Air Force Medical Support Agency (AFMSA)
Health Facilities Division

Quality Standards & Design Principles
Applicable to the Repair, Replacement & Modernization
of
Air Force Medical Facility Infrastructure Systems & Assets

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The Office of Primary Responsibility (OPR) for this Document is the Health Facility Division’s Facilities Operations and Engineering Branch. For questions regarding authority or content, please contact AFMSA/SGS8F, Mr. Christiansen, at DSN 945-1027 or Commercial (210) 925-1027.
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1. Purpose & Introduction

This document shall provide guidance to designers, maintenance providers and contractors engaged in the repair, renovation construction and modernization of Air Force Medical Service (AFMS) properties regardless of their location.

1.1 Intent

This guide is not intended to serve as complete specification in and of itself, but rather complement already published industry standard practices, the Uniform Building Codes, the Unified Design Facilities Criteria (UFC 4-510-01), the applicable codes and requirements published by NFPA, AIA, NESC, NRCA, IBC, SMACNA, ASHRAE, ASPE, current Engineering Technical Letters (ETLs) published by the Air Force Civil Engineering Center (AFCEC) and the Air Force Medical Support Agency (AFMSA), local and regional construction codes, regulations and other pertinent publications. Where existing publications are again mentioned or cited in this guide, it is done so to reiterate the significance of that publication.

1.2 Exceeding Codified Minimums

AFMS recognizes that the published codes and standards mentioned in paragraph 1.1 are above establish the minimum requirements for construction. It is the intent of this guide to establish criteria and require features that are generally above the minimum basic requirements for construction and performance as to provide a more efficient, reliable, maintainable, comfortable and healing environment for patients and staff. In the event of conflict, the most stringent requirement shall govern.

1.3 Compliance

The designer is responsible for incorporating the engineering philosophies herein into any design solution being proposed for application at an AFMS Medical Treatment Facility (MTF). Prior practice, precedent or design does NOT release the designer/contractor from compliance with the content of this guide as published at time of proposal offering. Where a contractor may desire to propose a design which is in deviation to this guide (but appears to meet the intent of the guidance), the contractor shall describe in detail any deviation with a narrative proposal and design drawings if an illustration will make the alteration more clear. The contractor will make the deviation a separate clear and notable exception in the proposal being submitted. Providing a notation of the exception (of the proposed deviation) in the proposal does not automatically make it acceptable or accepted by the government. The request for deviation must include a complete analysis of the deviation and reason for such. Include any supporting document such as calculations, equipment information, cost benefit to the government, etc.

1.4 Engineering Technical Letters (ETLs)

Headquarters Air Force Civil Engineering Center (AFCEC) Engineering Technical and Headquarters Air Force Medical Support Agency (AFMSA) both publish ETLs. The Civil Engineer for the Air Force (HAF/CE) and the Chief of the Health Facilities Division (AFMSA/SG8F) publish ETLs as interim guidance to Air Force Instructions (AFIs) and construction code requirements. Compliance with ETLs cannot be waived without specific approval of the authority publishing the ETL. Current ETLs published by the Air Force Civil Engineer are available on the AFCEC web-site.
2. Mechanical Infrastructure Systems

When making repairs, alterations or renovating existing mechanical infrastructure that requires major component or equipment replacement, the designer/contractor shall NOT assume that a “like-for-like” replacement is acceptable. The designer/contractor shall improve the system to better meet the existing and future load/service requirements by reducing energy consumption and improving reliability, operability, and maintainability.

2.1 Basis and Theory of Design

All new construction, or major renovation projects (as defined by UFC 4-510-01) must provide at least a 14% energy reduction below the current ASHRAE Standard 90.1 published baselines. The contractor shall submit ASHRAE 90.1 system analysis calculations and simulations. Any energy efficiency improvements greater than the 14% required will be heavily weighed against the type of equipment and overall reliability and life expectancy of the equipment.

2.1.1 Chilled and Condenser Water Systems

A. In-patient health care facilities (bedded hospitals) require chilled water systems with N+1 redundancy. A minimum of two chillers/pumps/towers with duty and backup capacity is required.

B. Chilled water system design for indoor mounted chillers shall include a piping arrangement that extends to the exterior of the facility with valved and flanged connections for use of a temporary chiller. The pipe connections at the system shall be so that a temporary chiller can be connected without requiring a temporary pump. Provide electric power and disconnect to the building exterior at the point of temporary connection. The electrical circuit shall intercept the service to the largest chiller and a three phase double through switch shall be installed where power can be diverted to the temporary chiller. Size piping and electric power to match the largest indoor chiller.

C. Select chillers that will provide modulation or unloading down to the 20% range and remain under stable operation without surging with constant design entering condenser water temperature. Provide head pressure control for chillers as required by manufacturer’s application guide.

D. Single chiller installations shall be at least dual compressor, dual circuit design sized with each circuit at 60% of maximum cooling load. Multiple chiller designs shall include same basis of design in that each machine must be sized for at least 60% of the maximum cooling load.

E. New or Renovation projects that include modification of chilled water systems shall require Variable Volume Chilled Water Systems (VVCWS) – unless otherwise approved by AFMSA. The designer/contractor shall document the design to AFMSA during the proposal stage.

F. Any space requiring “special” environmental conditions that are less than 70 degrees Fahrenheit and 50% relative humidity shall require a dedicated cooling system.

G. The condenser water design shall provide freeze protection (both operating and idle) and control of chiller condenser pressure.

H. Hydronic Economizer systems require less than or equal to a 10 year return on investment.

2.1.2 Heating Water/Steam Systems

A. In-patient health care facilities (bedded hospitals) require heating water systems with N+1 redundancy. A minimum of two boilers/pumps with duty and backup capacity is required.
B. The basis of design shall include natural gas fired, high efficiency or condensing, finned tube forced draft, packaged, hot water, boilers.

C. Provide dilution accessory to prevent acidic effluent from entering sewer system.

D. Designer shall eliminate or minimize steam based systems – where economically feasible.

E. Boiler design shall include dedicated constant volume boiler primary pump to ensure proper water flow at boiler and secondary loop pumps with variable frequency drives.

F. Select pump motors with 120% of selected brake horsepower at the design condition up to 25 HP and 110% of selected brake horsepower for motors over 25 HP.

2.1.3 Air Distribution Systems

A. Continuous cooling loads such as laboratories, pharmacies, IT equipment areas with heat generation equipment in the space shall be cooled utilizing building cooling systems when available but operating independently when building system is not available.

B. Heat recovery systems shall be provided for all 100% Outside Air systems; heat wheels shall NOT be used.

C. In major renovation projects, the design team shall convert all constant volume or multi zone or dual duct HVAC systems to Variable Air Volume Single Duct type. Convert 100% Outside Air systems to accommodate as much return air as allowable by code.

D. The airflow design shall include a room by room ventilation analysis. If the cooling/heating load airflow requirement is greater than the airflow required to meet minimum ventilation requirements, then that load requirement shall dictate the ventilation of that space. When the airflow volume to meet minimum ventilation requirements is greater than the thermal load requirement, then that airflow rate shall dictate the design for that space. In NO circumstance shall the airflow volume design for any space be less than 110% of the calculated minimum air exchange rates. This practice will apply to all spaces in the clinic or hospital that have a published air exchange requirement. No diversity that reduces airflow from design values shall be used. Follow UFC 4-510-01 for air change reduction in unoccupied surgery suites.

E. When a space requires a pressure relationship to an adjacent space, the design of the supply and exhaust airflow rates for the space requiring the pressure relationship shall utilize a minimum of 20% differential between the two flow rates. More airflow differential may be required based on the construction of the space and the measurable pressure differential required.

F. The room by room ventilation analysis shall be totalized to provide an overall minimum outside air supply rate for the entire zone. Provide airflow measuring station at the outside air intake of the affected air handler to provide continuous monitoring and control of the outside air volume. The designer shall not use a "worst case scenario" percentage of outside air for a single room in the zone to base the total design flow rate of an air handler.

G. One Variable Air Volume (VAV) terminal shall not serve more than six (6) rooms or 2,000 square feet. Designer shall not mix occupancies or exposures on a common VAV terminal.

H. Select all fans for not greater than 80% of the maximum fan RPM rating (at 110% of design load). Provide all fan motors (up to 25 Horsepower) with nameplate rating that is 120% of selected brake Horsepower. For fan motors above 25 Horsepower provide motors with nameplate rating of 110% of selected brake Horsepower.

