CHAPTER V

MECHANICAL

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1. **INTRODUCTION**:

1.1 **Criteria. These instructions apply to Southwestern Division and District Offices**. All mechanical work shall be designed in accordance with: The Architect-Engineer's (A-E) contract; all applicable technical manuals (TM for Army and AFM for Air Force); Technical Instructions (TI for Army) engineer technical letters (ETL); Corps of Engineers guide specifications (CEGS); and these instructions. For Army construction, the Architectural and Engineering Instructions (TI 800-01) "Design Criteria" is the basic criterion. For Air Force construction, Air Force Manuals (AFM), Regulations (AFR), and Military Handbooks (MIL-HDBK) are the basic criteria. Any conflict between criteria should be reported to the Engineering Manager. Applicable codes, standards, etc., that are not specifically for military design, and that are listed in specifications are required criteria unless they conflict with military criteria.

1.2 **Metrication.** The metric units used are the International System of Units(SI) adopted by the U.S. Government as described in Chapter I, paragraphs 3. and 4.2.1.

2. **GENERAL CRITERIA**

2.1 **Design Policy and Guides**:

2.1.1 References:

2.1.1.1 ER 1110-345-100 Design Policy for Military Construction

2.1.1.2 HQUSACE Architectural and Engineering Instructions "Design Criteria" (USACE TI 800-01)

2.1.1.3 Military Handbook (MIL-HDBK-1190) Facility Planning and Design Guide

2.1.2 General: Most major mechanical design criteria are referenced in this AEIM. The USACE TI 800-01 is the basic criterion for Army construction. Military Handbook MIL-HDBK-1190 is the basic criterion for Air Force construction. Comply with all codes, Standards, etc., that are listed in the specifications or referenced specifically for military design. Military criteria govern when a conflict occurs with nonmilitary criteria. Other sources of criteria include

Engineering Technical Letters (ETL's) issued by HQUSACE and the HQ US Air Force, Air Force General Design Guidance and Design Criteria Letters issued by the Division and District(s).

2.1.3 Additional criteria may be given to the designer that is general in nature or applicable to a specific project. These criteria will be documented and become part of the project design instructions.

2.1.4 Seismic design and criteria for piping, equipment and supports are included in TI 809-04 and Guide specification CEGS 13080. Fire sprinkler systems shall be in accordance with NFPA 13.

2.1.5 Piping designs for underfloor piping in expansive soils will be in accordance with SWDED-G letter Dated 29 Sep 1983, ER 1110-345-722.

2.1.6 HVAC designs will consider the effects of elevation in sizing equipment and ductwork. Schedules shall indicate SCFM or ACFM at elevation.

2.1.7 Force Protection mechanical features will be designed and provided in accordance with TM 5-853-1/2/3/4 for Army and AFMAN 32-701 Volumes 1/2/3 for Air Force.

3. DESIGN INSTRUCTIONS

3.1 **Carefully study the guide specifications** applicable to the project prior to starting final design to ensure that all stated requirements and references are coordinated.

3.2 **Use ASHRAE standard mechanical symbols** in the preparation of all mechanical drawings. See Chapter VIII for drafting standards. The A-E should obtain standard CADD symbols and abbreviations from the District responsible for the design. For standardized control designs use the standard symbols provided. Additional symbols contained in MIL-STD-17B and ASHRAE Handbook of Fundamentals are to be used if necessary symbols are not shown in the above documents.

3.3 **On standard plans**, do not change symbols to conform to paragraph 3.2; however, change plumbing fixture "P" designations as required to meet HQUSACE requirements for handicapped criteria.

3.4 **Design Temperatures and Conditions**:

3.4.1 Heating:

3.4.1.1 Outside Conditions:

3.4.1.1.1 Standard Designs (Plans)-- Outside design temperature used for Standard Designs have three design temperature ranges defined; -29^{0}C to -18^{0}C ,-18^{0}C to -6.5^{0}C, or -6.5^{0}C and above (-20^{0}F to 0^{0}F, 0^{0}F to +20^{0}F, or +20^{0}F and above). The designer will select the appropriate temperature range and loads based on the local site conditions.

3.4.1.1.2 Original (New) and Site Adapt Designs-- The outside design temperatures for Army and Air Force designs are listed in TM 5-785 (AFM 88-29) unless otherwise instructed. Refer to USACE TI 800-01, TI810-10, and MIL-HDBK-1190 for design parameters.

3.4.1.2 Inside Conditions:

3.4.1.2.1 Original Designs - New or Site Adapt projects for both Army and Air Force: 1) 20^{0}C (68^{0}F) for administrative areas, 2) 13^{0}C (55^{0}F) for working/warehouse areas and 3) 4.5^{0}C (40^{0}F) for unoccupied areas requiring freeze protection. Criteria include TI 810-10, USACE TI 800-01, and MIL-HDBK-1190.

3.4.1.2.2 Special Projects - Projects such as Hospitals, will be designed in accordance with DOD 4270.1-M (Army) and MIL-HDBK 1191 (Air Force), and other special criteria provided by the User. Design criteria of other special projects will be based on Design guides and guidance provided by the user.

3.4.1.3 Load Factors -- Heat gain and loss calculations may be increased up to 10% to account for unanticipated or undefined loads or changes in space usage. Increase boiler and heating coil capacity by 15% for normal pickup. Where the control system utilizes a night setback strategy, the equipment capacity may be increased by 30%, if justified by the load calculations. Ignore internal and solar loads in calculations for sizing of heating equipment. Include forced and natural ventilation. Where pipes exceed 30 meters in length, calculate piping losses and add to the boiler capacity.

3.4.2 Air-conditioning and Evaporative Cooling:

3.4.2.1 Outside design temperatures--Engineering Weather Data, a Joint Services Manual, (i.e., TM 5-785, Army and AFM 88-29, Air Force) is the source of design conditions unless

otherwise directed. For design of evaporative cooling system, see Appendix D. For specific design criteria refer to USACE TI 800-01, TI 810-10, and MIL-HDBK 1190 for Air Force projects.

3.4.2.2 Inside Design temperatures are 25.5^{0}C,D.B.(78^{0}F,D.B.) and 50 percent Relative Humidity, for mechanical cooling and 26.5^{0}C (80^{0}F) for evaporative cooling or as instructed for each individual project.

3.4.2.3 Load Factors-- Increase room heat gain calculations up to 10% to account for unanticipated or undefined loads or changes in space usage. Cooling equipment size may be increased (not to exceed 10%) to compensate for "pick up" loads due to set forward control design strategies if justified in the cooling load calculations. Include forced and natural ventilation loads in HVAC load calculations. Size and arrange cooling equipment and cooling coils to satisfy calculated latent as well as total cooling loads. Avoid the over sizing of cooling equipment to prevent short cycling and resultant reduction of moisture removal.

3.4.2.4 Special Designs: The design Ambient conditions for Critical Facilities (i.e., Computer and electronics systems, etc.) will be based on the 1% Dry bulb and 1% Mean Coincident Wet bulb for cooling. Loads for humid areas (for example Fort Polk, La.) will be based on the 2-1/2 % dry bulb and 5% wet bulb. See the USACE TI 800-01, MIL-HDBK 1190, and ETL 1110-3-455 for Humid Area definition and criteria.

3.4.2.5 Other Design Criteria: Design criteria are also included in various Technical Instructions Technical Manuals, ASHRAE Handbooks, Engineering Technical Letters, NFPA, CEGS, Project Books, Southwestern Division Numbered Criteria Letters, and special instructions for individual projects.

3.5 **Project Plans:**

3.5.1 Avoid designing around a particular manufacturer's equipment. Assure the availability of equipment to suit the design by selecting the products of three or more manufacturers. Outline an equipment footprint (and elevation) on project plans that will allow all three manufacturers equipment to fit within the space allotted. See Appendix A for an Equipment Selection data form to be included in the Design Analysis. Do not use manufacturer’s name on contract drawings.

3.5.2 Scales and lettering for all project plans will be in accordance with the district CADD Manual and be legible and easily read when reduced to half-size plans. Provide a

minimum of 1:50 scale plans and sections of all congested mechanical systems including HVAC ductwork, air handling units, plumbing in mechanical rooms, mechanical/electrical equipment mezzanines, toilets, kitchen areas, etc., (other special areas will be included). Use double line ductwork on drawings prepared for final and corrected final contract designs.

