CHAPTER 7

MECHANICAL

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7.1 GENERAL

This chapter provides design criteria and guidance for preparation and development for each of the different required submittal stages for mechanical design. Guidance for mechanical systems not included herein is provided in the AE contract.

The USACE proponent for Chapter 7 Mechanical is Brandon T. Martin, 502-315-6407, brandon.t.martin@usace.army.mil

7.2 REQUEST FOR PROPOSAL

Design-Build Requests for Proposal (RFP) shall require that the design conform to this design guide and all applicable Federal, Department of Defense, and agency specific criteria. The following shall also be provided in the RFP:

7.2.1

Include expected occupancy patterns for the facility for cooling load, diversity, and energy modeling purposes.

7.2.1.1

Example: Building is 50% occupied 0700-0800, 100% occupied 0800-1700, and unoccupied otherwise. Conference rooms on the 2nd floor are for use by building occupants only; no or limited usage by outside personnel expected.

7.2.2

Provide space matrices indicating the expected number of occupants, occupant activity level, equipment type, and any other information necessary to determine interior heat gains for load calculations for bidding purposes. The contractor shall be required by the RFP to determine the actual usage, equipment, etc. during design.

7.2.3

If the facility will have the building automation system or direct digital control systems integrated with an existing energy or utility monitoring and control system, sufficient information about the existing system must be provided to allow appropriate bids. All points required for override, alarm, monitoring, and trending must be identified in the RFP, either generically or specifically. The trending capabilities required in terms of the points, frequency, duration, etc. must be specifically required in the RFP.

7.2.4

Current fire flow test data must be provided for bidding purposes. The RFP must clearly state that the contractor is required to perform a fire flow test as the basis of their design.

7.3 DESIGN DEVELOPMENT

7.3.1 CONCEPT/PROJECT DEFINITION DESIGN (30-35%) SUBMITTAL REQUIREMENTS

7.3.1.1 Concept Design Analysis

The narrative forms the basis of the future Interim and Final Design Analysis. Include the following in narrative form:

7.3.1.1.1 Heating, Ventilation, and Air Conditioning

a. Criteria listings – include regulations, UFCs, handbooks, manuals, codes, standards, etc. applicable to the project. Indicate the version used for each criteria document listed.
b. Design conditions used in calculations -inside and outside temperatures/humidity, personnel load, equipment heat release, energy sources, exhaust and ventilation requirements, U-factors, and other special conditions.

c. Life cycle cost analyses including: narrative describing systems and equipment/systems compared, reasons for choices selected, and calculations. Include energy models for each system including input and output for schedules, building components, rooms/spaces, systems, plants, etc. Include calculations of water use. Include input and output for the LCCA analyses, calculation of installation costs, and calculations of maintenance costs. Identify source of cost data. When building energy optimization is required, refer to Chapter 10 Energy & Sustainability.
d. Block loads for heating and cooling. Load calculation software may include Trane Trace and Carrier HAP. Other load calculation software must be approved in advance by the District. For all computer generated calculations (cooling load, heating load), the design analysis shall contain layout sketches that show how the building or system was zoned for computer input. Include input and output for the calculation.
e. Load analysis and energy model input and output shall be organized such that each space, zone, system, item of equipment, building component, etc. is correlated with identifiers on design plans and easily identifiable. Examples: Conference Room #244 is identified as Conf Rm #244 on input/output documents; AHU-2-4 is identified as AHU-2-4 on input/output documents; Zone 3-4 on the input/output files is associated w/ VAV 3-4.
f. Narrative describing the systems considered, justification for selection, description of air distribution, zoning and control description, and description for any connections to existing systems.
g. Brief description of various items of equipment. Indicate operating temperatures and capacities. Example: "Two (2) condensing boilers size for 300 MBTUH each will provide heating…Heating hot water from boilers will be 140 F."
h. Description of piping systems including type of pipe, insulation requirements, and whether concealed or exposed.
i. Energy, Utility, or Facility Monitoring and Control System (EMCS) connection or installation requirements narrative identifying existing EMCS conditions and requirements for providing new or future EMCS on this project.
j. A list of items for which any additional criteria, clarification, or guidance is required.
k. Where heating or cooling is planned to be provided from an existing plant, provide verification that capacity, availability, and reliability of the plant are adequate to support project loads. Provide supporting calculations.

