**PART 11**

# HVAC DESIGN

* 1. **DESIGN CRITERIA**.
     1. Design and install (labor, material, permits, licenses, etc.) the HVAC systems. HVAC systems shall be designed, installed, and tested in accordance with all Applicable Criteria located in Part 2.
     2. HVAC control schemes and sequences shall as a minimum meet the requirements of ASHRAE Standard 90.1, Energy Standard for Buildings – Except Low-Rise Residential Buildings. Provide system enhancements beyond the minimum requirements of ASHRAE Standard 90.1 2007 as required to meet energy conservation requirements in Section 01 02 00.0048 Part 12 - Energy Conservation.
     3. The Contractor is responsible for obtaining any available rebates from the utility and crediting those rebates to the Government in the bid.
     4. Piping systems shall be identified per ANSI requirements. Equipment shall be identified with engraved and laminated plastic nameplates or black lamicoid sheets with white lettering. VAV units or similar units are to be labeled at their underside to allow identification after installation. Valves shall be provided with tags and indexed to a master schedule.
     5. Heating installations shall include pressure stack natural-draft Class B vent or venting suitable for condensing flue gases required by the application.
     6. The design of HVAC systems with respect to noise and vibration control shall be in accordance with ASHRAE HVAC Applications.
     7. Exhaust vents for all buildings shall have low leakage dampers and be located at least 15 feet from outdoor air intakes in accordance with UFC 4-010-01 and UFC 4-171-05 Section 3-8.5 requirements to prevent short-circuiting of exhaust air.
     8. All materials and equipment shall be the standard cataloged product of manufacturers regularly engaged in production of such materials and equipment, and shall be the manufacturer’s latest standard design.
     9. The Contractor shall comply with minimum Antiterrorism/Force Protection criteria in accordance with UFC 4-010-01 requirements to include locating outdoor air intakes at least 10 feet above grade with low leakage dampers. Contracting Officer will designate the locations of the emergency air distribution shut-off switches.
     10. No roof-mounted equipment is permitted except for equipment serving the kitchen.
     11. Equipment layout shall make provisions for manufacturer’s recommended clearance and code requirements.
     12. Select mechanical equipment utilizing replacement HFC-type refrigerants unless the equipment is only available with HCFC-type refrigerants. Equipment utilizing CFC-type refrigerants shall not be used. The Government preference is to not utilize HCFC-22 and other HCFC-type refrigerants.
     13. The HVAC systems listed in this part have proven in the past to provide reasonable efficiency (i.e. meet EPACT 2005) when coupled with minor envelope improvements. To meet increasing energy goals these systems may need to be enhanced (energy recovery, demand controlled ventilation, economizers, more envelope improvements) or substituted with systems such as ground source heat pumps (VRF systems are not permitted); however the general zoning capability of the systems listed in this part shall be maintained if a substitute system is proposed. Section 01 02 00.0048 Part 12 - Energy Conservation further details the energy requirements of this project.
  2. **DESIGN CALCULATIONS.**
     1. **Load Calculations.** Provide a design narrative and calculations as indicated in the Army Reserve Design Process and Submittal Requirements. Heat gain and loss calculations shall be, at a minimum, in accordance with the current edition of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals and the latest edition of the ASHRAE Cooling and Heating Load Calculation Manual. The load calculations shall be in accordance with ASHRAE Non-residential Cooling and Heating Load Calculations. Calculations shall be performed on a room-by-room basis. Heating load calculations shall not consider lights or internal loads as supplementing the heating system. Clearly describe the features of the systems being used. Demonstrate compliance with ASHRAE 90.1 2007 by completing the proper compliance forms available from ASHRAE. Summarize the outdoor and indoor design conditions used. State the design objectives and design assumptions to provide a comfortable building environment within ASHRAE 55 requirements. Outline design decisions made that affect the operation and maintenance of the systems. Provide all calculations used to support equipment selections, including but not limited to items such as; hydronic piping analysis, duct design analysis for air handler selection, air separator selection, utility service piping selection, boiler and chiller loads, etc. Calculations shall be checked for accuracy and initialed or signed by the design professional. The method of zoning the building spaces used for computerized building load calculation input shall be clearly shown as part of the calculations
     2. The cooling coil load shall be calculated at the cooling outside design condition and the 0.4% Dew Point / Mean Coincident Dry bulb condition (Dehumidification). The equipment shall be designed for the greater of the two cooling loads.