3.5.3 Mechanical floor plans: Do not show all mechanical systems on one floor plan. Exceptions require written approval from the District. Provide Separate sheets for plumbing, heating and air-conditioning, sprinkler systems, etc. Develop plans, elevations and sections sufficiently to show contractors how to install mechanical items and ensure that major equipment, piping and ductwork, do not interfere with structural members and electrical equipment. Conceal or furr-in all ductwork and piping for housing, recreational, school, administrative, and medical facilities. Provide exposed ductwork and piping in equipment, boiler, utility, storage, and other rooms of this nature. Provide access panels for fire dampers, valves, traps and air vents. Closely coordinate the design and location of piping and ductwork with architectural, structural and electrical design to eliminate interference and hold furring-in to a minimum. In accordance with NEC, insure that water piping is not located over transformers, panelboard or other electrical equipment. Where electrical items are shown in hazardous areas requiring appropriately rated electrical equipment, add note on mechanical drawings: "All equipment in this area shall be (insert appropriate electrical rating) as shown on Electrical Drawings." Indicate by means of dashed lines the scaled outline of all space dedicated to electrical panels and switchgear in mechanical equipment and boiler rooms to eliminate the possibility of equipment interference. In accordance with NEC, do not install piping, ductwork or equipment in or above dedicated spaces. Check three or more equipment manufacturers to determine the maximum weight and dimensions of the equipment. Coordinate the equipment weights with the structural design. The layout of mechanical equipment shall reflect a clear access path of 1 meter wide by 2 meters high, or greater, to all major equipment. Provide dashed lines on the plans to reflect required maintenance space for coil, tube and filter removal and maintenance space as recommended by the equipment manufacturer. Base the maintenance space on the composite equipment footprint to accommodate the greatest dimension of the manufacturers. Minimize the use of overhead mechanical equipment or other overhead items requiring periodic adjustment but where used coordinate method of access with the user and identify on drawings. To enhance maintainability of mechanical equipment and preserve roof integrity and longevity the use of roof

mounted equipment is to be minimized. Coordinate the location of ceiling diffuses, grilles, and registers with electrical and architectural design and includes in the reflected ceiling plan.

3.5.4 Drawing Organization: In general organize the work by grouping the following design elements on the drawings.

3.5.4.1 Demolition sheets with separate legends.

3.5.4.2 Legends, general notes and related material.

3.5.4.3 Plumbing floor plans, schedules and specific notes.

3.5.4.4 Plumbing riser diagrams, isometric diagrams.

3.5.4.5 Plumbing details.

3.5.4.6 HVAC schedules.

3.5.4.7 HVAC floor plans.

3.5.4.8 HVAC elevations, sections and design specific details, mechanical room floor plans.

3.5.4.9 General HVAC details, standard details such as coil piping details, boiler piping details, wall and floor piping penetrations, etc.

3.5.4.10 Sequence of controls, schematics, ladder diagrams.

3.5.4.11 Fire protection plan(s) and details.

3.5.5 For buildings where future expansion is contemplated, run piping, ducts, etc., where there will be a minimum of future revisions.

3.5.6 Preliminary Plans including Project Definition (Air Force), Project Engineering Phase and Concepts(Army) (10 to 35% design completion). Show heating, ventilation, air-conditioning, plumbing, sprinkler systems, and special items such as elevators and hoists equipment locations and space requirements on the plans. Also, include Government furnished equipment consisting of kitchen and/or medical equipment, flight simulators, etc. Show space for maintenance such as tube bundle removal. Show single-line layouts of ducts. Provide completed equipment schedules on the plans. Samples of schedules are shown in Appendix B.

3.5.7 Plumbing, Fixtures and Drains: Make provisions for handicapped in accordance with the Americans With Disabilities

Act unless otherwise directed. See USACE TI 800-01 for Army and MIL-HDBK-1190 for Air Force projects.

3.5.7.1 On the mechanical plans show all interior piping run to a point 1.5 meters from the building. Piping outside the 1.5 meters line is included in Chapter II, Civil, and shown on Utility Plans. Show sufficient riser diagrams to clarify the layout. Size pipe per the National Standard Plumbing Code. The location of plumbing fixtures is normally the function of the Architect. Show plumbing fixture "P" Number as shown in Guide Specifications.

3.5.7.2 Electrical Water Cooler (EWC) shall be of wall-hung type and conform to ARI 1010, with the type and size shown on the plans as necessary.

3.5.7.3 Provide floor drains as required by TM5-810-5 for Army and AFM 88-8 for Air Force projects. In utility and boiler rooms, provide floor drains or a covered trench leading to a drain sump, to keep above floor drain lines to a minimum. In UOPH's / UEPH's provide a floor drain in the laundry room. Do not provide floor drains in toilets with less than three water closets. Locate toilet drains under stall partitions and shower (dressing areas) drains in front of showers except for private showers.

3.5.7.4 Do not provide floor drains for Hangar areas of major hangars, shelters, or docks used as a closed wash rack. Slope floors 1 vertical to 150 horizontal to a steel grate-covered trench drain just inside of the door. Detailed instructions will be provided as needed.

3.5.7.5 Provide all buildings with a minimum of two outside wall hydrants or yard hydrants in accordance with TM 5-810-5/AFM 88-8. Where concealment of hydrant and piping is required but not feasible, use yard hydrants.

3.5.7.6 Coat and wrap all underground air piping. For industrial uses provide standard weight black steel pipe with malleable iron fittings. Intake piping to air compressors shall be nonmetallic or corrosion resistant.

3.5.7.7 Chrome plate all exposed piping in Air Force and Army kitchen scullery areas. Make every effort to keep piping out of kitchen mopping area.

3.5.7.8 Show stop valves on the drawings for all equipment supply and return connections for normal maintenance and replacement.

3.5.7.9 Vent domestic dryers with 100mm (4-inch) ducts and commercial dryers with 200mm (8-inch) ducts. For a dryer, duct runs of more than 3 meters or with more than two elbows and duct rises of more than 2 meters requires the use of supplemental powered exhaust to provide sufficient duct velocity to move the lint exhausted by the dryer. Equip sleeves through the wall with hood and back-draft damper constructed of aluminum or stainless steel.

3.5.7.10 Provide reduced pressure backflow preventer to isolate all potential point sources of toxic chemicals. Mount the backflow preventer in an accessible location in accordance with the National Standard Plumbing Code.

3.5.7.11 Roof drainage rainfall intensity rate and duration frequency guidance is in Chapter II of these Engineering Instructions. Use 15-minute peak and see the National Standard Plumbing Code for drainage calculations.

3.5.8 Fire Protection: MIL-HDBK-1008B is the basic design standard with AFFF systems designed to Air Force ETL 90-10 and Army ETL 1110-3-411.

3.5.8.1 Original designs require the services of a qualified fire protection engineer. Requirements are detailed in Southwestern Division Numbered Criteria Letters Part XI, Chapter 1, Letters 1-28, 1-29, and 1-30.

3.5.8.2 Hand fire extinguishers are furnished by the installation.

3.5.8.3 Design requirements:

3.5.8.3.1 Total Design; Provide a separate plan for the fire protection sprinkler system including one section through the sprinkled area. Show on the plans the available water supply GPM and pressure, riser locations, area classification design densities, seismic requirements, type sprinkler heads, and other appropriate items. Obtain water flow test data from the Base Civil Engineer or DEH. Show on the plans the total pressure (include the pressure drop through the backflow preventer, as high as 100 kPa) of the sprinkler system and show on the plans the total water demand of the sprinkler system (including hose stream requirements). Compare the flow test data to the water requirements to determine the supply pipe size and the need for fire pumps and water storage. Size underground pipe. Provide complete calculations in the Project Engineering and Project Definition submittal.

3.5.8.3.2 Performance design; In most cases performance designs are no longer allowed by the Air Force commands. Do

not provide a performance design unless approved by the Air Force. If performance design is allowed, do not show sprinkler heads or branch piping on the plans unless specifically requested. Indicate on plans the available water flow and residual pressure and the static pressure of the main. Indicate area classification, design densities, seismic requirement, type sprinkler heads, and riser locations. Provide a separate plan for the fire protection system with a minimum of one section through the sprinkled area. Compare the flow test data to the water requirements to determine the supply pipe size and the need for fire pumps and water storage. Size underground pipe. Provide calculations in the concept submittal. For Project Definition submittals provide calculations showing whether or not a fire pump is needed.

3.5.8.3.3 Coordinate all fire alarm signaling devices required to provide a fully integrated fire alarm/protection system.

3.5.8.3.4 Backflow preventers. For Air Force and Army designs, provide backflow prevention in accordance with National Standard Plumbing Code.

3.5.8.4 Provide fire dampers as required by NFPA 90A. In addition provide fire dampers in 1-hour fire rated enclosures for shafts stairs, elevators, etc., heater/boiler rooms with flames, and storage areas containing combustible storage. Show all required fire dampers and access doors on the plans.

3.5.9 Heating:

3.5.9.1 Size boilers for individual plants per Engineer Technical letters, TI810-l0 (Army) and MIL HDBK 1190 (Air Force).