7.3.1.1.2 Plumbing

a. Criteria listing – include regulations, UFCs, handbooks, manuals, codes, standards, etc. applicable to the project. Indicate the version used for each criteria document listed.
b. Plumbing calculations as necessary to determine number of fixture units, cold and hot water, sanitary, and vent capacity requirements, and equipment or capacities of miscellaneous and special systems. Indicate male and female building populations.
c. Fixture determination listing quantity and type of fixtures.
d. Life cycle cost analyses including: narrative describing systems and equipment/systems compared, reasons for choices selected, and calculations. Include energy/water usage calculations. Include input and output for the LCCA analyses, calculation of installation costs, and calculations of maintenance costs. When building energy optimization is required, refer to Chapter 10 Energy & Sustainability.
e. Description of domestic water heating and storage equipment, including capacity and type (gas, electric, boiler, water). Narrative describing the systems considered, justification for selection, and control description.
f. Piping types and location (concealed or exposed), together with material proposed and insulation requirements.
g. Brief description of miscellaneous systems such as compressed air (capacity, pressure, piping, location of air outlets, etc.), roof drainage, natural gas (pressure, quantity, and equipment to be served), POL, and other special systems.
h. Include a description of radon system requirements, including area radon levels, and planned system.
i. A list of items for which additional criteria, clarification, or guidance is required.

7.3.1.1.3 Utilities

a. Criteria listings – include regulations, UFCs, handbooks, manuals, codes, standards, etc. applicable to the project. Indicate the version used for each criteria document listed.

b. Discuss utility system owners, points of contact, and any special considerations related to obtaining services. Description of responsibility of project/contractor vs. utility provider. Indicate who provides service lines, meters, tanks, etc. Indicate metering requirements and backflow prevention requirements.
c. Pipe size calculations. Where project utilities are extensions of existing systems show that these are adequate for the additional load requirements.
d. Description of the utility systems chosen. For buildings remote from available utilities, provide life cycle cost analysis to justify utility system selection. Example: Justification of propane versus natural gas or justification for water tanks versus extending water mains. When building energy optimization is required, refer to Chapter 10 Energy & Sustainability.
e. Metering requirements shall be identified.
f. A list of items for which additional criteria, clarification, or guidance is required.

7.3.1.1.4 Fire Suppression

a. Criteria listings – include regulations, UFCs, handbooks, manuals, codes, standards, etc. applicable to the project. Indicate the version used for each criteria document listed.
b. Listing of the hazard classifications for each space and discussion of protection requirements for specific hazards.
c. Discussion of fire protection features to reflect the types of system; considered with a description of the systems selected.
d. Description of fire detection and alarm system controls which are used to actuate suppression systems.
e. If water sprinkler systems are to be provided, preliminary hydraulic calculations for the most hydraulically demanding area of each hazard classification to insure that flow and pressure requirements can be met with current water supply. Provide results of flow test data with preliminary hydraulic calculations. Identify the requirements for fire pumps and storage tanks and include associated calculations. Provide calculations for other suppression systems such as standpipes, deluge systems, or in-rack sprinkler systems, and include the source for calculation methodology.
f. List any special requirements requested by the local fire department.

7.3.1.2 Concept Drawings

7.3.1.2.1 HVAC

Heating, ventilating, and air conditioning equipment layout: chillers or refrigeration compressors, boilers, pumps, condensers or cooling tower, air handling units, fans, terminal units, air distribution duct layout (may be single line), hoods, ductless minisplit units, and other items of major equipment required for the facility. Show unique equipment tags/identifiers for each item of equipment.

7.3.1.2.2 Plumbing

Plumbing fixture layout, floor and area drains, and plumbing equipment layout (hot water generator, storage tank, air compressors, etc.).

7.3.1.2.3 Utilities

Indicate locations and sizes of outside utilities, high temperature water, steam, chilled water, and natural gas lines. Show same scale as other site work drawings. Show locations of fire department connections, hydrants, post indicator valves, exterior backflow preventers and meters, etc. Show locations of flow and test hydrants used for water flow tests. Show gas delivery pressure and capacity (cubic feet per hour) at the gas regulator.

