, and overall sequence of operation for the HVAC system.

5. Define the sequence for starting and balancing air distribution systems to ensure construction materials, such as architectural finishes, are installed under the appropriate environmental conditions. Also address the procedure that will be used to "dry out" the structure.]

D3090 OTHER HVAC SYSTEMS AND EQUIPMENT

D3091 SPECIAL SYSTEMS & DEVICES

A. ENERGY RECOVERY WHEELS

Provide total energy (enthalpy) type energy recovery wheels (heat wheels). Media shall be aluminum or a lightweight polymer coated with a corrosion-resistant finish. Etched or oxidized surfaces are not acceptable. Heat transfer surfaces shall be coated with a non-migrating (permanently bonded) absorbent specifically developed for the selective transfer of water vapor. Equal sensible and latent recovery efficiencies shall be documented through a certification program conducted per ASHRAE 84 and ARI 1060. The energy recovery wheel shall 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 shall alarm the HVAC control system. Filters sections shall be readily accessible for maintenance.

B. HEAT PIPES

Provide factory fabricated, assembled and tested heat pipes with counter-flow arrangement. Provide hermitically sealed, seamless aluminum tube cores with extended surfaces. Heat exchanger frame shall 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 shall be used as the working fluid. Type I refrigerants are not allowed.

D3093 DUST & FUME COLLECTORS

General

Design industrial ventilation systems per the latest edition of Industrial Ventilation, A Manual of Recommended Practice published by ACGIH. For Navy projects also comply with Military Handbook 1003/17, Industrial Ventilation Systems.

Design Guidelines

Research the process or operation before design starts (i.e., find out contaminants, toxicity, process temperature, etc.).

Design hoods for effective capture of contaminants while minimizing air flow for energy conservation. Do not specify a canopy hood unless process is nontoxic. Indicate required capture velocities and capture distances for all hoods on the drawings. Provide notes and contractor instructions on plans indicating that fan airflows shown for hoods are approximate and requiring the contractor to balance the system to achieve the capture velocities indicated. The scheduled fan and motor size should allow for adjustment of the airflow.

Specify the appropriate fan for the application. When selecting a fan, consider noise generation, material handled through the fan (e.g., corrosives, flammables, etc.), and future expansion or flexibility of the system.

Provide tempered make-up air for all ventilation systems. Ensure that make-up air does not cause turbulence at the exhaust hood. Interlock make-up air fan to exhaust fan. Do not recirculate exhaust air.

Provide an offset discharge stack, with drain, for exhaust systems. Do not use a "conical cap" exhaust stack. Provide at least 25 feet (7.5 m) between exhaust outlets and outside air inlets to prevent circulating contaminated exhaust air back into the building.

Provide an air cleaning device when required by state and federal regulations. Select air cleaning devices that will maximize contaminant removal and ease of maintenance while minimizing cost.

Provide air flow and static pressure calculations with each design following the methods of the ACGIH Ventilation Manual.

Battery Shop Ventilation Guidelines

General: Contact manufacturer of the batteries to be charged for additional criteria associated with various battery types.

Lead Acid Shops: Provide a minimum ventilation quantity of three air changes per hour or 400 CFM, whichever is greater. Perform calculations to document that ventilation will limit hydrogen buildup to less than 1% based on room volume.

Nickel-Cadmium (NICAD) Shops: Provide a minimum ventilation quantity of one air change per hour. Provide air conditioning or mechanical ventilation in the NICAD shop to limit the temperature to 85^{o}F (29.4^{o}F). If battery shop air conditioning is part of a general building air conditioning system, exhaust the shop's air directly to the outdoors. Do not return battery shop air to the air distribution system.

Local Exhaust: Use local exhaust ventilation where possible. Design local exhaust per ACGIH with a minimum capture velocity of 125 fpm (0.635 m/s).

General Dilution: If local exhaust is not practical, use general dilution ventilation. Slope shop ceilings 1/2 inch per foot. Use low point supply with 100% outside air. Provide high point exhaust equal to 110% of outside supply air quantity. Use non-sparking fan wheels and require motors to be located outside of the air stream.

Charging: Interlock chargers with exhaust fans to prevent charging without adequate ventilation.

D3096 PAINT SPRAY BOOTH VENTILATION

Design industrial ventilation systems per the latest edition of Industrial Ventilation, A Manual of Recommended Practice published by ACGIH. For Navy projects also comply with Military Handbook 1003/17, Industrial Ventilation Systems.

D3097 GENERAL CONSTRUCTION ITEMS (HVAC)

A. ANTI-TERRORISM PROTECTION FOR MECHANICAL SYSTEMS:

1. All buildings require seismically supported equipment, ductwork and piping. If the acceleration factor is such that seismic bracing is not required (or if this criteria exceeds the seismic criteria, ACOE TI-809-04) then the minimum design criteria for the equipment, ductwork and pipe supports shall resist forces of 0.5 times its weight in any direction and 1.5 times the weight in the downward direction.

2. Locate all outside air intakes a minimum of 3 meters (10 feet) above ground elevation.

3. Include an emergency shutoff switch in the control system that immediately shuts down the heating, ventilation, and air conditioning (HVAC) system of inhabited structures. There shall be a minimum of two switches per floor strategically placed based on building user input. The switch shall be placed in a flush mounted enclosure with a glass brake front with hammer (or equal anti tamper enclosure). In addition, a plastic laminate sign with engraved words shall be placed on the wall beside the switch that reads, "BUILDING VENTILATION SYSTEM EMERGENCY SHUTOFF SWITCH".

4. If walls or other screening devices with more than two sides are placed around mechanical equipment within the 33 feet (10 meter) wide unobstructed space zone, the equipment shall be enclosed on all four sides and the top. Openings in screening materials and gaps between the ground and screens or walls making up the enclosure will not be greater than 150mm (six inches). Any surfaces of the enclosures that can be opened will be secured so that unauthorized personnel cannot gain access through them.

5. Exterior mechanical equipment shall be placed either outside the 33 feet (10 meter) wide unobstructed space zone or placed in such a manner that there is no opportunity for the concealment of explosive devices.

-- End of Section --