3.5.9.2 Hot-water systems: Use two-pipe reversed return systems whenever practicable. Pitch pipe up in the direction of flow where possible. Show pipe pitch and air vents at high points on drawings. Design piping system without pockets to prevent the accumulation of air and keep venting to a minimum number of high points. Provide sectionalizing valves for simplified maintenance.

3.5.9.3 Provide automatic air relief valves at all high points in piping systems.

3.5.9.4 In buildings heated by radiation, state minimum height of radiator bottom cover. Coordinate height with installation of electrical outlets to prevent any interference. Where necessary to clear electrical receptacles, install fin-tube radiators with the bottom of

radiator cover 400mm above the floor, space permitting. Coordinate heater space requirements with architectural when radiation heating is installed in toilet rooms. In quarters, offices, administrative and recreation buildings, equip hot water fin-tube radiators with solid front, slotted, sloping top covers. Provide thermostatic control of radiation heaters.

3.5.9.5 In runs of pipe 15 meters and longer or where required in shorter runs, indicate on project plans the location of all anchors, bends, laps and expansion loops to provide for pipe expansion.

3.5.9.6 Load factors for sizing steam traps are as follows:

Main drips	3
Pipe coils in still air	3
Pipe coils submerged in water	4
Unit heaters, blast coils, etc.	3
H. W. Generators, kettles, etc.	4
Autoclaves, sterilizers	5

3.5.9.7 Discharge multiple boilers induced draft fans into a common breeching or flue.

3.5.9.8 Provide controls for individual building condensate pumping units with the storage tank. Provide controls for boiler feed pumps with the boiler. Provide adequate receiver storage capacity.

3.5.9.9 For building pipe tunnel design, include details on plans showing proper support of piping. Minimum sizes of a tunnel to be 1.200 meters wide by 1.5 meters clear height. Comply with CEGS, AFR 88-44, Air Force and Army ETL's for Underground heat distribution systems. Force Protection requirements shall be met.

3.5.9.10 Indicate by note on the heating schedules or plans the entering air temperature, system pressure, entering and leaving hot water temperature, mounting height and/or other information. The above is required to enable contractors to make proper selection of radiation heaters, unit heaters, heating coils and other equipment.

3.5.9.11 Controls for heating systems: See paragraph 3.5.14.7

3.5.10 Fuels:

3.5.10.1 Fuels used for cooking at individual installation are covered by special instruction for each project.

3.5.10.2 For Army, select space heating fuels per AR 420-49, HQUSACE TI 800-01, and SWD Criteria Letters.

3.5.10.3 Fuel selection for Air Force is to be in accordance with specific project data, and MIL-HDBK 1190, and Air Force ETL's.

3.5.10.4 Do not use electric resistance heating for comfort applications unless justified by life cycle cost analysis.

3.5.11 Boiler, Utility and Equipment Rooms:

3.5.11.1 Ensure that the floor plan includes adequate space (including headroom and maintenance) for mechanical and electrical equipment regardless of any mechanical space requirements identified in programming documents. This must be carefully checked on standard designs. Ensure that building arrangements and equipment access for service and/or replacement of coils, tube bundles, motors and other equipment items are sufficient and shown to scale on the drawings. Arrange pipe connections to coils and equipment containing tube bundles (converters, hot water generators, water chillers, etc.) to allow pulling coil or tube bundles without disassembling piping. Separate boiler and heater rooms from refrigeration equipment as required by codes. In other cases provide an economic analysis to determine if installing fuel fired equipment in a boiler/heater room segregated from other equipment is cost effective based on room ceiling and fire damper savings.

3.5.11.2 Provide all fuel fired boiler/heater rooms with fixed combustion air louvers per requirements of NFPA 54. Do not locate louvers in boiler room doors, preferably locate high on a wall. Investigate the need for combustion air heating to prevent freeze-ups. Where utility or equipment rooms are small and heat producing equipment such as compressors, hot water converters, hot water generators, steam pressure reducing stations, etc., can cause high temperatures and possible damage to electric equipment in the room, provide a wall-mounted supply fan with a motorized intake louver. Size ventilation equipment for Army and Air Force for the greater of 20 air changes per hour or 5.5^{0}C (10^{0}F) rise for summer and 10 air changes per hour for winter. Arrange supply fan and louver to prevent short circuiting, and control fan by a wide differential thermostat set to operate fan and motorized louver when room temperature exceeds 32^{0}C (90^{0}F). Do not use the supply fan to supply combustion air.

3.5.12 Chimneys and Gas Flues:

3.5.12.1 Design Chimneys, stacks and flues on Army projects per TI 810-10, TM 5-810-6 and NFPA. Design Air Force projects per AFM 88-8/1, AFM 88-8/5, and NFPA.

3.5.12.2 Provide guyed steel stacks at Ammunition Depots for all explosives operations buildings and auxiliary buildings within explosives restricted areas, and all buildings within 5km of ammunition demolition sites.

3.5.12.3 Where ladders for chimneys or stacks are considered necessary, equip ladders over 9 meters in length with a basket guard or with ladder climbers' safety device.

3.5.12.4 Obtain stack height and size for load requirements from Technical Manual and NFPA.

3.5.12.5 Locate stacks as conveniently as possible, regardless of location shown on definitive drawings.

3.5.12.6 Provide boilers and furnaces 300,000 watts (1,000,000 BTUs) and larger and smaller plants with height restrictions, with steel stub stacks and induced draft fans.

3.5.13 Ventilation:

3.5.13.1 For designs use the most stringent of ASHRAE 62-89, USACE TI 800-01 for Army, MIL-HDBK 1190 for Air Force.

3.5.13.2 Toilet rooms require mechanical ventilation. Do not recirculate toilet room air. Provide large toilet and locker rooms with mechanical ventilation.

3.5.13.3 Provide an exhaust fan in laundry room of dormitories, barracks, and BOQ's. Provide laundry (Laundromat) for Army with thermostatically controlled fan and louver. Size two-speed fans to provide 20 air changes/hour summer and 10 air changes/hour winter.

3.5.13.4 To minimize roof penetrations wall mount exhaust fans should be used where possible.

3.5.13.5 Design kitchen exhaust hoods per NFPA 96.

3.5.13.6 Design all ventilation systems per NFPA Pamphlet Numbers 90A, 90B, 91, and 96, as applicable.

3.5.13.7 The minimum ventilation rates for Army refrigerant compressor rooms for walk-in and reach-in refrigerators shall be:

3.5.13.7.1 Air cooled condensing unit with integral condensers, 400 L/s (800 CFM) of air per 750 watts (horsepower) nameplate rating, plus liter per second (CFM) required for other equipment.

3.5.13.7.2 Water cooled condensers or remote air cooled condensers, 40 L/s (80 CFM) of air per 750 watts (horsepower)nameplate rating, plus liter per second (CFM) required for other equipment.

3.5.14 Air-conditioning.

3.5.14.1 Design per Engineering Manuals, ASHRAE Handbooks, Engineering Technical Letters, NFPA, CEGS engineering notes, project book and special instructions for individual projects. Army criteria are also per the USACE TI 800-01. Air Force criteria are also per MIL HDBK 1190. Follow latest guidance regarding CFCs.

3.5.14.2 Design all air-conditioning per NFPA Pamphlet Numbers 90A, 90B, and 101.

3.5.14.3 For Army designs do not use corridors as a supply, return, or exhaust air plenum regardless of the type of occupancy. Corridors may be used as return plenum in rehab designs where no feasible space is available to install return ducts. For Air Force designs corridors may continue to be used as return air plenum for air-conditioning systems but must be equipped with fire detectors of type and location as indicated in MIL-HDBK 1190 and AF ETL's.

3.5.14.4 Air Force computer facility’s designs are per specific design-instructions and MIL-HDBK 1190, as applicable.

3.5.14.5 For occupancy diversity factors in quarters refer to USACE TI 800-01 for Army and MIL-HDBK 1190 for Air Force. Also, refer to the Engineering Instructions for type of quarters.

3.5.14.6 In general, standby air-conditioning units are not allowed and require a request for waiver of criteria. Refer to USACE TI 800-01 for Army, MIL-HDBK 1190 for Air Force, and Design Guide for U. S. Army Reserve Centers. Economic justification is required whether or not a waiver is necessary.

3.5.14.7 Provide HVAC control sequences, schematics and ladder control diagrams on drawings and coordinate with specifications. Air Force designs are per ETL 83-1, 83-1 change 1, or TI 810-11 and CEGS 15950 (HVAC Control Systems, Single Loop digital controls (SLDC) and other systems as

directed by command see Air Force projects below). Army designs are per CEGS 15950 and TI 810-11. Deviations to this must follow options for ARMY PROJECTS below. Options and necessary procedures for HVAC Controls packages follow.