7.3.1.2.4 Fire Suppression

Prepare a plan for each floor of each building. Provide the following types of information:
a. The location and coverage of any fire suppression systems (fire pumps, sprinkler risers, standpipes, inspector test and drain, fire department connection, etc.).
b. The location of any other major fire suppression equipment.
    i. Examples: In-rack sprinkler systems, deluge systems, hose racks, etc.
c. Indicate all areas and their hazard classification

7.3.1.2.5 Mechanical Room

A large scale plan of the mechanical room(s) showing all equipment to be located therein including but not limited to HVAC, plumbing, and fire suppression system equipment. Examples: air handling units, pumps,

boilers, expansion tanks, water heaters, sprinkler risers, etc. Ensure proper clearance between and around all equipment in mechanical room per appropriate codes/standards and manufacturers' recommendations keeping in mind filter, belt, valve, coil, damper and sensor maintenance/removal.

7.3.1.2.6 Legend

Provide a legend describing all symbology used in the drawings.

7.3.1.3 Concept Specifications

Provide a list of specifications to be used for the project.

7.3.2 PRELIMINARY/INTERIM (60-65%) DESIGN SUBMITTAL REQUIREMENTS

7.3.2.1 Interim Design Analysis

7.3.2.1.1 General

The Interim (60-65%) Design Submittal shall contain the information required for the Concept (30%) Design Analysis.

7.3.2.1.2 References

Identify all references to standard texts, handbooks, guidelines, etc., for all major design decisions or assumptions not covered by criteria references. Example: ASHRAE Handbooks.

7.3.2.1.3 Calculations

Provide capacity calculations for all major items of mechanical equipment such as air handling units and coils, condensing units, water chillers, boilers, humidifiers, cooling towers, fans, hot water heaters and tanks. Show manufacturer's make and model number of equipment used for layout purposes, and show weights of major items of equipment. Provide updated heating and cooling load analysis. Provide determination of ventilation and exhaust quantities including a room-by-room inventory that includes the design number of occupants, room area, ventilation required per person and per floor area, ventilation/system effectiveness/efficiency, and adjustments for intermittent or variable occupancy, multiple spaces, etc. Provide air balance calculations addressing space/building pressurization. Show determination of water quantities and temperature rise or drop for hot water, chilled water, and condenser water. For all computer generated calculations, the design analysis shall contain layout sketches that show how the building or system was zoned for computer input. Include input and output for the calculation organized as described for Concept Design Analysis. Provide vendor information for equipment selected and mark specific items on the vendor's literature indicating the intended features.

Submit a psychrometric plot of each air-conditioning, humidification, and dehumidification system clearly identifying all points in the process. List the sensible, latent, and total capacity requirements for the equipment accomplishing each process. Example: cooling coil, air washer, steam humidifier, etc. Demonstrate that design conditions, including humidity, are maintained during part-load cooling conditions.

7.3.2.1.4 Sizes

Provide pipe and duct size calculations. Size exterior heat, gas, and chilled water distribution piping. Show flow quantities, pipe sizes, pressure drops, total pressure drop, and initial and final pressures. Calculate expansion loop sizes for heat-distribution and for low temperature heating water distribution systems.

7.3.2.1.5 HVAC Controls

Include HVAC controls information. Include sequences of control narratives sufficient to describe generally how systems will operate. Detailed sequences not required for 60-65% Design. Example: Controls such as safties, economizer, setpoint resets, occupancy modes, unoccupied bypass, etc. shall be listed, but detailed written sequence not necessary.

7.3.2.1.6 Fire Suppression

Provide a detailed description of the Fire Suppression system and its controls such as activation of the system, interlocks with the HVAC system, and connection to detection and alarm systems.

Provide detailed description of volumes and quantities of agents used for clean agent systems or special hazards.

7.3.2.1.7 Sustainability

Provide a description of the energy and water conservation features of the systems. Include description of features that provide positive benefit to indoor environmental quality and materials and resource conservation to demonstrate compliance with UFC 1-200-02 and agency policies. Describe features used to satisfy LEED credit requirements, unless addressed elsewhere in the design analysis.

7.3.2.2 Interim Drawings

Show all information required for the Concept (30%) drawings but in greater detail. In addition, show the following:

7.3.2.2.1 Layout

Floor Plan layouts showing the location of all items of mechanical equipment, piping, ductwork, and fixtures. Ductwork and piping may be shown as single line. Indicate pipe and duct sizes. Detailed piping schematic diagrams, details, sections, and elevations are not required for 60-65% design unless required to show intent of design.