     3. **Outside Design Conditions.** Obtain outside design conditions for cooling and heating from the ASHRAE Handbook – Fundamentals, and in accordance with UFC 4-171-05 Design Guide for Army Reserve Facilities. The 1% dry bulb temperature with mean coincident wet bulb temperature shall be used for the cooling outside design condition. The 0.4% dew point temperature with the mean coincident dry bulb temperature shall be used for the high wet bulb cooling outside design condition. The 99% dry bulb temperature shall be used for the heating outside design condition. [RFP Preparer: Note climate zone of project. If weather data for project site indicates area is a humid area (wb temperature >67 for more than 3,000 hours or wb>73 for more than 1,500 hours) then specific humid area design must be performed. Humid area design includes more stringent outdoor design conditions (.4% dew point/MCWB) outdoor design and equipment selection), use of specific system types, and other considerations. Refer to UFC 3-410-01FA HVAC. Revise allowed HVAC systems as required for humid areas.]
     4. **Heating and Cooling – Design Conditions**: Refer to UFC 4-171-05 Design Guide for Army Reserve Facilities for Specific Space Criteria.
     5. **Occupancy Loads**: The sensible and latent loads for the occupied spaces shall be in accordance with the ASHRAE Handbook – Fundamentals. The number of people shall be determined by using UFC 4-171-05 and ASHRAE recommendations.
     6. **Lighting Load**: Fixture count and heat release data shall be used to calculate the lighting loads in each space.
     7. **Equipment Loads**: A 1.5 watt per square foot allowance shall be included for open office spaces. A 200 watt allowance shall be included for each computer workstation in private and semi‑private offices and Learning Centers. A 100 watt allowance shall be included for each desk and instructor position indicated on the furniture plans to accommodate laptop computers in classrooms. Refer to the Army Reserve IT Manual for equipment loads within TER, TR and other similar computer server rooms.
     8. Refer to UFC 4-171-05 for ventilation requirements, such as within toilets, showers, mechanical rooms, unit storage areas, arms vaults, vehicle maintenance bays, and other specific areas. Refer to the Army Reserve IT Manual for ventilation requirements within TER, TR and similar computer room spaces.
  3. **HVAC SYSTEMS – TRAINING CENTER AND SIMILAR BUILDINGS**.
     1. A minimum of two natural gas-fired boilers shall provide heat for the building. If two boilers are supplied, each boiler shall be sized for 70% of the total calculated heating load. If more than two boilers are supplied, at least 100% of the total calculated heating load shall be available from the remaining boilers when one of the boilers is down for service. As one of the strategies to help achieve the Government’s energy conservation requirement, the acceptable boilers to be supplied shall be either 85% minimum efficient, cast iron or steel forced draft boilers with modulating burners or condensing type boilers. [*For 99th RSC Projects only –* The 99th RSC prefers the use of 400,000 BTUH condensing boilers (96% efficient) installed in a modular application, operating in a lead/lag mode with weekly automatic rotation, to meet the requirements of this paragraph.][*For 88th RSC Projects only* – The 88th RSC requires that boiler systems be piped in accordance with manufacturer’s recommendations.]
        1. For the non‑condensing, each boiler shall have an inline primary boiler circulation pump. Heat shall be delivered to the various spaces with a secondary building heating pump through the hot water heating piping system with distribution to the air handling units, VAV terminal reheat coils, cabinet unit heaters, and unit heaters. A standby secondary building heating pump shall be provided. Both secondary pumps shall be provided with a variable frequency drive.
        2. For the condensing boilers, a single-loop variable speed parallel pumping system with standby variable speed pump shall be provided.
        3. Propylene glycol shall be used to provide heating water freeze protection. Contractor shall install the proper percentage of glycol antifreeze required for specific outdoor design conditions; applicable system use; and in accordance with glycol manufacturer’s recommendations for application freeze and burst protection.
        4. The hot water supply temperature is 190 degrees F, and the hot water return temperature is 160 degrees F. When condensing boilers are supplied, hot water supply and return temperatures shall be adjusted to maximize the efficiency of the condensing boiler.