I. Select air handler fans with lowest possible speed to minimize noise. Use ARI listed AHU performance ratings.
J. All new or renovated HVAC systems shall include air and/or hydronic economizer cycles as permitted by local climate. Air side economizer capability shall be included only for projects located in Climate Zones 3 – 7 of the ASHRAE Zone Map included as Attachment 1.

K. For any Air Handler with no airside economizer cycle, eliminate the return/relief air fan if design calculations demonstrate it is not required to overcome return duct static pressure and building pressure control can be maintained.

L. For Air Handlers designed with air side economizer cycles, the outside air duct must be sized to allow full design airflow.

M. Exhaust fans serving critical or hazardous spaces shall not be interlocked with associated air-handling units for automatic shut down.

N. Fan coil units are not acceptable for use in AFMSA Health Care Facilities.

2.2 Equipment Physical Characteristics

2.2.1 Chillers

A. Select condenser tube water side surface with smooth bore or rifled tubes only. Condensers shall have removable heads to allow brush cleaning of condenser tubes.

B. Provide a new refrigerant monitoring and alarm safety system having all features currently required by ASHRAE Std. 15-2010. Reuse of existing refrigerant safety systems in part or in full will be accepted if it can be demonstrated that as a complete assembly, it meets or exceeds the minimum performance standards and the contractor provides a full warranty.

C. Furnish only rotary type screw or scroll compressors for air cooled chillers. Condenser tubes shall be copper construction. Chillers located in coastal environments shall have copper fins and/or baked epoxy coating.

D. Furnish manufacturers louvered panels over the coil surface and the lower equipment enclosure areas on air cooled chillers.

E. Furnish only rotary type screw, scroll or centrifugal chillers for water cooled chillers.

F. Open drive chillers may not be used unless the contractor provides a means of discharging the motor heat from the chiller room, and warrants the shaft seal including all parts, labor, travel, refrigerant, and oil for a period of not less than five year.

2.2.2 Boilers

A. Thermal efficiency shall be as required by ASHRAE 90.1-2010.

B. Fully modulating boilers are required and must demonstrate stable operation without vibration or excessive noise throughout the full range of modulation.

C. When new steam boilers MUST be used in a design, medium pressure steam boilers shall have a minimum turn-down ratio of 3:1. For steam boilers over 50 HP, turn-down ratio shall be a minimum of 4:1.

D. Steam boilers shall utilize flow control devices (e.g. orifices) to restrict flow to no more than designed package capacity.

E. Utilize Lo-NOX boiler (or ultra-Lo-NoX, as required by local authorities) firing controls.

2.2.3 Pumps

A. Use only motors with a rated speed of 1,750 RPM or lower with TEFC NEMA premium efficiency.
B. Where pump motors will be controlled by VFDs, they will be so designed for continuous use/duty with VFDs.  
C. Provide testing ports at suction and discharge side of all new pumps. The discharge pressure fitting shall be at the discharge before any fitting or valve. On the suction side, the pressure port shall be no closer than one foot from any fitting or elbow.  
D. All pump bases shall be grouted after alignment is complete. All pump assemblies shall be laser aligned.  

2.2.4 Cooling Towers  
A. Towers shall have manufacturer’s access ladders, access platforms, interior walkways, and hand rails around the top of the tower. The towers shall have stainless steel construction throughout, and PVC fill.  
B. Use Variable Frequency Drive (VFD) and motors designed specifically for use with VFDs on tower fans.  
C. Provide side filtration and a basin cleaning system to remove solids from the basin and condenser water.  
D. Provide automatic water make-up control with separate metering. Meter shall be of type that can provide data to the BAS.  
E. Provide basin equalization piping on towers serving a common system.  
F. Tower installation shall provide sufficient height for required condenser pump NPSH.  
G. New cooling towers shall be of the induced draft cross flow design with TEFC (or TEAO) motors.  
H. Design cooling towers according to ambient temperatures listed in UFC 4-510-01. Select towers for not more than a 10 degree approach temperature at design conditions.  
I. Select pump motors and fan motors with 120% of selected brake horsepower at the design condition up to 25 HP and 110% of selected BHP for motors over 25 HP.  

2.2.5 Air Handlers  
A. Drain pans in AHUs shall be stainless steel and constructed so there is no standing water in the pan. Slope pans in two dimensions to the drain connection. Furnish drain pans under cooling coils, heating coils and humidifier dispersion tubes.  
B. Cooling coils (chilled water) shall be ARI listed for performance. Coils shall have no more than 12 fins per inch and serrated fins are not acceptable. The minimum design entering water temperature shall be 2 degrees F above system chilled water supply temperature as documented in latest official project plans with a water temperature differential across the coil of 12 degrees F. Provide stainless steel coil casings and intermittent supports. Aluminum coil fins shall be of 0.0075” minimum thickness. Copper coil tubing shall be of minimum tube wall thickness of .020” and 5/8” diameter. A single chilled water coil shall be no more than 8 rows. Where coil capacity requirements dictate more than 8 rows, the coil shall be split into two separate coils with minimum of 12 inches between them. Maximum cooling coil face velocity shall be no higher than 500 FPM at the AHU design capacity.  
C. Heating coils (hot water or steam) shall be ARI listed for performance. Coils shall have no more than 12 fins per inch and serrated fins are not acceptable Aluminum coil fins shall be of 0.0075” minimum thickness. Copper coil tubing shall be of minimum tube wall thickness of .020” and 5/8” diameter.  
D. Provide 200,000 hour (L10) rated bearings on shafts and motors. Provide TEFC (Totally Enclosed, Fan Cooled and NEMA premium efficiency) motors for fans.  
E. Provide laser alignment and belt tensioning of supply and return fans upon installation. Laser alignment and belt tensioning tool, as well as user training, shall be provided to local FM staff upon completion of project.
F. Air Handlers shall have access doors in all modules except coil modules. Doors must be hinged at one side and with latches on one side that take no tool to operate. Doors shall provide full swing or have pin and sleeve hinge for removal. Each module shall have a vision panel and interior lighting with switching at exterior of AHU.

G. AHU casings shall be designed and rated for 2” water column greater pressure than the fan’s total rated static pressure at maximum RPM. Provide gasketed panels and grommets on pipe and tubing penetrations of the exterior casing to eliminate air leakage.

H. All air handlers shall be double wall with interior insulation but no insulation exposed to the airstream. Galvanized smooth metal interior panels are required with no perforated panels acceptable.

I. Provide a thermal break between casing interior and exterior on all outdoor units and on those located within unconditioned interior spaces. “Sandwich” panel construction, consisting of closed cell foam that is injected between the outer and inner sheet metal panels shall be used.

J. Air dampers in Air handlers or in ducts shall be airfoil type with opposed blade design, low leakage type with a neoprene seal at blade edge. All rotating shafts shall be plated steel and bushings shall be stainless steel sleeve bearings. Provide extended shafts for attachment of damper actuators at the exterior of ducts and air handlers.

K. Provide a dedicated casing section with moisture eliminators for humidifier dispersion tubes. See UFC 4-510-01 for more additional requirements relating to humidification.

L. Air handlers and filter compartments shall have filter racks with spacers and gaskets necessary to prevent ANY air bypass around filters. Size the racks for max filter face velocity of 500 fpm. Design the filter racks to utilize only filter sizes that are Industry Standard and readily available as a Commercial off the Shelf product (COTS).

M. Refer to latest edition of UFC 4-510-01 for proper filter selection. The default filter arrangement is a pre-filter; located upstream of all coils, velocity sensing devices or other devices requiring protection from particulate accumulation, and an intermediate filter; located downstream of the supply fan or cooling coil, whichever is last. The pre-filter shall be a 4 inch thick (minimum thickness) disposable cartridge filter with pleated media and a Minimum Efficiency Reporting Value (MERV) rating of MERV-8. The intermediate filter (as required by UFC 4-510-01) shall be rated as MERV-14. Do NOT design or install systems which incorporate the use of bag or roll filters. Filters in outside air streams shall be metal frame type. See paragraphs 7-8.4 and 7-11.1 in UFC 4-510-01 for more instruction on air filters, their location and their protection.

N. For AHU retrofit projects, dimensional conflict between standard equipment dimension and limited available space does not exempt the designer or contractor from adhering to the aforementioned air filter requirements. Deviations offered in a proposal will be evaluated for adequacy of filtration and filter location.