7.3.2.2.2 Piping Plans

Chilled water, heating hot water, domestic water, drainage and vent, gas, and liquid fuel distribution plan showing location and size of distribution lines, anticipated grading of lines, and locations and sizes of expansion loops or joints and anchors. If lines are in pits, show locations of pits and pit equipment. Pits should accommodate maintenance personnel and operations. HVAC piping plans shall be separate from ductwork plans. Plumbing drainage and vent piping plans shall be separate from domestic water plans.

7.3.2.2.3 Enlarged Mechanical Room Plans

Equipment room layouts shall be sufficiently complete to show piping and duct layouts and access for maintenance. Indicate space required for maintenance of equipment on the plans.

7.3.2.2.4 Equipment Schedules

Provide equipment schedules filled out with what is known; schedules not required to be complete for 60-65% design. Show electrical characteristics in schedules. Minimum efficiency shall be included in the equipment schedules (Examples: efficiency %, EER, COP, etc.). Include part-load efficiency for equipment operating a significant portion of run-time at less than design load. (Examples: IPLV and NPLV) Where the appropriate standards defining rating test conditions are not referenced by specifications or do not exist, indicate conditions at which the equipment meets the indicated efficiency. Coordinate electrical requirements with the electrical engineer. For standard mechanical equipment, the salient features should be generic for at least three manufacturers to meet the requirements and specifications. A trade name and model may be provided as a basis of design; list as basis of design ..

7.3.2.2.5 Plumbing Schedules

Plumbing fixture schedule listing individual fixtures and pipe size connections (cold water, hot water, and waste).

7.3.2.2.6 Fire Suppression

Prepare a schedule describing the system with the following information: fire hazard and occupancy classifications for each room or area of the building, building construction type, gpm/sf sprinkler density, area of operation, demand area, area of coverage/head, sprinkler spacing, and flow test results as required.

7.3.2.2.7 Other

Any information other than the requirements listed above which the engineer considers necessary to show the intent of design.

7.3.2.3 Interim Specifications

The outline specifications previously submitted with the 30-35% phase shall be revised, updated, further developed and resubmitted. Prepare outline specifications for mechanical work included in the project. Where District or UFGS are to be used without change, a listing of the appropriate Guide specification numbers will suffice. Where a departure or addition to a Guide specification is required, include in listing a brief description of the equipment or procedure constituting the departure or addition. Where no Guide specification is available, prepare an outline specification from available criteria and instructions, giving all pertinent equipment and material characteristics.

7.3.3 FINAL (90%) DESIGN SUBMITTAL REQUIREMENTS

7.3.3.1 Final Design Analysis

7.3.3.1.1 General

The Final Design Analysis is a refinement of the 30-35% and/or 60-65% Design Analysis and contains all the information required for those sections of this chapter, even when Concept (30-35%) or Interim (60-65%) submittal is not required, as well as any analysis of significant design changes. Refer to additional requirements for design submittals in applicable Unified Facilities Criteria.

7.3.3.1.2 References

Show applicable references for design assumptions not found in common reference manuals which were not listed during the earlier design stage(s).

7.3.3.1.3 Air Flow

Show all duct sizing computations in the analysis. Show friction loss and clearly indicate the air velocities encountered in the main ducts. Include flow diagrams in the analysis. Provide flow rates and static pressure on fans and air handling units based upon complete take-off of static losses. Include dirty filter allowance. Consider system effect and calculate as necessary.

7.3.3.1.4 Water Flow

Include all pipe sizing computations in the analysis. Show design flow, pipe size, friction factors, slopes, lengths, and elevations where applicable, quantity conducted, and velocity in the various mains and branches. Include flow diagrams in the analysis. Include pump capacity and head calculations and valve Cv calculations.

7.3.3.1.5 Plumbing Analysis

Include piping diagrams. The plumbing piping analysis shall clearly show the main and branch loads in terms of "fixture units" as well as flow quantities.

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7.3.3.1.7 Fire Suppression

For fire sprinkler system information, include hazard classification, zoning (if appropriate), and sizes of all riser pipes including wet and dry pipes, sprinkler valves, mains, and principle branches based on available water pressures by either computer-generated hydraulic analysis or manual calculations. When a fire pump is required, provide vendor information on fire pumps. Thoroughly develop smoke evacuation and clean agent and special hazard extinguisher systems when required.

7.3.3.1.8 Checking

All computations must be checked. A registered professional engineer must perform or check the computations.