3.5.14.7.1 Air Force Projects

3.5.14.7.1.1 Installation desires HVAC controls to be Direct Digital Controls (DDC) and tied into the existing energy Monitoring Control System (EMCS) in the future.

3.5.14.7.1.1.1 Option 1. User must request a waiver through their command and receive authority for sole source procurement of control equipment.

3.5.14.7.1.1.2 Option 2. Provide controls design using the SLDC system with a contractor's option to provide a DDC system manufactured by the supplier of the base wide EMCS system

3.5.14.7.1.1.3 Option 3. If the user can provide the name of at least three (3) manufacturers who have DDC systems that have successfully interfaced with the base wide system, then specify these three manufacturers.

3.5.14.7.1.1.4 Option 4. If the installation has a multi-year procurement contract for DDC HVAC control hardware and software. The DDC hardware and software would then be government furnished by the installation to the construction contractor.

3.5.14.7.1.2 Installation desires DDC controls, but does have a known requirement for tying into a base EMCS. Competitive procurement for DDC controls under this circumstance needs only to be requested by the installation.

3.5.14.7.2 Army Projects

3.5.14.7.2.1 Installation desires HVAC controls to be DDC and be tied into the existing EMCS in the future. Options are the same as those for Air Force options 1 through 4, above.

3.5.14.7.2.2 Installation desires HVAC controls, but does have a known requirement for tying into a base EMCS. A waiver must be obtained per CESWD Numbered Criteria Letter V, 1-189.

3.5.14.7.3 Contract documents for HVAC control systems

3.5.14.7.3.1 Single Loop Digital Controls

3.5.14.7.3.1.1. Select Control Drawings from TI 810-11

3.5.14.7.3.1.2 Use CEGS 15950 for Control Specifications

3.5.14.7.3.1.3 Future tie-in to EMCS

3.5.14.7.3.1.3.1 Include EMCS Building Prep Specification, CEGS 13814

3.5.14.7.3.1.3.2 Provide Input-Output (I-O) summary for all items other than those shown on the SLDC control drawings. Clarify this by adding the following note to the bottom of the I-O Summary: **"All I-O points indicated on the HVAC control drawings shown to be 'available to the EMCS' shall be wired to the data terminal cabinet (DTC)."**

3.5.14.7.3.2 Direct Digital control

3.5.14.7.3.2.1 Control Drawings: DDC drawings (developed by Savannah District) are available through the District Engineering Manager. These drawings have the same logic as those in TI 810-11.

3.5.14.7.3.2.2 Use CEGS 15951 (Direct Digital Controls for HVAC Systems) for Control Specifications

3.5.14.7.3.2.3 Future tie-in to EMCS/UMCS

3.5.14.7.3.2.3.1 A DTC is required if other than HVAC I-O points are included (e.g. electric, gas, and water meter, etc

3.5.14.7.3.2.3.2 Use of Building Prep specification is required for specifying DTC, wiring to other than HVAC sensors and controls, pulse initiators for metering, etc.

3.5.14.7.3.2.4 Contractor option for SLDC or single manufacturer of DDC system compatible with installation's EMCS System. (For Air Force Option 2, above). Note use of this option shall be fully coordinated with the installation personnel responsible for controls maintenance. If this option is selected it will be fully documented in the 35% design analysis (points of contact, name and model of base wide EMCS system, etc.) and general note on the HVAC drawings stating to see specifications for option of DDC in lieu of SLDC.

3.5.14.7.3.2.4.1 Control drawings: SLDC package for each system shall be provided.

3.5.14.7.3.2.4.2 Specifications: Use Section 15950 and add the following after paragraph **1.2 GENERAL REQUIREMENTS:**

"1.2.1 OPTION TO SINGLE LOOP DIGITAL CONTROLS: In lieu of single loop digital controllers (SLDC) the contractor shall have the option of providing Direct Digital Controls (DDC) that are manufactured by (include name of EMCS manufacturer) and is capable of fully communicating with the (model and/or number) base wide Energy Monitoring and Control System (EMCS). If the DDC option is chosen, the following conditions apply:

1.2.1.1 All submittals shall meet those specified herein with the exception of the controller. The DDC hardware substituted for the SLDC shall be the most current model available at the time of contract award, which will function properly when connected to the specified EMCS system. A newer version of the DDC hardware can be provided, if the necessary hardware and software to make the interface with the existing base wide EMCS is also provided.

1.2.1.2 All hardware (sensors, wiring, dampers, etc.) shall meet the requirements herein specified.

1.2.1.3 All Control sequences shall be provided as specified or shown on the drawings. Commissioning procedures shall be followed as specified with references to SLDC substituted with DDC. Control point setpoints indicted on the drawings shall be capable of being changed by the operator at the field control panel, or a device (i.e. lap top computer) shall be provided as part of this contract to make changes to the set points prior to connection to the base wide EMCS system.

1.2.1.4 Connection to the base wide EMCS shall be capable of being made from a single location. All points specified or shown to be connected to the EMCS shall also be wired to this single location"

3.5.14.7.3.2.4.3 Specification 13814 (EMCS Building Prep): Replace paragraph 1.2.1 with the following:

"The contractor shall provide all services, material, and equipment necessary to prepare the control system to interface with the base EMCS when the Single Loop Digital Controls specified in Section 15950 is selected by the Contractor. When the Direct Digital Control System option is selected (see section 15950 paragraph 1.2.1), the requirements of this section shall be met, except

for the data terminal cabinet, which shall be replaced by an interface for connection to the existing EMCS. The Contractor shall demonstrate that all points, indicated on the drawings and required by the specifications, are capable of communicating with the base EMCS."

3.5.14.8 Provide an air flow schematic on the drawings showing a complete breakdown of the air distribution system including outside air, air supplied to the space(s), zone air flows and exhausted air. Utilize symbols for fans, dampers, diffuses, etc.

3.5.15 Mechanical Equipment Noise Control. Design to comply with the requirements of SWD criteria letter V 1-186, (Design Requirements to Control Noise Generated by Mechanical Equipment) and TM 5-805-4/AFM 88-37.

3.5.16 Fuel Supply:

3.5.16.1 Gas Piping Systems:

3.5.16.1.1 Provide gas meters.

3.5.16.1.2 Unless otherwise instructed, provide each building with an outdoor gas regulator with an automatic cutoff. Indicate on the project plans the normal inlet and outlet pressures, gas capacity and pressure setting of a full capacity relief valve. Provide an insulating coupling. Refer to CEGS.

3.5.16.1.3 Show gas piping on plumbing plans and designed per TM 5-8lO-6 (Army), AFM 88-8, Chapter 5 (Air Force), and NFPA No. 54.

3.5.16.1.4 L.P. gas system shall comply with NFPA and state codes.

3.5.16.1.5 Divide gas piping design work shown on drawings between site utilities plan and mechanical floor plan per the division of work in specification sections: Gas Distribution and Gas Piping.

3.5.16.2 Fuel Oil. Provide flow meters per criteria.

3.5.17 Refrigeration. Design refrigeration systems per the latest Guide Specifications, ARI and ASHRAE Standards, design guides, MIL-HDBK 1190 for Air Force and TM5-810-3 and the USACE TI 800-01 for Army.

3.5.18 Steam and High Temperature Water Systems:

3.5.18.1 Design systems per TI 8lO-10 for Army Projects and MIL-HDBK 1190 for Air Force and latest CEGS and ETLs.

3.5.18.2 Design systems wherever possible with expansion loops, bends and offsets instead of expansion joints to reduce maintenance and eliminate manholes on underground lines.

3.5.18.3 Read guide specifications notes before initiating design of underground steam distribution systems.

3.5.18.4 Show the location of existing utilities. Eliminate interference with new services, buildings, roads, etc.

3.5.18.5 Specifications for underground conduits require the contractor to provide a detailed design layout prepared by the system supplier. Therefore, show only location and size of pipe, anchors, expansion loops, Z-bends and L-bends on the design drawings. Also, provide the calculated millimeters of expansion in each direction at 90-degree bends and legs of loops so that the contractor can provide sufficient space for expansion.

3.5.18.6 Provide profiles for all underground distribution systems showing minimum cover of conduits under ditches, roads and railroads for protection from heavy traffic, etc.

3.5.19 Food Service Equipment:

3.5.19.1 Show all hood, water, sewer, air, gas, and steam connections for food service equipment. Insure those floor drains to service ice chests, refrigerators, cold pans, steam kettles and similar items are provided. Allow space on drawings to show all connections. Piping will be located in crawl spaces under kitchen area unless directed otherwise. Coordinate equipment and utility connection size with the architectural equipment list.