O. Furnish manufacturer’s continuous base rails on indoor AHUs. Provide reinforced concrete housekeeping pad (4” minimum) in combination with the base rail to provide overall height for proper condensate trap construction. Contractor shall provide trap design detail to show that trap is designed for a trap depth minimum 1” greater than total fan static pressure. Trap design shall be specific to draw through and blow through coil designs.

P. Air handlers with multiple supply fans in a “fan wall” configuration shall include dedicated VFD for each fan and each fan shall have a backdraft damper at the discharge to allow operation of the AHU with a single fan in the failed mode.

2.2.6 Variable Air Volume Terminals

A. All Variable Air Volume (VAV) terminal boxes shall be pressure independent type.
B. Heating water coils in VAV terminals serving exterior zones shall be two rows.
C. VAV terminals shall be double wall with insulation between panels so not to be exposed to airstream. Provide terminals with double-walled insulated manufacturer's access panel at an easily accessible area for all interior components. Install VAV boxes to provide unhindered access to the access panel and controls.
D. Flex connector from medium pressure ductwork to VAV box inlet shall not exceed six (6) inches in length.

2.2.7 Piping Systems, Duct Systems and Miscellaneous General Requirements
A. All motors controlled by Variable Frequency Drives shall be of the design that reduces or eliminates inducted transient rotor voltage. This can be either motors fitted with grounding rotor brushes, ceramic bearings or other AFMSA approved technology.
B. Stencil or label all finished pipe surfaces to clearly label content and normal flow direction in agreement with ANSI/ASME A13.1. Provide identification each twenty feet at minimum.
C. All roof top equipment must be installed per the equipment manufactures' recommendation. The curb, base anchoring point and/or manufacturer equipment stand shall be securely anchored to the underlying structural members and meet the requirements for wind loading and uplift for the geographical area. Curbs should be installed per NRCA recommendations unless otherwise designed by a professional structural engineer as needed to meet special unique requirements specific to the site or region. Treated wooden skids, timbers and similar materials used for curbs and mounting platforms shall be coated, covered and flashed as necessary to eliminate exposure to UV and the elements; and shall present a seamless matching appearance consistent with the roof system. Minimize the use of roof mounted equipment.
D. When using existing concrete housekeeping pad for any mechanical equipment, contractor must verify the pad size. Contractor must completely remove the old pad down to solid foundation and construct a new housekeeping pad if the existing pad is deteriorated or not sized to fit new equipment. Pad extensions are not acceptable.
E. Isolation valves, flow measuring ports and balance valves shall be installed on all coils and all components requiring TAB. Strainers required ahead of all control valves and pumps.
F. Above ceiling spaces shall not be used as return air plenum (See AFMSA ETL 2010-01 in Attachment 2).
G. Where ducts must be located outside the building, provide dimpled metal jacketing with an anodized finish in the color selected to best harmonize architecturally with the building.
H. Provide all stainless steel duct construction, with seamless welded joints; (to include all accessories) downstream from trim humidifiers or high efficiency final filters serving surgical procedure spaces. Provide drain nipple with plug in SS duct (i.e., Operating Rooms, Dental Surgery, Labor & Delivery, etc.). See UFC 4-510-01 Section 7-11.5.1 for additional details.
I. Flex duct connecting terminal boxes to supply air devices shall not exceed five (5) feet in length. Do not use flex duct for return or exhaust duct systems. Where the facility is undergoing a renovation involving complete replacement of ceilings and ceiling mounted air devices throughout a large contiguous space, the contractor shall replace the all old / existing flex duct with new.
J. Ductwork design shall use long radius elbows.
K. Supply, return and outdoor air ductwork shall be sealed with water based mastic at all joints and externally insulated. Insulation shall be 2” thick mineral fiber blanket with foil vapor barrier. Test all new ductwork per SMACNA standard.

L. All branch ducts shall have manual balancing dampers. This includes branch ducts on various floor levels connected to a vertical riser.

M. During a major renovation project including duct modifications the contractor shall not reuse existing duct if the duct (or a section thereof within the space) is internally insulated, damaged, not properly sized, or more than 25 years old. Duct cleaning is not an option.

N. Duct cleaning shall only be considered on exhaust and return air distribution systems. Cleaning supply air distribution ducts and components that are downstream of the final filter bank shall require special exemption and prior approval by AFMSA/SG8FE; who shall provide detailed guidance on the specific methods to be employed during the cleaning and post cleaning start of air distribution systems.

O. Where exhaust and return air duct system must be cleaned, the duct cleaning process must follow procedures pursuant to guidelines established and published by ASHRAE and the National Air Duct Cleaners Association (NADCA).

P. All pipe and duct insulation shall meet or exceed ASHRAE 90.1-2010 and National Insulation Association (NIA) guidelines as prescribed by Whole Building Design Guide and “Federal High Performance & Sustainable Buildings.”

Q. All chilled water pipes shall be insulated with Cellular Glass material. Mineral fiber or unicellular insulation is not acceptable.

R. All indoor piping insulation shall be covered with PVC jacketing with a thickness of that least 30 mil. PVC shall match local fluid color schemes where applicable. Painting is not a substitute for PVC jacketing, nor will PVC be painted unless specified by code. Provide stenciling or labeling of the finished exterior pipe covering to show contents and direction of flow. Provide identification at intervals not exceeding twenty feet.

S. All outdoor mechanical insulation shall utilize metallic jacketing to protect such insulation from exposure and elements.

T. All supply, return, exhaust, and outside air ductwork shall be insulated.

U. In areas of known or anticipated “climbing” on/over of the insulated component by personnel, walkways or bridges shall be installed. In areas where the installation of a walkway is not possible due to dimensional clearance constraints, the appropriate rigid durable insulation materials shall be used: Calcite (or approved alternate) for steam / heating / domestic hot water, cellular glass (or approved alternate) for chilled water. Heavy sheet metal jacket or protective cover shall be installed by the contractor to protect the insulation.

V. Leave no insulation exposed to the air stream in any ductwork or equipment.

W. All chilled water lines shall utilize a compartmentalized vapor seal. Vapor seals shall be no more than four (4) insulation joints in length.

X. Insulating materials containing polyisocyanurate with a smoke index greater than 50 shall NOT be utilized in AFMS facilities.

Y. For closed loop hydronic systems provide weldalets, feeders and other devices to accommodate chemical treatment. Include corrosion test coupon assembly.

Z. Include water meter with pulse counter contactor on make-up water line, and connect to BAS.
AA. For condenser water systems, provide a high quality controller for controlling bleed, inhibitor feed and biocide feed. The controller is to have multiple modes for configuring the timer for the scale and corrosion inhibitor but its default mode is to control chemical feed proportional to make-up water.

AB. Include two (2) biocide timers with the capability to lock-out the bleed following a biocide addition. Use a pre-bleed timer in conjunction with the bleed lock-out.

AC. Install corrosion test coupon assembly.

AD. Non-chemical based systems (such as ozone or magnets) are not acceptable.

2.3 HVAC Controls

2.3.1 Building Automation Systems (BAS) and Energy Management System (EMS) are used synonymously and refer to the digital, programmable, computer based electric automatic control system.

A. Projects shall remove existing pneumatic HVAC control systems and replace them with direct digital programmable control systems.

B. When a control system is replaced, no existing control components are to be re-used.

C. All firmware and software being proposed for projects in AFMSA properties must be compliant with HQ AFCEC Engineering Technical Letter (ETL) 09-11 dated 26 Oct 2009 titled “Civil Engineering Industrial Control Information Assurance Compliance,” and be approved for use on DOD / Air Force distributed networks. The software must be most recent version at time of commissioning, with a remaining application life and compatibility with future systems for at least five (5) years. If a new version is released and approved for use on AF networks within 12 months of system commissioning, the contractor shall provide, install and commission an update to the most recent version without additional cost to the Government. For renovation or expansion projects, the contractor shall provide a software update to the most current version for the entire control system.

D. Include a desk top computer with the latest operating system (having the necessary DOD required security patches) and 21 inch flat screen monitor (minimum), and an ink jet printer.