7.3.3.1.9 Engineering Considerations

Provide "Engineering Considerations for Field Personnel" as necessary for mechanical aspects of the construction. Considerations should address critical submittals, list submittals of particular importance for AE review, special inspections or tests for systems, unusual features of the systems, utility coordination issues, permitting, or other information that could mitigate risk during construction.

7.3.3.2 Final Drawings

Final plans are refinements of the 30-35% and 60-65% drawings and add additional detail. Unified Facilities Criteria (UFC) shall not be referenced; all requirements for the project shall be explicitly shown in the drawings. Refer to additional requirements for design submittals in applicable Unified Facilities Criteria. In addition, show the following:

7.3.3.2.1 Sections and Elevations

Show sufficient sections and elevations to clearly indicate the exact location of the particular item in relation to other building components or equipment. Sections shall indicate critical interference between mechanical items and building features. Provide at least one section through the mechanical room and two sections for complex, congested mechanical rooms. The number of sections and elevations must be sufficient to allow construction and installation of work without additional design work by the AE or construction contractor. Examples: mechanical rooms, duct/piping crossovers, wall-mounted ducts in hangars, etc.

7.3.3.2.2 Risers and Isometric Views

Show isometric riser diagrams for domestic water, drainage and vent, gas, compressed air and other piping systems. Show all piping sizes, valves, water hammer arrestors, etc.

When using BIM, provide an isometric view of the mechanical equipment rooms. Label all equipment in the mechanical equipment room isometric; sizes and other notes not required. Indicate that the isometric is for information only.

7.3.3.2.3 Details

The number of details must be sufficient to allow construction and installation of the work without additional design work by the AE or construction contractor.

7.3.3.2.4 Accessories

Where equipment connection details are shown, indicate all required valves, gages, and fittings required. Coordinate with specification requirements and ensure that valves, fittings, etc., that are specified to be furnished with each piece of equipment are included in the detail.

7.3.3.2.5 Plans

Final plans must show all pipe and duct sizes. Draw ductwork to scale on plans and indicate duct pressure class. Show locations for sensors; Examples: Differential pressure, thermostats, humidistats, CO2 sensors, etc. Show locations for HVAC emergency shutdown switch and boiler emergency shutdown switch. Show locations of control panels, variable frequency drives, etc. Label thermostats to clearly indicated associated equipment. The air suction and discharge directions of such items as louvers, wall-mounted grilles/diffusers, fans, air-cooled condensers, and cooling towers shall be indicated on the drawings. Provide sequences of operation for plumbing equipment such as water heaters, recirculating systems, solar hot water heating systems, pressure booster systems, etc. Include control and monitoring points on building automation system or HVAC control point schedules. Coordinate with HVAC Controls.
Detail catwalks, ladders, platforms, access panels, and doors required for operation and maintenance of equipment, valves, and accessories. Show all locations of isolation valves, turning vanes, and all volume, fire, and smoke dampers. Show locations of access panels and doors in walls, floors, and ceilings (except lay-in ceilings.) On mechanical equipment room plans, clearly indicate by dotted lines, the space required for equipment maintenance. Example: filter replacement, coil replacement, and "tube pulling" on such items as boilers, chillers, condensers, etc. Allow sufficient room for maintenance, coil removal, filter removal, etc., on each piece of equipment.

7.3.3.2.6 Equipment Schedules

Place performance characteristics for all items of mechanical equipment in carefully prepared equipment schedules. Equipment characteristics selected shall not be restrictive to anyone manufacturer but must be competitive among at least three major manufacturers. Performance characteristics shall be minimums or maximums for proper system operation and shall not be based solely on a single vendor’s equipment. Ensure required performance characteristics and features of equipment are fully described.

7.3.3.2.7 Ventilation Schedule

Provide a ventilation schedule showing, for each breathing zone, the total supply air flow rate, ventilation air flow rate, and the number of anticipated occupants. Indicate that the schedule is for information purposes only.

7.3.3.2.8 Duct Construction Classifications and Testing Schedule

Provide a completed Ductwork Construction and Leakage Testing Table (reference UFC 3-410-01) and indicate duct static pressure, seal and leakage classifications, test type and test pressures.