     2. An air-cooled scroll or rotary screw packaged water chiller, located on grade adjacent to the building, shall provide cooling for the building. Either a single-loop variable speed parallel pumping system with standby variable speed pump shall be provided, each with its own variable frequency drive, or a primary chiller pump/ secondary variable speed building circulation pump system shall be provided, with the secondary pump provided with a variable frequency drive. A standby secondary building circulation pump is not required. Selection of either pumping system shall be subject to the minimum flow requirements of the packaged water chiller. Propylene glycol shall be used to provide chilled water freeze protection in climates where freezing can occur. Contractor shall install the proper percentage of glycol antifreeze required for specific outdoor design conditions; applicable system use; and in accordance with glycol manufacturer’s recommendations for application freeze or burst protection. The chilled water supply temperature is 44 degrees F and the chilled water return temperature is 58 degrees F.
     3. Heating, cooling and ventilation for the building is to be provided through VAV air-handling units by means of an outside air duct connected to each unit mixing box module. The outside air shall connect to the top of the mixing box, and the return air shall connect to the bottom rear of the mixing box. The outside air and relief air ducts shall be sized for economizer operation of the air-handling units.
        1. Supply air is to be distributed to each zone using VAV terminals, each with a terminal reheat coil. The VAV terminal modulates the airflow into the zone to maintain the zone space temperature setting. Individual thermostat control shall be provided for each VAV box. The kitchen, classrooms and conference rooms shall have dedicated VAV boxes. Offices may be grouped such that one VAV box serves a maximum of four (4) individual offices with similar heat loads. Other building spaces with similar heat loads, occupancy and schedule may be grouped together with control areas not to exceed 2,000 square feet. Spaces with excessive heat loss/gain or spaces affected by solar radiation at different times of day shall be independently controlled with a separate VAV box. The boxes shall be installed as to be easily accessible for maintenance personnel.
        2. Return air is transferred from each room into the ceiling return plenum through a transfer grille assembly with a minimum of two 90 degree elbows to create a sound trap, and returned to each unit through branch return air ductwork via a return/ exhaust fan. Provide multiple return air duct branches with duct openings and balancing dampers into individual ceiling plenum spaces. Locate each duct opening such that the distance between the opening and any single return air grille in the ceiling is not greater than 30 feet.
        3. The return/exhaust fan relieves air from the building and returns the remaining air to the air-handling unit. The building shall be maintained at a slight positive pressure. Ventilation shall comply with ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality. Contractor may utilize means to dynamically reset the outside air requirements for demand-controlled ventilation.
     4. Provide separate dedicated exhaust ventilation systems for mail rooms in accordance with UFC 4-010-01.
     5. The locker rooms shall be directly air conditioned from the central air handling system. The toilet and shower areas shall not be directly air conditioned. Air shall be transferred from the locker rooms into these areas. Exhaust fans shall relieve air from these spaces maintaining a slight negative pressure for odor control.
     6. Provide dedicated split system DX refrigerant air conditioning for the TER and TR rooms. Recirculating DX air conditioning unit shall be located in ceiling space of rooms. Air-cooled condensing units shall be located outdoor at grade.
     7. The unit storage areas shall be ventilated using a heating/ventilating air handling unit and exhaust fans. Space-mounted hot water unit heaters shall provide heat to the area.
     8. Provide hot water heating cabinet unit heaters for the vestibule areas. Provide space-mounted hot water unit heaters for mechanical rooms.
     9. Kitchen areas have a number of exhaust hoods. Outdoor air makeup ventilation shall be supplied to the kitchen via a natural gas direct-fired makeup air unit. The kitchen area shall be maintained slightly negative with respect to the surrounding rooms.
     10. Vault areas shall have a wall or shelf-mounted automatic self-contained portable dehumidifier.
     11. Elevator equipment rooms shall be ventilated and/or conditioned in accordance with the elevator manufacturer’s requirements.
     12. [Include HVAC for special areas, such as SCIFs, etc.]
     13. A direct digital control (DDC) automatic temperature control system shall be provided to control and monitor all HVAC systems. The system shall be capable of monitoring energy usage through the electric, water, and gas meters. The DDC system shall be capable of remote monitoring and alarm notification via direct connection to the ARnet (Army Reserve Intranet). The system meet [LonWorks *or* BACnet] protocol requirements. [Include proprietary manufacturers only after receiving Project Officer approval and required Government waiver.]
         1. Currently only the following systems are Certified to Operate (CTO) on the ARnet: [***RFP Preparer to verify this list with USARC G2/G6 representative for updates/addtions.***]