E. The BAS graphical user interface (GUI) shall be user friendly, incorporate animated illustrations of all major equipment to depict piping flow and indicate status of operation. The access and update time between screen displays shall not be greater than 2 seconds following initiation of change. The GUI shall at minimum include animated illustrations, but not limited to the following displays:

- Floor plans with room numbers, temperature sensors, terminal boxes and AHU’s accurately located.
- VAV boxes with CFM (feedback), damper position (percentage), space temperature (feedback), space temperature set point, discharge air temperature (feedback) and reheat valve position (percentage).
- AHU depicting fan operation (feedback), fan speeds, duct static pressure (feedback), preheat mode, cooling modes, control valve status (percentage), CHW and HW coil leaving air temperatures (feedback), return and mix air temperatures (feedback), damper positions (percentage), total supply air CFM (feedback), outside air temperature (feedback), outside air CFM (feedback), chilled and hot water leaving temperatures (feedback), filter pressure drop (feedback).
- Where the BAS is going to be installed in a foreign location, maintained and operated by local foreign nationals, the BAS shall be so equipped to easily toggle the graphical interface and text to be displayed in both the local native language and modern English; and the system measurements can be toggled between SAE and metric units.
• Chilled water/condenser water/heating water systems: On the graphic of each system show all temperatures, fan speeds, pump speed, valve positions, percent equipment load, firing rate, along with all set points.

F. The installer/contractor shall train maintenance personnel in the use of the building control system to the level where they can independently control room set points, adjust operating schedules, recognize abnormal performance, acknowledge alarms, utilize the event log and generate trend logs. Operators must demonstrate their proficiency in these skills at final commissioning and before acceptance of the system.

G. The installing contractor shall establish user specific access password protection that is specific to each authorized operator and that will not allow any operator to access functions for which they have not demonstrated competency. Generic passwords, such as “Operator”, are not acceptable and must be removed at time of acceptance. BAS system security protocols and passwords must comply with HQ AFCEC Engineering Technical Letter (ETL) 11-1 dated 30 Mar 2011 titled “Civil Engineering Industrial Control Information Assurance Compliance” (See Attachment 2).

H. Provide a BACnet Object List that includes the hardware (input/output) points and also includes software points such as set points, trends and alarms. Identify points in language that is understandable to maintenance personnel. Generic, computer generated, point designators are not acceptable.

I. Provide detailed written Sequences of Operation for all controlled systems that describes how the system is designed to function under an array of anticipated conditions. Night set-back and Antiterrorist Force Protection (ATFP) emergency shutdown must be included in control sequences. Sequences of Operation must be submitted with the 65% design submittal and accepted by AFMSA/SG8FE.

J. Provide Control Schematics for all controlled equipment and systems. Identify control points with the same designator used above in the BACnet Object List.

K. All new systems shall utilize a BACnet/IP “backbone” for connection to system level panels and computer access terminals, as a minimum.
  • As a minimum, use BACnet communications protocol at the system level and provide for data access and sharing with other BACnet compatible vendors.
  • All devices below the system level (end device unit controllers) shall communicate in open (non-proprietary) protocol

L. Leave the project in a state that with the approval of the government, other vendors can be permitted to tie in and access for future alteration and expansion.

M. Provide lightning and transient voltage protection for system level panels.

N. Provide auto archiving/back-up software program for routine back-up of the programs, including historical trending.

O. Provide one hour minimum UPS for system level programmable controllers mounted securely off of the floor.

P. All controllers are to utilize non-volatile memory.

Q. All controllers and actuators connected to equipment such as an air handler or VAV terminal that serves a critical care space and the equipment is connected to the emergency power system, will also be powered from the emergency power system.

R. All new HVAC control systems shall be native BACnet type that can communicate in an auto-recognizable (plug-n-play) manner with other installed systems and do so without the need for intermediary translation device or
“gateway.” Systems shall be BACnet compliant down to the end device without need for intermediary translation device or “gateway.”

S. A complete set of trend logs of system operation shall be submitted to the government prior functional performance testing and final commissioning to demonstrate system performance. One purpose of the trend log(s) is to determine the stability of the system at the device level in automatic mode and without human intervention. These trend logs are to be recorded after the control system is in automatic mode, all global set points and limits removed, all control loop tuning and the TAB is complete. The trend logs must contain at minimum five (5) consecutive days of trends two of which are weekends or holiday. AHU trend logs to include the following:

- Outside Air Temperature
- Return Air Temperature
- Mixed Air Temperature
- Supply Air Temperature
- Mixed Air Damper Position
- Chilled Water Coil Valve Position
- Fan Speeds
- Supply, Return, and Exhaust Duct Static Pressure
- Preheat Coil Valve Position
- Reheat Coil Valve Position
- Space Relative Humidity
- Outside Air CFM
- For VAV boxes the trend log shall include:
  - Inlet Air Temperature
  - Discharge Air Temperature,
  - Reheat Valve Position
  - Air Damper Position
  - Air Volume

T. During Unoccupied Periods (period of non-use for procedures or when vacant), operating room air volume shall be reduced to as low as 6 air changes per hour, while maintaining a positive pressure in the surgery room of 0.20” minimum (required air balance). The control for the Occupied/Un-Occupied modes shall be automated through the use of room occupancy sensors that will initiate a switch to Un-Occupied mode once a 15 to 30 minute (User adjustable) timed delay expires after the room has been vacated; and it will switch back to Occupied mode following a 3 minute delay once occupancy has been sensed. An illuminated visual indicator of HVAC Mode (Occupied / Un-Occupied) shall be provided within the surgery room.

U. Utilize occupancy sensors in common areas (e.g. meeting rooms, corridors, janitor closets, public restrooms, etc) to reset thermostats to unoccupied status and to turn lights off (see Electrical section 6.15 for additional information for lighting control).

V. Unless otherwise specified, all VAV static pressure (through supply fan VFD) shall be controlled utilizing critical zone reset (aka critical zone loading). Static pressure set point is continually adjusted (reset) so that at least one
terminal unit in the system is 90% open. The static-pressure controller monitors the position of each terminal unit and resets the duct-static-pressure set point based on the critical zone terminal position.

W. Provide open protocol BACnet access to the chiller and boiler local controls. Written site specific exemptions for LonTalk may be requested from AFMSA/SG8FE.

X. Chilled water control valves at air handling units shall be two-way, modulating, type that will vary the water flow properly through each coil to meet the building load. Valves are to have shut off pressure rating adequate to close off against pump maximum discharge pressure.

Y. Design systems to maintain water flow through coils, heat exchangers, towers, pumps, piping, exposed to temperatures below 32 dF. Provide heat trace or other freeze protection for exposed utilities as required.

Z. Heating water system supply temperature set point shall utilize outside air reset schedule to maximize efficiency.

AA. When an AHU is renovated or replaced, provide outside air (OA) flow measuring stations to control and monitor OA flows. Return air duct mounted CO2 sensors shall NOT be used for OA controls. Provide OA flow stations that are not subject to clogging.

AB. For spaces where humidity requirements are not specifically prescribed under UFC 4-S10-01 Appendix A, humidity control shall be designed to maintain an envelope of 30% to 60% RH during normally occupied periods. The design engineer shall determine the interior RH based on the outside air condition and interior latent loads. Humidifiers shall be provided if the analysis indicates that RH will drop below 30% during periods of occupancy. In this case, it is acceptable to provide a humidifier at the outside air make up unit (if available) or in the AHU's to improve general indoor RH condition.

AC. All humidifiers shall have duct mounted high limit humidity sensors to prevent relative humidity above 80% in the supply air duct.

AD. All exhaust fans shall be controlled and monitored by BAS.

3.0 Testing, Adjusting, and Balancing of Air and Water Systems

All new or renovated HVAC systems shall be tested and balanced pursuant to Associated Air Balance Control (AABC) or National Environmental Balancing Bureau (NEBB) standards.

3.1 Experience and Knowledge of the TAB professional(s) and/or TAB firm

The qualifications, experience and knowledge of the TAB professional and TAB firm shall be identified, within the proposal. TAB professional shall have at least 5 years healthcare experience and be certified by NEBB or AABC

3.2 TAB Definitions

For purposes of clarification, the word “Owner” is synonymous with Medical Group Facility Manager. The term “Government” is synonymous with AFMS.

3.3 TAB Requirements

A. TAB shall be accomplished for any system downstream of the equipment modified

B. All phases of the TAB work including preplanning, execution of field work, and reporting requirements shall be in strict accordance with the National Environmental Balancing Bureau (NEBB) Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, 2005 – 7th Edition. Similarly, strict compliance with the Associated Air Balance Council (AABC) “Test & Balance Procedures”, latest edition, shall be acceptable. All TAB
work shall be executed and reported according to one of the two aforementioned industry standards without exception.