7.3.3.2.8 HVAC Controls

HVAC Control drawings shall include every mode of operation, sequence of operation, interlock, safety, etc. to fully describe system operation for all equipment. Include plumbing or other systems that will be included in the control systems. Packaged equipment internal controls are not required to be described in detail; however, all elements of operation related to the equipment and interaction w/ other parts of the systems must be described. Example: describe when dampers are open or closed, unit start/stop, unit status, conditions maintained by the unit, etc. for an energy recovery unit. Final HVAC controls plans shall included:

a. Legend/Symbols defining all symbology.
b. Schematic for each unique item of equipment/system including all sensors, dampers, valves, and other control devices.
c. Written sequences of operation for each item of equipment/system. Include point name within the sequence coordinated with the Point Schedule.
d. Points Schedule indicating point name, setpoints, control/operating ranges, overrides, alarms, EMCS monitor/control points, etc.
e. Description of system architecture including a diagram of the building level and EMCS controls, alarm handling and system scheduling information, and system integration requirements.
f. For critical control sequences or when necessary to clarify complicated control sequences, logic and ladder diagrams with point names coordinated with the Points Schedule.
g. Control valve schedule showing identifier, location, function, type (2-way/3-way, modulating/2-position, etc.), current range, Cv, and close-off rating (or minimum torque).
h. Control damper schedule showing identifier, location, function, type (modulating/2-position, etc.), current range, size, and opposed or parallel blade.
i. Room sensor schedules showing locations, unit served, and features such as unoccupied override, occupancy sensors, etc.
j. Occupancy schedule showing initial times for occupied and unoccupied mode.
k. All labeling for devices and equipment must be consistent across all drawings including equipment schedules, details, plans, schematic diagrams, sequences of operation, point schedules, etc.

7.3.3.2.9 Fire Suppression

Label fire protection drawings "PRELIMINARY", and provide flow test and results, densities, demand area, areas protected, hazard classification of all areas, sprinkler head coverage, zoning requirements, building entrances, exact control system locations (must include all locations if shown), and device locations. Anything shown must be correct as to numbers and approximate as to locations and sizes for "non-critical projects". Unified Facilities Criteria (UFC) shall not be referenced; all requirements for the project shall be explicitly shown or described in the plans.

7.3.3.3 Final Specifications

7.3.3.3.1 General

Provide original final project specifications. Read and comply with specifier notes included in the UFGS .sec files with respect to editing the specification sections. Apply tailoring options using SpecsIntact as appropriate for the project and using service. Unified Facilities Criteria (UFC) shall not be referenced; all requirements for the project shall be explicitly described in the specifications. Request for exceptions may be routed to the LDMDG Mechanical Chapter proponent through the USACE PE/A.

7.3.3.3.2 Equipment Designations

The nature of the UFGS system level specifications makes it difficult to associate items of equipment with the applicable specification sections or paragraphs. In the Products part of specification section, add equipment identifiers to paragraph titles or elsewhere to clearly associate equipment to its specification requirements.

7.3.3.3.3 Trade Names

Specifications must not be restrictive or proprietary. Generally, the description will be such that at least three manufacturers can meet the specified requirements. Specifications shall be adequate to maintain quality of product and installation without reliance on naming specific equipment make/models. Where trade names and model numbers are listed, provide from at least three manufacturers and indicate OR APPROVED EQUAL.

7.3.3.3.4 Components

Give particular care to the compatibility of components. For example, the burner requirements should suit the boiler; the combustion controls should suit the type of burner selected.

7.3.3.3.5 Fire Suppression

Prepare specifications for fire suppression systems from UFGS, or other approved sources, adapted for the project. Specify components such as smoke detectors, heat actuated devices, and control valves for special hazard or clean agent systems in separate fire suppression specifications.

7.3.3.3.6 Coordination with Drawings

Ensure that equipment and systems are fully specified through combination of drawings and specifications. Avoid duplicating requirements and conflicts. Where a specification references drawings, the drawings should reflect the items indicated. Example: Specification states, “Access doors where shown.” Drawings should show access door locations.

7.3.3.3.7 Submittal Register

Ensure that all appropriate submittals are correctly marked for Government Approval and approving office in the submittal register. Generally, the designer of record should review the following:

a. Major items of equipment which include fans, coils, pumps, heat generation (ex: boilers), cooling plant (ex: chillers), etc.
b. Extensions of design. Examples: fire suppression design, controls design, in-floor radiant systems, etc.
c. Testing, Adjusting, and Balancing (TAB) procedures and reports.
d. Commissioning Plans and Reports.

7.3.4 CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS

Update design submittals based on resolutions to Final design review comments or to address customer changes.