3.5.19.2 Use the District's latest Food Service Equipment Guide Specification.

3.5.20 Medical Facilities:

3.5.20.1 Design Air Force facilities per MIL-HDBK 1191 and as otherwise directed by the command.

3.5.20.2 Design Army facilities per MIL-HDBK 1191 and DOD 4270.1-M dated 15 Dec. 1983 or as otherwise directed.

3.5.20.3 HQUSACE will provide special instructions for selecting and specifying kitchen equipment, medical equipment and government furnished equipment.

3.5.20.4 Provide water softening where required by TM 5-813-3 and MIL-HDBK 1190. Pipe soft water to all sterilizers and other medical equipment requiring cold water, and to entire hot-water system.

3.5.20.5 Size the utility services to all equipment.

3.5.20.6 Do not supply steam from boilers that could be chemically treated to equipment using direct steam such as sterilizers, humidifiers and food service equipment.

3.5.21 Design sewer and water treatment plants and sewer lift stations per criteria provided for each project and per applicable Technical Manual.

3.5.22 Solar Design:

3.5.22.1 Inside and outside design conditions are the same as noted in the paragraphs on Heating above.

3.5.21.2 Weather data is provided by "Input Data for Solar Systems" dated November 1978 and prepared by the Department of Energy and the National Oceanic and Atmospheric Administration, or as otherwise identified by ETL's.

3.5.22.3 Economic analysis is per applicable ETL's. Use generic studies or SOLFEASE whenever possible. For additional information the A-E should request from the COE supervising district a Generic Active Solar Feasibility Study for the Continental United States and computer program users manual for the Economic Analysis Computer Program On Life Cycle Costs In Design by Linda K.Lawrie and Dwight A. Beranek.

3.5.22.4 Design solar per Engineering Manuals, ASHRAE Handbook of Fundamentals, ASHRAE 93-77, ASHRAE 94-77, DOE Facilities Solar Design Handbook, Design of Solar Heating and Cooling Systems (CERL TR-E-139) by Construction Engineering Research Laboratory, special engineering instructions and ETL's.

3.5.22.5 Do not use safety factors in calculations or for sizing equipment.

3.5.22.6 Provide a solar panel efficiency curve based on net square feet of panel on the contract drawing.

3.5.22.7 Freeze Protection/Reduction of Freeze Damage. Design shall limit damage due to freezing temperatures by use of heat tape, antifreeze mixtures, etc.

3.5.23 Energy Monitoring and Control Systems:

3.5.23.1 Design per TI 811-12, guide specifications, cost estimating guidelines, and any special requirements issued by command for Air Force projects.

3.5.23.2 Coordination with the District's EMCS Technical Coordinator is mandatory and must be through the COE technical manager.

3.5.23.3 Coordinate the expansion of an existing EMCS for either single or multiple buildings, with the district and the base EMCS Technical Coordinator prior to Concept/Early Preliminary submittal.

3.5.23.4 Procurement regulations require the connection to a central EMCS/UMCS system to be by a standalone-negotiated contract.

3.5.24 Underground Petroleum Products Storage and Dispensing Systems. Design requirements for these systems are included in Guide Specification CEGS-11140 (Fueling System, Service Station Type) and include double wall tanks and piping, coatings, and cathodic protection, leak detection systems, etc. Other underground petroleum product containers also require the above features. See the plates in the Structural chapter for underground tank foundation/buoyancy requirements.

3.5.25 Ductwork: The Air Supply and Distribution guide specification note for sheet metal ductwork requires the pressure classification, including points of changes in pressure classification, to be noted on the drawings for duct systems (supply & return) per SMACNA. Indicate pressure classification for each 250Pa (1-inch).

4. **ENERGY AND ECONOMIC STUDIES**:

4.1 **Economic Studies**:

4.1.1 The following economic feasibility studies are required for Army and Air Force designs: general design studies, extraordinary energy saving studies, solar studies, and energy conservation investment Program (ECIP) studies.

4.1.2 Basic requirements for general design studies are included within TM 5-802-1 and the USACE TI 800-01. Special

requirements for extraordinary energy saving, solar, and ECIP studies are established by statute or executive order.

4.1.3 Basic criteria and standards requiring Army and Air Force economic studies are contained in regulations entitled "Economic Analysis and Program Evaluation for Resource Management," AR 11-28 and AFR 178-1, respectively.

4.1.4 Supplemental criteria/standards, and guidance are provided in TM 5-802-1, USACE TI 800-01, TI 810-10, MIL HDBK 1190, Air Force general design guidance, applicable Army and Air Force ETLs, and USARC Design Guidance.

4.1.5 Additional guidance providing minimum report requirements is published by the Fort Worth District. This document is available upon request.

4.1.6 Two computer programs developed by the Construction Engineering Research Laboratory (CERL) incorporating current economic methodology are available for purchase and use by anyone performing Government work. Life Cycle Cost in Design (LCCID) and Solar Feasibility (SOLFEAS) can be ordered directly from CERL (phone 1-800-UI-BLAST). Current costs, availability and other information are available at http://www.bso.uiuc.edu/blastmain.htm LCCID describes the input required for a computer economic analysis of any of the studies described above. SOLFEAS describes the input data required for a computer analysis of the performance of a typical active solar assist system and the economic feasibility of the system. The ECOLIF, SOLRLIF, and SIZNCSI Programs are no longer being updated with the current regional fuel escalation rates or prices. If these programs are used, the regional data must be updated. Sources of supply for copies of computer analysis programs may be obtained from the COE technical manager.

4.1.7 In general the economic analysis portions of industry based computer energy analysis programs do not conform to Air Force/Army methodology requirements. Before making an economic analysis using industry programs, proprietary programs, or manual methods, approval of the economic analysis methodology must be obtained from the district.

4.1.8 Fuel Costs: Life cycle cost analyses for specific projects shall include input of current actual energy costs from the particular Air Force Base or Army installation.

4.2 **Energy Studies**:

4.2.1 Requirements for energy studies are per the USACE TI 800-01, MIL-HDBK 1190 respectively for Army and Air Force and per ETLs and general design guidance.

4.2.2 Note that energy studies are related to, but entirely different from, general design economic studies. Energy studies are conducted after the general design studies, require separate and distinct annual energy consumption estimates, and may dictate extraordinary energy saving economic analysis of a different set of alternatives.

4.3 Alternative Systems:

4.3.1 The designer shall submit the following recommendations for approval by the Districts within 10 working days after the predesign conference (or Pre-Project Definition or Project Engineering conference) or after award of the Architect-Engineer contract or design build contract, whichever is earlier:

4.3.1.1 Proposed alternatives for building, equipment, systems, and component items which will be evaluated. Evaluate a minimum of three applicable HVAC alternatives or provide justification of study for fewer systems for approval.

4.3.1.2 A description of the software/methods/systems that will be used to perform the energy studies.

4.3.1.3 The extent to which previous energy studies will be used to satisfy study requirements.

4.4 **General Design Studies, Energy Studies**: Use a technical engineering report format in the presentation of the study. The report shall be a standalone document written for an audience that is unfamiliar with the project plans, specifications and design analysis. The minimum report shall contain:

4.4.1 A discussion of what was studied and why it was studied.

4.4.2 A discussion of calculation methods including, all input data, method of calculation, and output.

4.4.3 A discussion of the results, conclusions derived, and recommendations. Include tabulated results of various alternatives.

4.4.4 Calculations included in an appendix. Document any computer calculations as required by the SWD AEIM for design analysis.

4.4.5 Report format shall generally be as follows:

4.4.5.1 Summary

4.4.5.2 Introduction

4.4.5.3 Conclusions

4.4.5.4 Recommendations

4.4.5.5 Text (Main Body of Report including results)

4.4.5.6 Appendices

4.4.6 A one line scaled building sketch showing HVAC zoning.

4.4.7 A sample (previous) report (if available) may be obtained from the COE Technical Manager for guidance in preparing the study reports.

5. **DESIGN ANALYSIS**:

5.1 **Project Definition (Air Force), Project Engineering (Army), and Concept (Army) submittals** (10 to 35% design) shall contain information as defined by following Chapter IX, Part V. Address general parameters, functional and technical requirements, design objectives and provisions, and economic justification for the systems proposed and/or evaluated. Provide block heating and air-conditioning loads, quantity of plumbing fixtures, adequacy of water, gas and sewer connections, ventilation system capacities, domestic hot water requirements, and characteristics of other systems to enable the reviewer to have a clear understanding of all work.

5.2 **Final Submittal** shall include calculations and be complete and contain information as defined by Chapter IX, Part V. Provide manual block heating and cooling load calculations to confirm the hour by hour computer run. The manual block load calculations can be run on the computer but must be based on the manual method. Provide a narrative in the design analysis giving the percentage difference between the manual block load calculation and the equivalent computer run calculation and justification for the differences.