3.4 TAB Submittals and Approvals
A. During the submittal phase of the project, and before the TAB firm provides any billable work on the project, a statement of qualifications must be submitted and approved. The submittal will be provided through the typical submittal process and be reviewed and approved by the Contractor. Upon approval of the Contractor, the submittal must be forwarded to the Design Engineer of Record (DoR) for review and approval. Upon DoR approval, the TAB qualification submittal shall be forwarded to the AFMSA/SG8FE engineer for review and approval. Only after such submittal and approval is complete shall the TAB agent start work and provide services on a project.

B. The submittal shall follow NEBB or AABC standards.

3.5 TAB Preplanning Requirements
A. For projects that include renovation or modification of an existing HVAC (air and/or hydronic) system, the TAB agent MUST obtain engineering performance and design data for the current existing system BEFORE the proposed/current project modifications. The system operating design values must be obtained by the TAB agent.

B. The DoR and AFMSA/SG8FE representative will review the TAB Agent’s preplanning documentation and project preparation before field work is started.

3.6 TAB Reporting Requirements
A. The TAB agent shall communicate with the contractor and DOR on progress toward work complete and report and address problems as encountered on the project. The TAB agent shall communicate the system deficiencies to the contractor in written form and may provide recommendations for resolving such items.

B. The final TAB report with summaries, explanations, and notes, with the AABC or NEBB professional’s stamp and signature shall be submitted to the contractor and DoR for review and approval. Upon that review and approval, the report shall be submitted to the AFMSA/SG8FE representative for review. The signatures of the TAB agent, Contractor, and DOR shall be on the report before it is submitted to the AFMSA/SG8FE representative.

4.0 Commissioning of HVAC Systems –
The functional testing (also referred to as “Commissioning” or “Cx”) shall be performed in accordance with ASHRAE Guideline 0.

4.1 Functional Performance Testing Prerequisites
The contractor shall have the following documents and items on the project site when the CxA (Commissioning Agent) arrives on site. If the completion of a task or availability of any document or component is questionable, the Cx should
not be scheduled. The CxA will spend the first day on site reviewing this documentation in detail BEFORE any system testing is started:

A. The FINAL Test and Balance (TAB) report with design engineer’s written review and approval (including seal).

B. The final construction documents. This includes the final drawings, specifications, SOW, and “Best and Final” accepted proposal.

C. The written controls sequence of operation. The document must be clear and include the sequence of operation for each and every system component including: fan speeds, duct pressure, valve modulation, damper modulation, alarms, special cycles, lead/lag, air temperature, overrides, occupied/unoccupied, and all other sequences.

D. A minimum of five days of trend logs for each system modified or installed in the contract. The five days must include a weekend. All overrides and global set points must have been released and the systems in full automatic operation during the trend log data sampling. For each air handler trend logs must include: outside air temperature, return air temperature, return air humidity (or space humidity), mixed air temperature, leaving coil(s) air temperature, supply air temperature, heating valve(s) position, chilled water valve position, return fan speed, supply fan speed, supply duct static pressure, return air damper position, outside air damper position, and set points for supply air temperature, supply duct static pressure, and mixed air temperature. The sample shall be each five minutes. For a minimum of five VAV boxes per individual system trend logs shall include: inlet air temperature, discharge air temperature, heat valve position, air damper position, space temperature, space temperature set point. For water cooled chiller point shall include: CHW entering and leaving temperature, CDW entering and leaving temperature, percent load (compressor amperes), cooling tower fan speed, cooling tower bypass valve position. For other systems, consult the CxA prior to setting up trends.

E. A written summary document defining each part of the project that the final system deviated from the original design, intent, or “best and final” proposal.

F. A written statement signed by the controls contractor that all controls have been calibrated, completely programmed per the approved sequence of operation, and graphics complete and installed for use during Commissioning.

G. Owner Training documents to include written Training Agenda and sign-in sheets for each system for which training was provided.

H. Operation and Maintenance manuals.

I. Final As-Built drawings.

J. All required third party testing and certification documents. This includes fire alarm/detection system, fire sprinkler system, and certification of air exchanges and pressure relationships of patient care areas including operating rooms, isolation rooms, and others as required by AIA and ASHRAE.

4.2 Other Requirements of Functional Testing

A. During Commissioning, the General Contractor, Mechanical Contractor, Controls Contractor and TAB agent must be present. The design engineer of record shall also be present. The Controls Contractor must be the same individual who actually wrote and installed the sequence of operation programming.

B. If the manipulation of the digital control system will be on a laptop, an external monitor of at least 22” must be provided during the Cx process for group viewing of the system commissioning.
4.3 Functional Testing On-Site Review Steps

A. The first day will include the review of documentation described above.

B. The second step of the Cx process will be the site inspection of the systems and equipment modified and installed in the project scope. The CxA will perform physical inspection of the installation and equipment condition to determine any part that does not meet the design intent, construction drawings, code requirements, is incomplete, has not been properly tagged/identified, or not installed in a “workmanlike” manner.

C. The third step of the Cx process will be the validation of the TAB report. The CxA will randomly select a sample of the TAB readings from the final TAB report for this function.

D. The fourth and final step of the Cx process will be the verification of the programmed sequence of operation and manipulation of the controls sequence of operation. This is a dynamic process and may not follow an exact predetermined plan. As system inputs are changed and the system reacts, deficiencies are manifested that may not be expected. Therefore, the controls are verified through a dynamic and flexible process directed by the CxA.

E. Items found to be deficient during this process will be documented and included in a Cx report for correction. Items determined deficient can be the contractor, engineer, owner, or TAB agent’s responsibility to correct. Upon completion of all corrections, the contractor shall forward a written response describing the corrective action, date corrected, and person making correction to the CxA for review and approval. During Commissioning, if the majority of deficiencies are adjusted and corrected on site, then the process may continue and be acceptable. However, if the proper paperwork is not on site, is found to be inaccurate, cannot be verified, control of the systems is not per design intent, sequence of operation is not as approved in design, systems cannot maintain design set points, and/or the proper contractor functions are not present to perform testing, then the Commissioning process may be declared a failure and rescheduled. This rescheduling will not be cause for justifiable contract extension to complete the project.

F. The BAS system, while in automated mode, shall perform all control functions without human intervention. Should a discrepancy that requires programming or alteration in the control programming be experienced, the test of the BAS must be completely re-accomplished to demonstrate the discrepancy did not affect other elements of the system previously tested.

5.0 Plumbing Systems Including Medical Gas and Fire Protection

5.1 Waste and Supply Piping

5.1.1 General

A. Sanitary sewer (SS) “main” as well as all main laterals shall not be less than six (6) inch diameter.

B. Sanitary sewer piping shall be CPVC and where handling high temperature effluent the first 10’ shall be cast iron before transitioning to CPVC.

C. Supply piping shall be Type L Copper.

D. Designs shall not create (and in renovations shall eliminate) "deadlegs" in the domestic hot water system. Non-recirculating domestic hot water supply pipes shall not exceed six feet (6 ft) from the circulating main pipe.

E. Domestic hot water systems shall include a recirculation piping and pump system to continuously circulate hot water in the system. The time taken for the Domestic hot water to reach a minimum 5°F temperature rise at any fixture outlet shall be no more than 10 seconds..
F. Design shall eliminate domestic hot water storage, tube and shell heat exchangers, steam to water converters as much as possible. Multiple parallel, condensing, high efficiency, rapid recovery water heaters shall be the basis of design.

G. Design purified water systems with polyethylene or schedule 80 PVC pipe and fittings. No glass pipe is allowed.

H. Natural gas piping shall be schedule 40 steel.

I. All new water and gas meters shall communicate with energy monitoring system and are subject to AFMSA/SG8FE approval.

J. Connect domestic water heaters and pumps to the BAS. Provide firing rate for heaters, supply water temperature, return water temperature, status of recirculating pump, and control of auto isolation valves.

K. Provide thermostatic mixing valves for each separate hot water temperature supply system. Monitor supply water at discharge of mixing valve with BAS connection.

L. Plumbing supply pipe shall be insulated with preformed fiberglass pipe insulation with FSK jacket. Label all pipe as described in section 2.

M. All new buildings shall provide separate condensate hub drains and separate piping system for future condensate collection system. Whenever practical for renovation projects, collect cooling coil condensing water for non-potable water applications such as irrigation or cooling tower makeup.