7.4 DESIGN/TECHNICAL REQUIREMENTS

7.4.1 BASIS OF DESIGN

Avoid designing based on a single manufacturer’s product. Multiple manufacturers must be able to compete to provide specified equipment. During design, verify that at least three manufacturer’s provide equipment meeting specified requirements. Develop a justification and obtain approval through the PE/A for any equipment or system that must come from a single source.

7.4.2 INSTALLATION

Ensure that systems will be installed in accordance with manufacturer’s installation requirements and recommendations and accommodate manufacturer required or recommended service or maintenance clearances. Sufficient space shall be provided to allow for changing filters, cleaning or removing coils, and other operations as required to maintain the systems. Mechanical or equipment room layouts shall facilitate ease of maintenance. Bottom of suspended ductwork, piping, and equipment located in mechanical or equipment rooms shall not be lower than 6 feet above finished floor where possible.

Means shall be provided for access to equipment for maintenance without damage to other building components including ladders, catwalks, or platforms as necessary. Maintenance access shall be fixed and shall not require the use of cranes or lifts. For example: Heating and Ventilating Units suspended from the roof structure in a maintenance bay shall have grated catwalks and platforms to facilitate maintenance without the use of a lift. Components on suspended equipment that require maintenance shall be easily maintained, repaired, or replaced from the access point. For example: Variable Air Volume terminal units and Air Handling Units suspended above ceilings should have all components within reach of a service technician from the point of access. Access doors shall be provided for access to all components requiring inspection, cleaning, or removal. Means shall be provided to allow maintenance staff to easily and quickly find above-ceiling or otherwise hidden equipment or other system components requiring maintenance or replacement.

System installation and building construction shall be coordinated to allow replacement of equipment without damage to systems or building components.

Conceal all piping and ductwork in habitable areas of all buildings, except storage or service facilities. Minimize roof penetrations where possible.

7.4.3 NOISE/VIBRATION

Design to control noise and vibration in accordance with applicable UFC and ASHRAE Handbooks.

7.4.4 SEISMIC PROTECTION

Earthquake resistant ("seismic") design of nonstructural systems and components shall be in accordance with the applicable UFC, references within the UFC, and facility specific requirements.

7.4.5 GUIDE SPECIFICATIONS

When use of UFGS specifications is required, read the specifications and imbedded specifier notes prior to design. Often, the specification and notes reflect criteria required for the design.

7.4.6 MECHANICAL EQUIPMENT SPACES

Mechanical equipment, piping, and accessories in boiler and equipment rooms will be drawn to scale in the drawings in both plan and elevations. Since the physical characteristics of mechanical equipment (dimension, weight, connections) vary between manufacturers, the level of detail for the drawings can be general so that the equipment from at least three manufactures can be used. The purpose of the details is to show the intent concerning equipment placement. Adequate space will provided for maintenance, operations, and replacement of equipment, piping, and accessories. Catwalks, ladders, platforms, access panels and doors required for operation and maintenance of equipment, valves and accessories will also be indicated and detailed on the drawings.

7.4.7 SYSTEM SELECTION

Identify several appropriate HVAC system alternatives for the project. Minimum is a minimally energy standard compliant baseline and four alternatives. HVAC alternatives must meet design criteria, be appropriate to the climate and application, and be based on building heating and cooling loads. In the event no reasonable alternatives are available for comparison or other reasons exist that preclude several alternative systems, develop a justification and pursue a waiver through the project PE/A.

HVAC system shall be selected to function to meet project requirements and minimum design criteria while limiting first cost, replacement costs, utility costs, energy/water consumption, greenhouse gas and considering maintainability. HVAC system selection shall occur prior to or shortly after submission of Concept Design Submittal or Charrette Document. Coordinate approval for selected HVAC systems with the PE/A. Concept Energy Modeling and Life Cycle Cost Analyses shall be performed and provided to evaluate the HVAC system alternatives a part of the basis for system selection.

Where appropriate, include determination of the feasibility for use of ground source heat pump systems based on ground conditions (if available).

7.4.8 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

7.4.8.1 Design Conditions

Design Conditions shall be in accordance with applicable UFC or specific customer requirements. In addition to design temperatures and humidity consider acceptable air velocities, radiant temperatures, and temperature and humidity drifts or ramps. Comply with the latest version of ASHRAE Standard 55. The maximum allowed space relative humidity drift within a 15 minute period is 3% and within a 30 minute period is 4%. Perform a psychrometric analysis showing that design conditions, including humidity, are maintained during part-load cooling conditions. Designer shall design and select appropriate systems for climate zone of project. This includes proper treatment of ventilation air in humid climates.
At part-load conditions, systems including constant-volume air flow or DX may have difficulty maintaining space humidity conditions while delivering the required ventilation air flow. DX systems need to be able to unload to match part-load conditions sufficiently to prevent increase of space humidity beyond the acceptable range. Rather than use constant-volume air flow systems for single zones, consider the use of variable-volume systems instead.