5.3 **Medical facility design analysis** submittal requirements are per DOD 4270.1M for Army and AFR 88-50 for Air Force.

5.4 **Special Projects** are per specific instructions or as indicated above if special instructions are not furnished.

6. **MECHANICAL CHECKLIST** - Reference Appendix C for a checklist of recurring deficiencies. Mechanical Design/Review checklists should be requested from the district.

APPENDIX A

CHAPTER V

EQUIPMENT SELECTION DATA SHEET
EQUIPMENT SELECTION

CONTRACT SCHEDULE EQUIPMENT NAME AND I.D._____

REQUIRED CAPACITY_____

1. MANUFACTURER/ADDRESS/PERSON CONTACTED/PHONE NUMBER

_____
_____
MODEL NO._____ CAPACITY_____
SIZE L_____W_____H_____ WEIGHT_____
SERVICE CLEARANCE: ITEM_____ L_____W_____H_____
REMARKS_____

2. MANUFACTURER/ADDRESS/PERSON CONTACTED/PHONE NUMBER

_____
_____
MODEL NO._____ CAPACITY_____
SIZE L_____W_____H_____ WEIGHT_____
SERVICE CLEARANCE: ITEM_____ L_____W_____H_____
REMARKS_____

3. MANUFACTURER/ADDRESS/PERSON CONTACTED/PHONE NUMBER

_____
_____
MODEL NO._____ CAPACITY_____
SIZE L_____W_____H_____ WEIGHT_____
SERVICE CLEARANCE: ITEM_____ L_____W_____H_____
REMARKS_____

4. MANUFACTURER/ADDRESS/PERSON CONTACTED/PHONE NUMBER
_____
_____
_____
_____
MODEL NO._____ CAPACITY_____
SIZE L_____W_____H_____ WEIGHT_____
SERVICE CLEARANCE: ITEM_____ L_____W_____H_____
REMARKS_____

APPENDIX B
CHAPTER V

INDEX OF MECHANICAL SCHEDULES/DETAILS

AIR HANDLING UNIT SCHEDULE				
SYMBOL		AHU-1	MZ-1	
FAN	TOTAL AIR L/s			
	OUTSIDE AIR L/s			
	EXTERNAL S.P. Pa			
COOLING COIL	COIL AIR L/s			
	ENTERING AIR D.B. °C			
	ENTERING AIR W.B. °C			
	SENSIBLE W			
	COIL TOTAL W			
	COIL L/s @ P.D. kPa			
	MAX COIL FACE VEL m/s			
	CHILLED WATER TEMP °C			
HEATING COIL	COIL AIR L/s			
	ENTERING AIR D.B. °C			
	H.W. COIL CAP. W			
	COIL L/s @ P.D. kPa			
FILTER TYPE				
MIN FAN W				
ELECTRICAL				
REMARKS			ZONE - L/s	

AIR HANDLING UNIT SCHEDULE

EVAPORATIVE COOLER SCHEDULE							
SYMBOL	L/s	EXT. S.P. Pa	ELECTRICAL		PUMP		REMARKS
			W	VOLT/PH	L/s	VOLT/PH	
EC-1							

EVAPORATIVE COOLER SCHEDULE

WARM AIR FURNACE SCHEDULE			
SYMBOL		WAF-1	
FAN	TOTAL AIR L/s		
	EXTERNAL S.P. Pa		
	MIN FAN W		
	FAN ELECTRICAL		
DX COILING	COIL AIR L/s		
	ENTERING AIR D.B. °C		
	ENTERING AIR W.B. °C		
	SENSIBLE LOAD W		
	TOTAL LOAD W		
	MIN SEER	SEE SPECIFICATIONS	
	COND UNIT kW		
	COND UNIT ELECTRICAL		
FURNACE	MIN OUTPUT W		
	ENTERING AIR D.B. °C		
	MIN A.F.U.E.		
	FUEL TYPE		
FILTER TYPE			
REMARKS			

WARM AIR FURNACE SCHEDULE

GAS FIRED MAKE-UP AIR UNIT SCHEDULE							
SYMBOL	OUTPUT W	FUEL	TOTAL L/s	ST. PRES. Pa	ELECTRICAL		REMARKS
					W	VOLT/PH	
UHGM-1							

GAS FIRED MAKE-UP AIR UNIT SCHEDULE

FAN SCHEDULE								
SYMBOL	Air Flow L/s	TYPE	MAX O.V. m/s	EXT. S.P. Pa	DRIVE	ELECTRICAL		REMARKS
						W	VOLT/PH	
EF-1								

FAN SCHEDULE

FAN SOUND POWER LEVELS (db RE 10^{-12} WATT)									
SYMBOL	DESCRIPTION	FAN OCTAVE BAND CENTER FREQUENCY Hz							
		63	125	250	500	1000	2000	4000	8000

FAN SOUND POWER LEVELS

PUMP SCHEDULE						
SYMBOL	SERVICE	FLOW L/s	HEAD kPa	ELECTRICAL		REMARKS
				W	VOLT/PH	

BCP - BOILER WATER CIRCULATING PUMP
CP - CONDENSER WATER PUMP
CHP - CHILLED/HOT WATER PUMP
CWP - CHILLED WATER PUMP
DCP - DOMESTIC HOT WATER CIRCULATING PUMP
HWP - HEATING WATER PUMP
DOM - DOMESTIC COLD WATER PUMP

PUMP SCHEDULE

HOT WATER BOILER SCHEDULE					
SYMBOL	GROSS OUTPUT W	OPERATING TEMP °C	OPERATING PRES. kPa	FUEL	REMARKS
B-1					

HOT WATER BOILER SCHEDULE

DUCT HEATER SCHEDULE						
SYMBOL	CAPACITY W	TOTAL AIR L/s	ENT. AIR D.B. °C	ENT. WTR TEMP °C	COIL L/s @ P.D. kPa	REMARKS
DH-1						

DUCT HEATER SCHEDULE

HOT WATER HEATING & VENTILATING UNIT SCHEDULE									
SYMBOL	CAPACITY W	COIL L/S @ P.D. kPa	TOTAL AIR L/s	OUTSIDE AIR L/s		EXT. S.P. Pa	ELECTRICAL		REMARKS
				MIN	MAX		W	VOLT/PH	
HVW-1									

HOT WATER HEATING & VENTILATING UNIT SCHEDULE

GAS FIRED HEATING & VENTILATING UNIT SCHEDULE									
SYMBOL	INPUT W	FUEL	TOTAL L/s	OUTSIDE AIR L/s		EXT. S.P. Pa	ELECTRICAL		REMARKS
				MIN	MAX		W	VOLT/PH	
HVG-1									

GAS FIRED HEATING & VENTILATING UNIT SCHEDULE

GAS FIRED WALL HEATER SCHEDULE					
SYMBOL	INPUT W	AIR FLOW L/s	ELECTRICAL		REMARKS
			W	VOLT/PH	
GFWH-1					

GAS FIRED WALL HEATER SCHEDULE

CONVECTOR SCHEDULE						
SYMBOL	TYPE	CAPACITY W	FLOW L/s	ENT. AIR TEMP °C	ENT. WTR TEMP °C	REMARKS
CONV-1						

CONVECTOR SCHEDULE

GAS FIRED UNIT HEATER SCHEDULE					
SYMBOL	INPUT W	AIR FLOW L/s	ELECTRICAL		REMARKS
			W	VOLT/PH	
GFUH-1					

GAS FIRED UNIT HEATER SCHEDULE

PACKAGED AIR COOLED CHILLER SCHEDULE		
SYMBOL	PACCH-1	
CAPACITY kW		
CHW FLOW L/s		
WATER TEMP OUT °C		
MAX EVAP P.D. kPa		
EVAP FOULING FACTOR	0.00025	
AMBIENT TEMP °C		
COND FAN W		
MIN. COP		
MIN. IPLV		
ELECTRICAL		
REMARKS		

PACKAGED AIR COOLED CHILLER SCHEDULE

WATER COOLED CHILLER SCHEDULE		
SYMBOL	WCCH-1	
CAPACITY kW		
CHW FLOW L/s		
EVAP LWT °C		
MAX EVAP P.D. kPa		
EVAP FOULING FACTOR	0.00025	
CONDENSING TEMP °C		
COND WATER FLOW L/s		
COND EWT °C		
MAX COND P. C. kPa		
COND FOULING FACTOR		
MIN. COP		
MIN. IPLV		
ELECTRICAL		
REMARKS		

WATER COOLED CHILLER SCHEDULE

COOLING TOWER SCHEDULE							
SYMBOL	AMBIENT W.B. °C	WATER TEMP °C		COND. WTR L/s	ELECTRICAL		REMARKS
		IN	OUT		W	VOLT/PH	
CT-1							