5.1.2 Fixtures

A. Waterless urinals are NOT allowed.

B. Auto sensor operated flush valves and hand wash faucets shall be used in public restroom areas.

5.2 Medical Gas Systems

5.2.1 General


B. Provide zone valve boxes with a minimum of one spare space for future gas pipe and valve.

C. Provide area alarm panels with a minimum of one spare space for future gas alarm.

D. Main piping shall be sized one pipe size larger than calculated requirement.

E. Basis of design for medical air compressors shall be assemblies with multiple oil less scroll compressors. No reciprocating or oil sump air compressors are allowed.

F. Basis of design for medical vacuum pumps shall be rotary oil-less type.

G. Connect medical gas source equipment to the BAS to show status of equipment, motors, compressors, as well as supply pressure of the system at the source equipment.

5.3 Fire Protection Systems

5.3.1 General

A. Fire protection systems shall conform to all NFPA and UFC standards.

B. Wet pipe sprinkler piping shall be schedule 40 steel for all threaded pipe and schedule 10 steel for all grooved pipe. CPVC piping may be allowable only on branch laterals. Flexible stainless steel braided pipe may be used for connection to the heads. The flexible pipe cannot be kinked.

C. Install new or modified sprinkler system heads in the center of ceiling tiles.
D. The sprinkler piping shall not be installed directly on top of the ceiling and shall be coordinated with the general contractor, mechanical contractor, and the project engineer before any pipe is installed.

6.0 Electrical Infrastructure Systems

6.1 General Requirements
A. Pursuant the HQ Air Force Civil Engineer ETL 10-2: Light-Emitting Diode (LED) Fixture Design and Installation Criteria for Interior and Exterior Lighting Applications, dated 18 Mar 2010, LEDs are not permitted for use as luminaires inside Air Force facilities (which include AFMS facilities). The only exception is for exterior lighting, task lighting, lighting in display cases and bulletin boards. Refer to AFEC ETL 10-2 and UFC 3-530-01 for additional information.
B. Interior Electrical Distribution (600 volts or less). Interior lighting and power loads shall be served at the highest voltage available.
C. Light Fixture Type - Fluorescent lighting shall be T-5 or T-8, (T-8 lamps shall be limited to 28 watt) electronic ballast and supplied with 277/480 volt system. Exemption: Electronic ballast with RFI filters shall be used in operating rooms, delivery rooms, laboratories, special procedure rooms, MRI areas, medical equipment repair and test areas.
D. T-5 High Output (HO) fluorescent lighting will be used in high ceiling areas (over 20') and mechanical machine rooms and warehouse areas in lieu of HID.
E. Dry type transformers shall be utilized to provide 120/208 volt power for 120 volt lighting, receptacle and small equipment loads. All dry type transformers shall be copper wound, NEMA TP-1 compliant; K-rated based on non-linear load content and shall be wired and grounded as a separately derived system.
F. Switchgear and switchboards shall be listed as an assembly. NOTE: in OCONUS locations equipment shall comply with all local host-nation standards.
G. Medical hospital switchgear shall be configured incorporating a Main/Tie/Main configuration. Breakers shall be electrically operated, of draw out design, with solid state overcurrent, short time instantaneous and ground fault (if required) adjustable trip devices.
H. All branch circuit distribution panel boards shall be of the bolt-on circuit breaker type and equipped with a main breaker for multi-story buildings only.
I. Ground fault protection shall be coordinated for selective overload, short-circuit and ground fault protection.
J. Bus-in switchboards, panel boards and transformer windings shall be copper. Aluminum bus or aluminum transformer windings are not allowed (Exception – Aluminum windings are allowable on large pad mounted liquid filled power transformers greater than 1500 kVa.)
K. New electrical meters shall have "Modbus RTU Communication" capability for future energy consumption monitoring applications.

6.2 Location and Space Requirements
A. Electrical equipment rooms shall be located at or near the building exterior to facilitate initial installation, maintenance and when necessary the replacement of large equipment or defective equipment. Equipment physical dimension, aisle ways and doorways within the electrical and mechanical equipment rooms shall be so sized, spaced and arranged to permit the movement of physical plant major equipment assemblies without
having to completely disassemble said apparatus. Pipes and other equipment foreign to the electrical equipment shall not be located in, enter, or pass through such spaces or rooms. At all times the provisions and requirements for clear working space as stated in NFPA 70 must be met.

6.3 Conduit, Cable Tray and Wire.
A. All wiring shall be insulated copper in conduits and installed per NFPA 70 and UFC 4-510-01. Metal enclosed feeders, plug-in bus-ways or surface metal raceway may be used.
B. Conduit fittings for Electrical Metallic Tubing (EMT) shall be compression steel type.
C. Conduits 1-1/4” trade size and larger shall have grounding bushings. All others shall have plastic or fiber bushings.
D. All conduits and other wall penetrations shall be sleeved and fire stopped.
E. All conduits terminating at vibrating equipment shall utilize water-tight flexible metal conduit, the flexible metal water-tight conduit shall not exceed 36”.

6.4 Grounding Conductors
A. A green insulated copper ground conductor shall be run with all branch circuits. A clearly marked and identified grounding conductor shall be installed with each feeder.

6.5 Critical Care Panel-boards
A. Branch circuit panels serving critical care areas shall be located in the vicinity of their loads. Under no circumstances shall a panel-board be placed in a hallway.

6.6 Critical Care Wiring
A. Wiring in all patient care areas, the life safety branch and critical care branch circuits of the essential electrical system shall consist of insulated conductors installed in a separate metallic raceway. Open cable trays are not be used in the main switchgear room or generator room. Conductors installed to furnish emergency power shall not be installed in the same raceway with normal power conductors. All normal and emergency power junction boxes pull boxes and similar parts shall be readily accessible with clearly identified access panels for proper maintenance and operation of the electrical distribution system.

6.7 Hospital Grade Receptacles
A. Hospital grade receptacles shall be provided in the following areas and annotated as “HG” receptacles on the final as-built drawings:
- General care patient bed locations.
- Critical care patient bed locations.
- Any location where a patient bed or patient care service console is located.
- Anesthetizing locations, operating rooms, delivery rooms, oral surgery, cystoscopy, cardiac catheterization lab, angiography, CT scanning room, MRI scanning room, medical maintenance, intensive care, emergency trauma rooms, fluoroscopy rooms, endoscopy rooms, pulmonary/respiratory therapy, and nuclear medicine.
6.8 Ground Fault Circuit Interrupters (GFCI)
   A. Hospital grade Class A GFCI receptacle protection shall be provided at locations required by NFPA 70 and “WET” locations. GFCI are NOT to be installed on circuits serving critical life support equipment.

6.9 Wet Locations
   A. GFCI receptacles shall be used in the following locations: Hydrotherapy, Therapeutic Pool Areas, and Toilet Areas with Showers, Staff Lockers with toilet areas, patient toilet bathrooms, showers, staff lounge with kitchen facilities, outdoor receptacles, receptacles accessible from a building roof, and crawl spaces. Sub-sterile and scrub areas to Surgery and Delivery are classified as “DAMP” areas and GFCI receptacles are not required.

6.10 Operating Room and Delivery Room Receptacles & Power Requirements
   NOTE: Operating and Delivery Rooms shall be considered as “wet procedure locations” and require the utilization of Isolation Panels unless a complete risk assessment is completed in accordance with NFPA 99.
   A. Surgery, Operating and Delivery rooms shall be provided with at least thirty-six (36) each simplex or duplex receptacles. Twelve (12) shall be located in each service column and six on each wall mounted 3 feet above the floor. These receptacles shall be 20-ampere, 125-volt, 2-pole, 3-wire, straight blade, grounded type.
   B. Each Surgery, Operating and Delivery room shall also be provided with at least one (1) each 60-ampere, 250-volt, 2-pole, 3-wire, twist lock, ground-type flush mounted receptacle for mobile fluoroscopy unit or laser photo coagulator.
   C. Each Surgery, Operating and Delivery room shall be provided with two (2) each three phase panel-boards located within the respective room. These panels shall be fed from a separate critical branch subpanel and whenever practical from separate critical branch automatic transfer switches. Panel phases shall be connected in the same phase arrangement.
   D. Patient Care Area Grounding. General care areas and critical care areas including all anesthetizing locations shall be provided with a grounding system as required by, NFPA 70 and NFPA 99. Grounding system design and initial testing shall be included in the contract documents.