7.4.8.2 Year-Round Cooling Requirements

If an air conditioning system serves areas having high internal heat gains, consider year-round cooling requirements and design the system accordingly; this shall include provisions for low ambient operation of air-cooled equipment, use of glycol, cycling of water pumps, the use of an outside air economizer cycle, or other strategies as appropriate.

7.4.8.3 Redundancy

Hydronic heating systems and ground and water source heat pump systems shall include at least two pumps for the building circuit. If the ground source heat pump system includes ground well circuit in addition to the building circuit, two pumps shall be provided for the ground well circuit. With a single pump off-line, the remaining pump(s) shall be capable of providing not less than 65% of the design maximum system flow rate. Hydronic heating systems that include heating only from boiler shall include at least two boilers. With a single boiler off-line, the remaining boiler(s) shall be capable of providing not less than 65% of the maximum winter design load.

7.4.8.4 Coil Freeze Protection

Design to avoid potential water or glycol coil freeze or burst conditions and nuisance temperature low-limit alarm operations. Ensure outdoor air and return air streams are well-mixed upstream of coils, provide preheat or energy recovery, etc. as appropriate.

7.4.8.5 Boiler System Design

Consider part-load heating conditions in the design of boiler systems and optimize energy conservation and life of equipment. Consider using multiple boilers. Example: Use a smaller boiler during normal part-load operation and use a larger boiler when higher loads are required.

7.4.8.6 Variable Refrigerant Flow (VRF) Systems

VRF systems shall conform to Buy American Act and other applicable trade agreement requirements. For design-bid-build projects, the AE must show, prior to solicitation, that there are at least two vendors capable of meeting the design requirements and meet the Buy American Act. This may require a component listing w/ country of manufacture. Coordinate with USACE PE/A.

VRF systems shall provide for simultaneous heating and cooling of different zones through the use of energy recovery. Ensure compliance with ASHRAE Standard 15.

7.4.8.7 HVAC Controls

HVAC Controls shall be designed in accordance with applicable UFC or customer requirements. Direct Digital Control system shall be used unless renovating an existing building w/ mechanical controls. Example: Existing building using pneumatic controls.

The DDC control system shall be a single complete non-proprietary system. The system shall be open in that it is designed and installed such that the Government or its agents are able to repair, replace, upgrade,

or expand the system without further dependence on the original contractor. DDC controls systems shall use open-protocols (BACNet or LONWorks) in accordance with operator (DPW, RSC, BCE, etc.) requirements.

7.4.8.8 Energy Monitoring and Control Systems (EMCS)

Determine the requirements for EMCS integration from applicable UFC, the using service, and project PE/A as appropriate.

7.4.9 PLUMBING/UTILITIES

7.4.9.1 Chemical Treatment

When a potable water supply is connected with a system such as heating system, chilled water system or cooling tower which is equipped with chemical treatment, provide a positive break such as an air gap or reduced pressure type backflow-prevention device. The positive break should occur between the potable water supply and the system. If the water in such systems is not to be chemically treated, then specify reduced pressure backflow prevention.

7.4.9.2 Expansive Soils

Design piping systems in expansive soils as appropriate.

7.4.9.3 Cathodic Protection

Cathodic protection is required on all underground waterlines and gas lines in areas defined in UFC 3-570-02A, Cathodic Protection. Cathodic protection is also required for all tanks and piping containing environmentally hazardous materials (i.e., fuel, oil, POL, etc.). Provide cathodic protection to protect tanks and piping in all other areas for which life cycle cost studies justify such an installation

7.4.10 FIRE SUPPRESSION

Plans developed for sprinkler systems are of the preliminary layout type. Sprinkler plans are to be a guide for subsequent preparation by the construction contractor of detailed working drawings which will be coordinated with requirements required by the preliminary plans. Show details for risers, fire department connections, flow test results, design conditions, and coverage in the contract documents. However, do not show sprinkler head locations, branch and pipe lateral sizes.

----END OF SECTION----