COOLING TOWER SCHEDULE

AIR COOLED CONDENSER SCHEDULE							
SYMBOL	NET REFRIG. EFFECT W	TEMPERATURE °C			ELECTRICAL		REMARKS
		SUCTION	AMBIENT	CONDENSING	W	VOLT/PH	
ACC-1							

AIR COOLED CONDENSER SCHEDULE

AIR COOLED CONDENSING UNIT SCHEDULE						
SYMBOL	NET REFRIG. EFFECT W	AMB. AIR TEMP °C	SAT. SUC TEMP °C	ELECTRICAL		REMARKS
				KW	VOLT/PH	
ACCU-1						

AIR COOLED CONDENSING UNIT SCHEDULE

REFRIGERANT COMPRESSOR SCHEDULE		
SYMBOL	RC-1	
CAPACITY W		
SUCTION TEMP °C		
CONDENSING TEMP °C		
ELECTRICAL		
CAPACITY REDUCTION		
REMARKS		

REFRIGERANT COMPRESSOR SCHEDULE

PLUMBING FIXTURE SCHEDULE (Sizes in mm)						
SYMBOL	DESCRIPTION	COLD WATER	HOT WATER	VENT	WASTE	REMARKS (SEE SPECS FOR SUPPORTS)
P-1	WATER CLOSET	25	-	50	100	
P-2	WATER CLOSET HANDICAPPED	25	-	50	100	
P-3	URINAL	20	-	32	50	
P-5	LAVATORY	15	15	32	32	
P-6	LAVATORY WHEELCHAIR	15	15	32	32	
P-8	SERVICE SINK	15	15	40	80	
P-13	SHOWER	15	15	-	50	
P-15	ELECTRIC WATER COOLER	15	-	32	32	0.008 L/s STD. ARI RATING TYPE PB-A-W

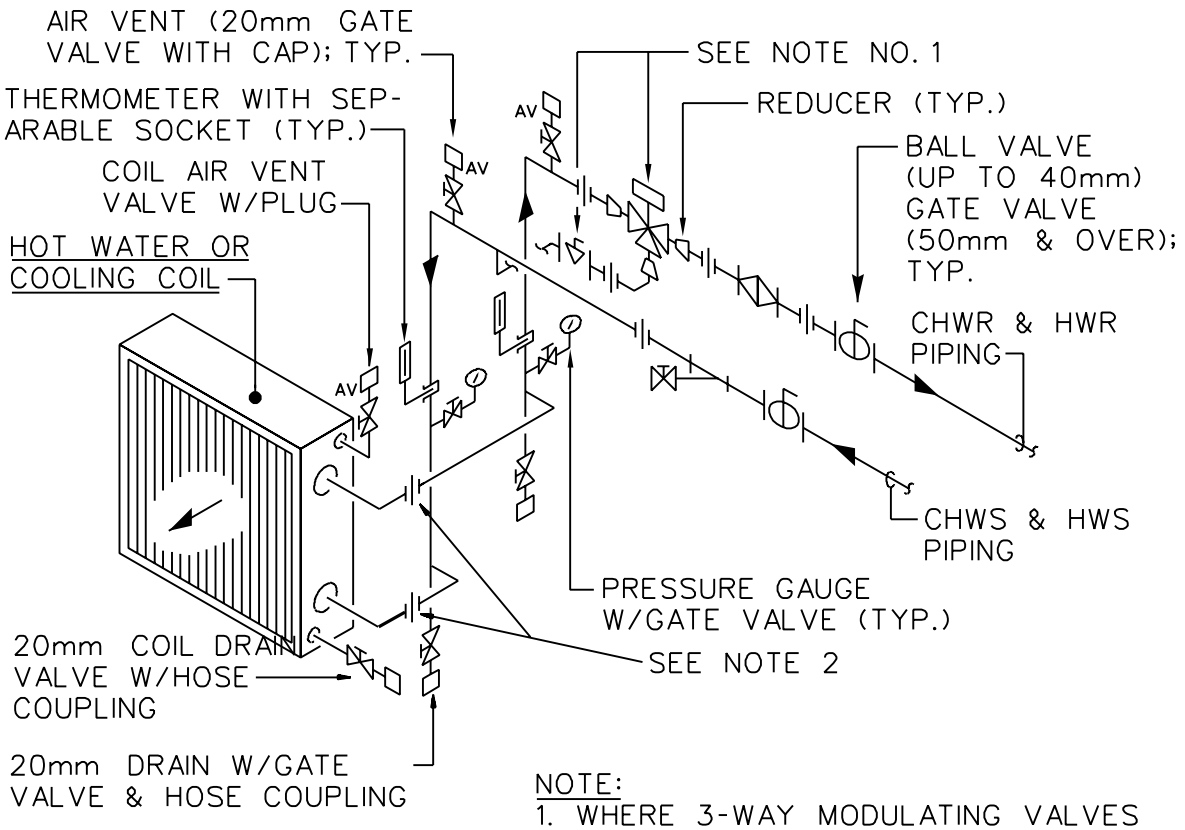
PLUMBING FIXTURE SCHEDULE

AIR COMPRESSOR SYSTEM SCHEDULE			
	AC-1		
TYPE			
NUMBER OF STAGES			
RATED AIR DELIVERY:			
-FLOW (L/s) AT			
-OPERATING PRESS (kPa)			
MAX. OPERATING PRESSURE (kPa)			
SAFETY VALVE SETTING (kPa)			
INLET CONDITIONS:			
-TEMPERATURE (°C)			
-PRESSURE (KPa)			
WATT			
ELECTRICAL (VOLTS/PHASE)			
AFTER COOLER TYPE			
RECEIVING TANK:	RT-1		
-CAPACITY (L)			
-NOMINAL SIZE (DIA. HEIGHT IN mm)			
WORKING PRESSURE			
DRYING UNIT:	DU-1		
-TYPE			
-ELECTRICAL (VOLTS/PHASE)			
NOTES:			

AIR COMPRESSOR SYSTEM SCHEDULE

DESIGN NOTES:

1. THIS SCHEDULE IS FOR SEPERATE AIR COMPRESSOR AND RECEIVING TANK. REMOVE THE SYMBOL RT-1 AND THE ENTRY FOR THE TANK NOMINAL SIZE IF A TANK MOUNTED COMPRESSOR IS USED.
2. DETAIL A VALVED SCHRADER CONNECTION FOR PERIODIC HOOKUP TO A NITROGEN BOTTLE FOR LINE PURGING/DRYING ON CONTROL AIR SYSTEMS.
3. COMPRESSOR INLET CONDITIONS SHALL REFLECT ALTITUDE AND PRESSURE LOSS OF ANY INLET PIPING OR FILTERS.
4. IF OTHER THAN AIR TYPE AFTER COOLER IS REQUIRED, INDICATE TYPE AND NOTE SOURCE OF COOLANT AND FLOW RATE.
5. NUMBER OF STAGES ON A RECIPICATING COMPRESSOR DIRECTLY AFFECTS HORSE POWER.
6. IF DUPLEX COMPRESSORS ARE REQUIRED, COORDINATE WITH SPECS. AND INDICATE IN NOTES (IE PROVIDE DUPLEX UNIT WITH EACH COMPRESSOR CAPABLE OF DELIVERING THE FLOW INDICATED.

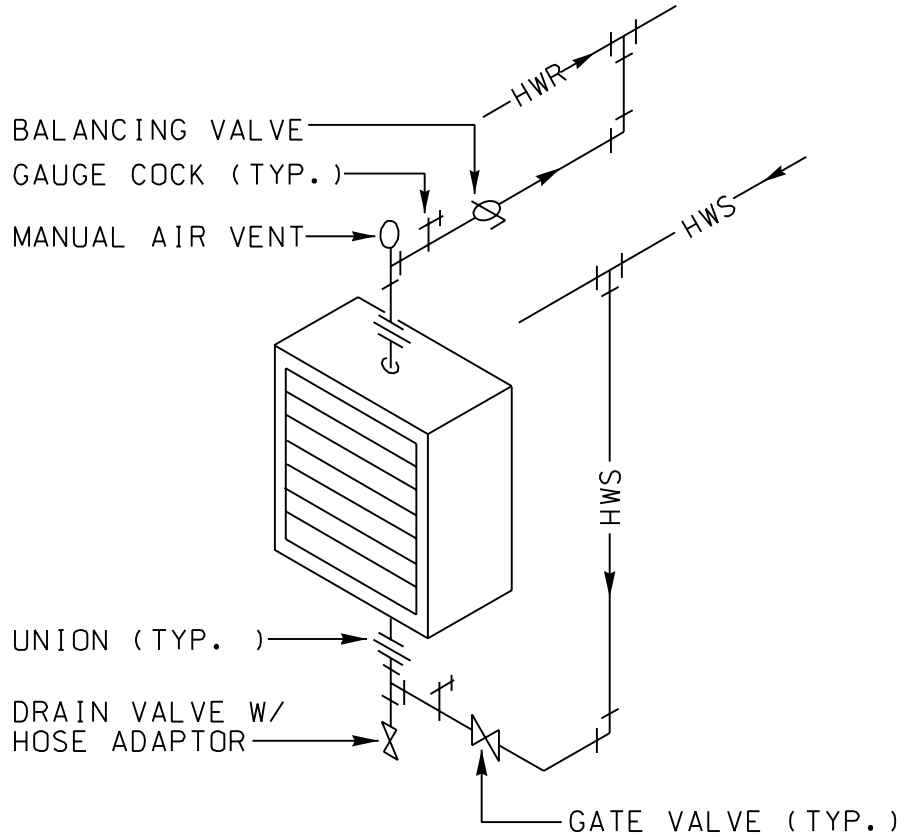


NOTE:

1. WHERE 3-WAY MODULATING VALVES ARE REQUIRED, PROVIDE ADDITIONAL PIPING & ACCESSORIES AS SHOWN.
2. OFF SET UNION CONNECTIONS TO ALLOW COIL REMOVAL.