6.11 Medium Voltage Apparatus (Above 600 Volts)
   A. All exterior medium voltage switchgear, transformers, cable junction pedestals and vacuum switches shall match and meet the published requirements, including color, manufacturer and construction type of the local base.
   B. All medium voltage switchgear enclosures shall have site glasses installed that provide visibility switch contact positions and operable connections. Switchgear enclosures shall also be equipped with removable panels and inspection ports that provide an easy and safe view and infrared thermal inspection of critical connection points.
   C. Switchgear, transformers and other similar apparatus that is to be positioned outside on grade, shall be provided a permanent foundation with substantial footing on compacted soil to support the apparatus. Pre-formed concrete pads are not acceptable.
   D. Transformers shall be:
      • Fused protected on the primary (H) side of the coils
      • Equipped with a load break on/off switch
      • Non-PCB, mineral oil or silicone oil filled
      • Loop feed-through load-break elbow connected with parking stands and arresters.
• Equipped with no-load tap changers with two +2.5% taps and two -2.5% taps.
• Newly installed cable junction pedestals and/or "sectionalizers" shall match any published standards for the existing base. The cable pedestals shall contain sections for both 600 amp and 200 amp connections. Cable junction pedestals shall not be placed on a pre-formed concrete pad.

E. Medium voltage electrical cable shall be 133% insulation, Type MV-105, EPR, ribbon shielded unless otherwise directed by base requirements.

F. Medium voltage underground conduit shall be schedule 40 PVC, except for 90 degree elbows, which shall be long radius rigid conduit. Four (4) inch trade size minimum and shall comply with any local base standards.

G. All underground conduits shall be installed in a minimum depth of 3’ and encased in a minimum of 3” of red concrete and shall have a traceable marking tape placed not less than 12” above the concrete encasement which marks the hazard.

H. All conduits emerging from grade shall be corrosion wrapped or PVC coated rigid metal conduit (RMC). The first elbow shall be a long radius RMC.

I. All conduit terminated at the concrete pad shall have a grounded bushing installed.

J. Grounding electrodes (rods) shall be copper clad and a minimum 5/8” diameter and at minimum of eight (8) feet in length or longer as necessary to achieve an adequate ground path. Ground wire shall be a minimum 2/0 AWG stranded bare annealed copper wire and all connections must be either exothermic weld or irreversible compression fittings. Ground field resistance shall not exceed 25 ohms.

6.12 Hospital Electrical Utility Main Service Entrances

A. Hospitals shall require more than one (1) utility feeder (from separate utility sources) and Main-Tie-Main, best-source, auto-throwover switchgear.

6.12.1 Hospital low voltage main service entrance switchgear

A. Shall be listed as an assembly and contain two (2) main breakers and a bus tie breaker. The “A” Bus and “B” bus breakers shall share equal loads during normal operation, which is with the “TIE” breaker in the open position. These breakers shall be electrically controlled, electrically interlocked and with closing coils or operators powered from a DC control power battery bank or stored energy as necessary for an “Automatic Throw-over” in the event power is lost at either the “A” Main breaker or the “B” Main breaker. Load shall initially be distributed such that neither side supports more than 60% of the total load.

6.12.2 “Best Source Select” Controls

A. If power is lost at the “A” Main breaker, the “TIE” breaker shall close electrically, the “B” Main breaker remains closed and the “A” Main breaker remains open. In the event either A or B breakers opens and the Tie closes, and audible or visual alarm device shall be initiated. Once power is restored to the “A” Main breaker, the switchgear shall be user selected automatic or manual return back to the normal configuration with both the “A” and “B” breaker closed and the “TIE” breaker open. User selected manual return allows for switching back to normal at a time when minimum disruption to the facility will occur. The switchgear shall also provide a digital display for both “A” and “B” bus which consists of voltage phase to neutral, phase to phase, amperage for all three phases, neutral current, KVA, KWH, and complete history.
6.12.3 Status Display

A. A graphical display shall be provided on the main panel door(s) which illustrate the current configuration and display the voltage phase to neutral, phase to phase, amperage for all three phases, neutral current, KVA, KWH, and complete history of all primary input feeders and breakers. The switchgear shall be controlled electrically by a non-proprietary Programmable Logic Controller (PLC).

B. All circuit breakers shall be electrically operated, draw out type with digital or electronic trip modules.

C. Load bank Connection - The generator switchgear shall be equipped with a breaker protected cubicle with suitable quick connect stabs for the connection of an external load bank.

D. Service Entrance Grounding - Each hospital main electrical room shall have a ground counterpoise system installed and connected to building steel and the main water supply with a minimum 4/0 AWG stranded copper conductor and shall provide a reading of less than 25 ohms. Ground reading locations shall be marked and visible to the maintenance provider. All electrical equipment in the electrical room shall be connected to the counterpoise system by utilizing either exothermic weld connection or compression connections. Where more than one service is provided, each service ground system shall be bonded together at a common point to equalize the ground potential.

6.13 Main Utility Room, Generator and EES Room Lighting.

A. Lighting in the main electrical switchgear rooms shall be T-5 HO fluorescent lights with battery ballasts, to facilitate ease of switching and repairs. Lighting shall meet the requirements for ASHRAE lighting power density and controls.

6.14 Essential Electrical Systems for Medical Healthcare Occupancies

A. The essential electrical system shall consist of at least two (2) (N +1) diesel engine generator sets; automatic transfer switches with maintenance bypass capability (for essential loads), user selectable priority load management control systems and paralleling switchgear.

B. The essential electrical system shall not be provided with ground fault protections devices. The generator circuit breaker and essential electrical main distribution board circuit breaker will be provided with ground fault detection features to indicate a ground fault and sound an audible alarm but not trip the breaker.


Generator sets and auxiliaries shall be sized and approved in accordance with AFCEC ETL 13-4, C1, dated 15 May 2014 and located as close as possible to the hospital to minimize line losses and prevent excessive cable runs. Service entrance transformers and other equipment not supporting the essential emergency system shall not be installed in the same room as the engine generator sets. When configured as a pair (2 generators), each generator sets shall be
individually sized N+1 and capable for indendentlly carrying 120% of the Life Safety, Critical Care and Essential Equipment loads continuously for at least 72 hours. When configured in a three (3) generator plant, each generator shall be sized such that any one generator can carry the Life Safety and Critical Care load; and two generators can carry 120% of the Life Safety, Critical Care and Essential Equipment loads continuously for 72 hours. The alternators shall be brushless, 60 Hertz, 277/480 volts, except in overseas areas where local conditions will dictate different system voltages and frequencies.

A. Prime mover emissions shall meet the minimum requirements of Tier II requirements unless local published standards are more stringent.

B. Generator diesel muffler/silencers shall be rated for “residential” attenuation. Recommend critical grade silencers and total system noise attenuation performance to be measured at 70dB weighted “A” scale at 50’0” from openings at grade.

C. Fuel supply in the day tank shall sized to provide for 4 hours run time. The main tank shall be sized to provide a minimum 96 hour run time for the plant at full rated load pursuant ETL 13-4, C1 dated 15 May 2014.

D. All raceways/conduits within the generator room shall be Intermediate Metallic Conduit (IMC) or RMC; and transitions for terminations shall be water-tight flexible metal conduit.

E. The generators shall be electric start, contain jacket water heaters and pre-lube pumps as necessary to provide fast and reliable start response.

F. The radiators can be either skid mounted or remote mounted, however if the radiators are skid mounted, a metal shroud shall be installed to direct the air intake.

G. The generator room shall be equipped with ventilation exhaust fans that run upon generator start up, and maintain the interior environment while operating at rated load on an ASHRAE design day.

6.14.2 Generator Paralleling Switchgear

A. Generator switchgear shall be listed and tested as a complete assembly and controlled by a non-proprietary Programmable Logic Controller (PLC). The PLC circuitry shall be powered by an uninterruptible power supply (UPS) and part of the Life Safety branch. The generator switchgear shall also provide for temporary generator connection, these connections shall be in a separate enclosure and terminations shall be in accordance with AFCEC ETL 10-7.

B. The control board shall provide individual flat screen illuminated color graphical displays for each generator panel door and similar flat screen color graphical display on master control cabinet door that illustrates the entire EES system. The graphical displays shall incorporate animation graphics which simulate operations, movements, position changes and flows consistent with the actual functions.