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| * + - * 1. Honeywell CP-403-AX HVAC Monitoring System |
| * + - * 1. Honeywell WC 2003 HVAC Monitoring System |
| * + - * 1. Johnson N30 HVAC Monitoring System |
| * + - * 1. Johnson NAE HVAC Monitoring System |
| * + - * 1. Johnson NCM HVAC Monitoring System |
| * + - * 1. Johnson NIE HVAC Monitoring System |
| * + - * 1. Novar Lingo HVAC Monitoring System |
| * + - * 1. Noval Savvy HVAC Monitoring System |
| * + - * 1. Trane BCU HVAC Monitoring System |
| * + - * 1. Alerton VLX HVAC Monitoring System |

* 1. **HVAC SYSTEMS – VEHICLE MAINTENANCE SHOPS.**
     1. Gas-fired infrared radiant heaters suspended from the roof structure shall provide heat for the maintenance bays.
     2. [Hydronic in-floor heating system is to be provided for the vehicle maintenance bays, in addition to infrared heating, if the heating degree days are greater than 5000 (base 65ºF). ***The RFP preparer shall include the requirements for the in-floor heating system within this paragraph based on the location’s heating degree days***. The in-floor heating system is to include dedicated hot water boilers, in-floor piping, manifolds and controls. Each workbay should have a designated area, for the installation of future equipment that does not have in-floor radiant heat.]
     3. Office and administration heating and cooling shall be provided through single zone gas-fired furnace fan coil units with DX refrigerant cooling and remote grade mounted air-cooled condensing units. Ventilation for units to be supplied through outside air connection to furnace fan coil unit return duct. Provide a transfer fan to pressurize the vestibule maintaining separation between the office and maintenance bay areas.
     4. The controlled waste and flammable storage rooms shall be heated using explosion-proof electric unit heaters with remote wall-mounted thermostats and shall be ventilated with explosion-proof exhaust fans in accordance with NFPA 30.
     5. Mechanical rooms shall be heated with hot water unit heaters if hot water is available. If boilers are not installed, provide electric unit heaters.
     6. Toilet rooms shall not be directly cooled. Air shall be transferred from the adjacent ceiling plenum spaces or rooms into these areas. Toilet rooms located at the perimeter of the building shall have supplemental [electric][hot water baseboard] heating.
     7. Tool, parts and supply rooms shall be heated with a dedicated single zone gas-fired furnace. Ventilation for units to be supplied through outside air connection to furnace.
     8. The TR and other information technology (IT) spaces shall be cooled with a dedicated split system air conditioning unit with an air-cooled condensing unit located on grade, adjacent to the building. Temperature sensors and remote alarm lights shall be provided for the spaces. Electric heat shall be provided for rooms located at perimeter of building.
     9. **Exhaust Systems**.