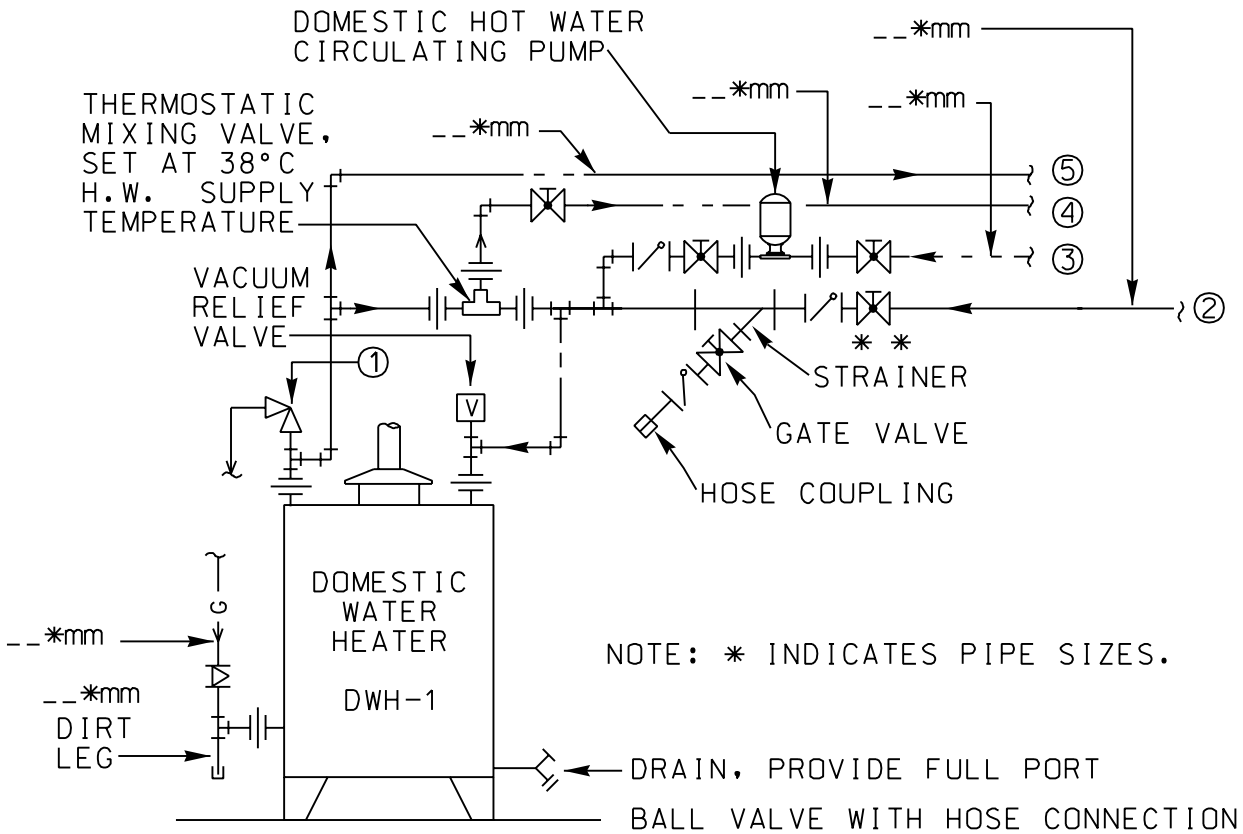
AIR HANDLING UNIT COIL PIPING SINGLE COIL CONNECTION

NOT TO SCALE



HOT WATER UNIT HEATER DETAIL

NOT TO SCALE



DOMESTIC WATER HEATER PIPING SCHEMATIC

NOT TO SCALE

KEYED NOTES:

① TEMP. AND PRESSURE RELIEF VALVE W/FULL SIZE DISCHARGE ROUTE TO FLOOR DRAIN.

② COLD WATER SUPPLY

③ HOT WATER RETURN

④ 38°C HOT WATER

⑤ 45°C HOT WATER TO KITCHEN SINK

* * NOTE TO DESIGNER
PROVIDE EXPANSION TANK IF
CHECK VALVE IS USED

APPENDIX C

CHAPTER V

RECURRING DEFICIENCY CHECKLIST

1. Must include piping, ductwork, and exhaust fan calculations in Design Analysis.

2. Must ventilation electrical closets in hospitals.

3. Use electrical resistance heating only where allowed by criteria.

4. The narrative portion of design analysis must be complete (design solution, system descriptions, etc., included).

5. Must identify drinking water coolers as to size or type.

6. Roof walkways must be provided for equipment.

7. Must provide fixed combustion louvers for equipment rooms.

8. Fire damper locations shown and any details coordinated with specifications.

9. Must show fire protection (sprinkler hazard) requirements.

10. Where Steam Humidifiers are used, together with steam-to-steam generators specifications must be provided.

11. Include information on drawings to allow contractor to provide optional hydraulic design of fire protection system, where contractor design is allowed by the installation.

12. Identify all existing equipment on rehabs and all government furnished equipment.

13. Must include seismic design when calculating "U" factor and equipment support.

14. Do not discharge a showerhead toward the shower door (opening).

15. Check location of mechanical equipment, ductwork, grilles, registers, etc., for interference with electrical, structural, and architectural features.

16. Coordinate equipment schedules between plans, design analysis, and, where needed, with specifications.

17. Show cleanouts on drawings in accessible locations and designate as floor or wall cleanout.

18. Plumbing waste, vents, and water piping locations shall agree on all plans and be coordinated with architectural and structural. Particularly check for water closets over beams.

19. Provide wall hydrants around the outside of the building. Locate per criteria.

20. In areas where expansive soil conditions exist, comply with expansive soil criteria.

21. Piping to equipment requiring coil or tube pulling shall be arranged to permit maintenance. Ensure adequate mechanical room clearances.

22. Assure proper routing of water lines and ductwork around electrical equipment such as panels, transformers, etc.

23. Verify adequate maintenance access and maintenance space for equipment.

24. Comply with the SWD criteria letter (V 1-186) on noise.

25. Provide complete mechanical legends to identify all piping, HVAC equipment, fixtures, etc.

APPENDIX D

CHAPTER V

EVAPORATIVE COOLING SYSTEM DESIGN CRITERIA

1. Evaporative Cooling. Use the following data as a basis for calculations:

a. Temperature Differential.

(1) Assume an efficiency of 80% (per specification requirement) for single stage cooler except in case of special air washers. Use multistage coolers when economically justified. Use special air washers of 90% efficiency when economically justified.

(2) Allowable Temperature Rise.

(a) For Air Force Installations: Allowable temperature rise is based on criteria in AFR 88-15.

(b) For Army use 27^0C (80^0F) as the target for the room leaving air temperature except that the temperature rise is to be not less than 4^0C (7^0F) where outdoor design wet bulb is 21^0C (70^0F) or less; but 3^0C (6^0F) rise may be employed on locations where the wet bulb is over 21^0C (70^0F).

(c) Outside design: 2 1/2% wet bulb column.

b. Controls. Provide control systems consistent with technical and functional requirements in combination with energy conservation policies.

2. Equipment.

a. Provide winterizing dampers on the discharge of each evaporative cooler.

b. Provide bleed-off provisions for the circulating water.

3. Design Analysis. The design analysis shall include evaporative cooling calculations. The submittal shall clearly show the design outside and inside dry bulb, wet bulb, and percentage relative humidity, and walls, glass, ceiling, occupants and lighting sensible heat gains for the space to be cooled. Calculations may be performed manually or with a computer program.