Provide individual exhaust systems at each vehicle maintenance bay within the Vehicle Maintenance Shop with individual hose reel drops for each exhaust fan. Each fan shall be controlled by a manually operated switch located within the wheeled vehicle bay served by the fan. Each fan shall be sized to serve the anticipated vehicles being maintained. Makeup air for the individual vehicle tailpipe exhaust is to be provided by a wall-mounted intake louver and interlocked damper. This air is tempered by a gas-fired unit heater. Makeup air may also be provided by the general exhaust system variable flow makeup air unit. A duty cycle of 50% of the capacity of the vehicle exhaust can be considered. Where possible hose reel exhaust should be routed out through the exterior walls and not through the roof.

* + - 1. Provide a variable flow general exhaust system for the vehicle maintenance bays within the Vehicle Maintenance Shop. The general exhaust system shall be equipped with variable frequency drives. The general exhaust system shall be sized for a minimum of 1.5 cfm/sq. ft. Provide a manual switch to allow the general exhaust and interlocked makeup air systems to operate manually when the bays are in use. The system shall operate at a reduced ventilation rate in accordance with code requirements during normal operation. The electronic control system shall operate the general exhaust system at the high exhaust rate when either the level of carbon monoxide is detected above set point, or the level of nitrogen dioxide is detected above set point as determined by gas monitors.
      2. A natural gas direct-fired variable flow makeup air system for the general exhaust shall be provided for the Vehicle Maintenance Shop vehicle maintenance bays. Provide 10 percent less capacity than the exhaust system to maintain a slightly negative pressure in the space. The makeup air system shall be equipped with variable frequency drives and shall temper outside air to the space design heating temperature at a minimum. Carbon monoxide and nitrogen dioxide sensors shall initiate general exhaust and makeup for the vehicle maintenance bays. The makeup air unit shall be interlocked with the general exhaust system for vehicle maintenance bays.
      3. Provide gas monitoring system to monitor the Vehicle Maintenance Shop wheeled vehicle bays for carbon monoxide and nitrogen dioxide. Provide minimum of one carbon monoxide sensor, and one nitrogen dioxide sensor for each 5,000 sq. ft. of floor area. Provide local wall-mounted audible alarm with manual momentary silence switch to signal high contaminant levels.

**[*RFP Preparer to determine which functionality of battery room is being provided one for storage or one for charging and edit appropriately.*]**

* + - 1. [Provide Battery Rooms with ventilation required to keep the space within 10 degrees of ambient] [Provide Battery Rooms where charging occurs with a dedicated exhaust fan interlocked with the battery charger so that the charger will not operate without ventilation. A wall-mounted fan switch with timer shall control each fan. Provide fan motors outside the battery room. Each blower shall have a non-sparking fan. Size the exhaust fan as follows, but not less than 1.5 cfm/sq.ft.

Q = 0.053 x I x N

where

Q = required ventilation rate in cfm

I = 0.21 x capacity of the largest battery in amp-hrs

Or

I = 0.25 x maximum obtainable amperes from the charger whichever is greater

N = the number of 2-volt cells (A 12-volt battery has six 2-volt cells)]

* + - 1. Exhaust fans interlocked with ducted outside air dampers shall provide ventilation for the non air-conditioned areas.
    1. A DDC control system shall be provided to control all HVAC systems. The DDC system shall also be include and shall be capable of monitoring energy usage through the electric, water and gas meters. The control system shall be by the same manufacturer and have similar capabilities to the one in the Training Center.
  1. **HVAC SYSTEMS – UNHEATED STORAGE BUILDINGS**.
     1. There are no heating or ventilating system requirements within these buildings. [***RFP preparer should consider adding a wall-mounted intake and exhaust fan for UHS Buildings in hot climates. Fan should be manually controlled with a timer switch, rather than temperature controlled***.]
     2. [If a fire protection system is required, provide electric heat at the fire protection water service entrance room where freezing is a concern.]
  2. **DUCTWORK, PIPING AND ACCESSORIES**.
     1. **Duct System Design**.
        1. The ductwork shall be sized using industry standard friction rates and velocities. Duct locations shall be coordinated with all disciplines. Insulate ductwork as required. Provide volume control dampers at supply and return branch duct work take-off locations. Balancing shall not be performed at the grilles, registers, and diffusers.
        2. Flexible duct shall be insulated metallic and shall be limited to 5’-0” spans.
        3. Provide duct access panels before and after all duct-mounted equipment.
     2. **Fire Dampers and Smoke Dampers**.
        1. Fire dampers and smoke dampers shall be fire rated according to the areas being protected. Fire dampers and smoke dampers shall be dynamically rated.
     3. **Hydronic and Refrigerant Piping**.
        1. Hydronic piping shall be designed to be efficient, easily hydraulically balanced, and accessible. Pipe size to be within ASHRAE standards. Riser piping located in interior partitions or exterior walls is prohibited. Insulate hydronic and refrigerant piping systems.
     4. **Access Panels**.
        1. Access panels/doors shall be provided for valves and appurtenances of the HVAC system located behind hard walls or ceilings.
     5. **Water Quality and Treatment**.
        1. The Contractor shall provide glycol makeup units for hydronic heating and chilled water cooling systems. Each makeup unit shall include tank and pump, shot feeder and accessories for chemical treatment of the hydronic heating and chilled water cooling system. Chemical treatment shall cover startup and entire warranty period of the building.
     6. **Diffusers, Grilles and Registers**.
        1. Air distribution devices shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts.
  3. **TESTING, ADJUSTING, AND BALANCING**
     1. Testing, adjusting, and balancing shall be provided for HVAC ductwork systems and hydronic heating and cooling systems. Air balancing shall not begin until after building envelope sealing and testing is completed. See the Technical Outline Specifications for additional requirements.
  4. **COMMISSIONING**
     1. See Section 01 46 00.00 06 for commissioning requirements.
  5. **BUILDING OCCUPANCY FOR ENERGY CALCULATIONS**

**[*RFP preparer to edit occupancy schedule based on allocation of full time reservists and drill weekends.*]**

* + 1. For bidding purposes the following occupancy shall be used. Actual occupancy rates shall be determined during design with coordination with the Users.
    2. The following spaces in the Training Center Building shall be designed for occupancy during the work week (full time occupancy) (7:00 am - 6:00 pm):

Full time individual offices and Full time common office areas  
Administrative Support Areas  
Lobby  
Restrooms  
Break Area

* + 1. The following spaces in the Training Center Building should utilize occupancy sensors to determine when the room is occupied during the work week:

Recruiting/Retention Office (M & F - 7:00 am - 5:00 pm)  
Family Support Office (M,W & F - 12:30 pm - 5:00 pm)  
Assembly Hall (F - 4:00 am - 6:00 pm)  
Classrooms (M, W & F - 7:00 am - 5:00 pm) (1 classroom)  
Library Reading Room (M-F - 10:00 am - 2:00 pm)  
Weapons Simulator - (M & F - 7:00 am - 5:00 pm)  
Physical Readiness Training (M-F 7:00 am – 8:00 am, 4:00 am – 6:00 pm)  
Learning Center/Distance Learning Center (M-F - 1:00 pm - 6:00 pm)  
SIPRNET Café (M, W & F - 1:00 pm - 5:00 pm)

* + 1. The entire Training Center Building shall be designed for occupancy during the drill weekends. ([1] [2] [3] Weekends per month) (6:00 am – 6:00 pm)
    2. The following spaces in the Organizational Maintenance Shop shall be designed for occupancy during the work week (full-time occupancy) (7:00 am - 5:00 pm):

Full time offices  
Restrooms

* + 1. The entire Organizational Maintenance Shop shall be designed for occupancy during drill weekends with the exception of the maintenance bays. ([1] [2] [3] Weekends per month) (6:00 am – 6:00 pm)
    2. The Maintenance Bay in the Organizational Maintenance Shop shall utilize an occupancy switch or the CO/NOX sensors to activate the general ventilation system. General Ventilation system in the workbays will be assumed to operate [ ] hours a day during the work week and [ ] hours a day during [ ] drill weekends.