C. PLC Alarm and Event History/Log - The PLC will have a non-volatile memory and user friendly report generator that can display and generate an alarm, systems operations, fault/failure, test and event chronological log/record/report. The PLC memory shall be capable of storing at least 20,000 critical events that cannot be purged or erased from memory, and 100 gigabytes worth of memory for non-critical data where the oldest non-critical events can be downloaded and/or erased when no longer required.
D. Priority Load Management – Healthcare essential electrical loads are divided into three categories: Life Safety, Critical Care, and Essential Equipment Loads. In some locations, a fourth (4th) priority is established for critical “mission” loads such as the Medical Command Center and communications. All other loads are considered “non-essential” must be sacrificed (shed) to salvage the higher priority loads should the system become overloaded. Sensing shall be accomplished through the use of a watt-transducer and as the system approaches capacity (80% of the available generator rating), load management will be initiated and shedding of lesser priority loads shall commence until at or below 70% of the available generator capacity, or added generators are brought on-line to accept and/or reduce bus load. The order for shedding loads is in reverse order of importance. The first load to be shed is all non-essential loads, followed by the essential equipment load (with the exception of the Fire Pump and Fire Pump Controls), then the critical care load. The Life Safety load is never shed and the EES will run to failure to protect this vital load.

6.14.3 Automatic Transfer Switches (ATS)
A. All ATS shall be double-throw, 4 poles with draw-out design/ construction and grounded as a separately derived system. All ATS shall be listed as an assembly and shall be factory assembled (to include the ATS enclosure). ATSs shall have indicator lights to identify Normal Power (green in color) and Emergency Power (red in color). Where multiple ATSs are employed, the physical arrangement, lights and indicators shall be arranged alike as to not confuse the operator when visually scanning all systems.
B. All Life Safety and Critical Care loads shall have ATS equipped with no load break by-pass isolation switch and must be initiated with no more than two movements of the hand to either position regardless of the position or condition of the ATS to maintain normal or emergency power while the ATS is being repaired or maintained.
C. Load by-pass must be achieved with no load interruption.
D. ATSs feeding high efficiency motors rated 25 horsepower or larger shall be provided with an in-phase monitor to prevent an out of phase transfer. The in-phase transfer shall be achieved without control of the frequency of either power source to prevent excessive motor in-rush current. Closed transition switches shall not be utilized. By-pass isolation switch for the ATS serving non-essential loads are optional.
E. Each ATS shall be equipped with a manual “TEST” switch. Each “TEST” switch shall simulate a normal power source failure and automatically cause the engine generator set to start, attain rated frequency and voltage, and transfer associated electrical system loads from the normal source to the emergency source.
F. Depending upon the number of ATSs a group of switches may be installed at a centralized location in order for the operator to conduct the test at a single point. These switches shall be wired in series with its corresponding ATS.

A. A remote alarm annunciation panel that is storage battery powered shall be provided in a location readily observed by facility management personnel at a regular work station. The annunciation panel shall indicate alarm conditions of the alternate power source and shall include as a minimum the following:
   • Battery and battery charger malfunction.
   • Engine generator runs status.
   • Engine generator alarms.
• Fuel levels, less than 4 hours supply in the day tank and less than 96 hours supply in the main storage tank. A separate audible and visual derangement signal shall be provided within the hospital at a location that is continuously monitored such as a nurse station. The derangement signal shall be appropriately labeled but need not display individual alarm conditions.

6.14.5 General Emergency Electrical Systems Requirements

A. When converting an inpatient hospital into an outpatient clinic, the existing emergency power system (generators, switchboard and transfer switches) shall be modified to only one emergency generator and one emergency power circuit to feed egress lighting, certain mechanical loads (to be determined) to preserve the building in the event of an extended power outage, fire alarm and security panels, the server room, the laboratory and immunizations. No other loads are authorized and the generator and transfer equipment shall be sized to the mentioned loads. Any new emergency power generator must first be requested and authorized pursuant to AFCEC ETL 13-4, C1 dated 15 May 2014.

B. When the facility renovation (typically Level II and Level III) drives the replacement or redistribution of building electrical power distribution systems in the building an opportunity for the removal of the Emergency Power generator will be leveraged. When removing the generator and redistributing generator power the following features shall be provided:
   b. A four pole manual generator power transfer switch and generator twist-lock quick connect box (disconnecting means) properly sized to support the refrigeration loads discussed in Para 4.15.4.1.3 plus 20% shall be installed in an exterior location where a portable generator can be easily connected to the twist-lock quick connect junction box. The manual transfer switch can be located in an electrical closet, electrical room or mechanical room. If the manual transfer switch is to be located on the exterior of the building, it shall be at minimum NEMA 3R. In lieu of a manual transfer switch, a circuit breaker assembly with kirk-key interlocks will be acceptable. If the circuit breaker assembly is utilized a permanent, complete set of written instructions for kirk-key operation and circuit breaker operation must be attached to the assembly or enclosure.
   c. An electrical distribution panel board properly sized to serve mission critical refrigeration equipment power outlets that are required in the following sections, no other loads are authorized.
      • Pharmacy refrigeration equipment.
      • Laboratory (mission critical) refrigeration equipment.
      • Immunizations clinic refrigeration equipment.
      • Logistic (war reserve material) refrigeration equipment.
   Where possible, these loads will all be served by a centrally located panel board which is to be connected to the load side of the manual portable generator transfer switch.

6.15 Energy Conservation and Sustainable Requirements.

A. Do not exceed 80 percent of the lighting power densities for exterior areas and 50 percent for building facades and landscape features as defined by ASHRAE/IESNA Standard 90.1-2010. Lighting controls shall be utilized to reduce energy consumption.
B. Lighting controls systems shall be provided to turnoff lights automatically when the space is not in use. Provide duel technology occupancy sensors in non-occupied spaces (corridors, class rooms, conference rooms and break rooms etc.) and other common areas (building entrances, lobby areas, waiting areas and cafeteria etc.). Provide daylight controls to automatically turn off certain lights while day light is sufficient. Lighting in office areas and outpatient clinic spaces shall be scheduled off during off hours or controlled by motion sensors. Consider using day lighting technology in design, such as light shelves, to bring light further inside of the building and reduce glare. Provide task lighting where appropriate. In patient rooms, for an example, task lighting facilitates exams and can be turned off so patients rest in lower ambient light level.

C. Motor Efficiency. Motors shall be high-energy efficient type. Minimum motor efficiencies shall be either Energy Star or in accordance with DOE Buying Energy Efficient Products Recommendations (reference to www.eren.doe.gov/femp/procurement for recommended efficiencies).

D. All equipment and systems selected for this project shall be energy efficient. The goal is to reduce 30% from the consumption levels calculated under ASHRAE Standard 90.1-2010 standard.

E. Building Lightning Protection Systems shall be required and installed in areas pursuant UFC 3-575-01 and NFPA 780. UFC 3-575-01 prescribes that unless lightning frequency at the project site averages five or less thunderstorms per year, lightning protection will be provided for buildings and structures as follows:
   - Buildings of up to four floors having elevator or stairwell penthouses or other similar projections above roof.
   - Buildings of five floors or more with or without projections above roof.
   - Structures such as steel towers, aluminum and reinforced concrete towers, and flagpoles without inherent grounding, and smoke-stacks and steeples of 50-foot elevation or more above lowest point of contact with finished grade.

F. Surge Protective Devices shall be installed pursuant to UFC 3-520-01, Interior Electrical Systems, dated 3 February 2010. The number, type of surge protective devices or determination if surge protective devices are required shall be made during design.

6.16 Fire Alarm System

A. The fire alarms system shall be designed by a registered professional Fire Protection Engineer (or NICET III/IV certified designer) approved by the Authority Having Jurisdiction (AHJ) and AFMSA prior to commencement of installation. All drawings must be approved and stamped by a registered professional Fire Protection Engineer prior to installation.

B. Reporting system as a means for automatically and manually reporting fires to base fire departments. Fire alarm system must meet the requirements of Para. 5-2.3 UFC 3-600-01

C. The Fire Alarm System Installer shall be a qualified and licensed fire protection technician.

D. The signaling devices shall be mounted on the ceiling.

E. Pull stations shall conform to ADA height and location requirements.

6.17 Conduits
A. Prior to reutilizing any existing fire alarm conduits, conduits must be inspected for damage, loose connections and loose straps
B. All existing wires and cables must be removed.
C. Any additional conduits attached to the existing conduit run must conform to this design guide section 4.3 Conduit, Cable Tray and Wire.
D. Mass Notification system shall be installed in conjunction with a new fire alarms system as outlined in UFC 4-021-01 and NFPA 72.

7.0 Building Envelope & Roofing Systems

General Requirements

A. The contractor shall protect interior of facility from asphalt, asphalt smoke, smoke, chemicals, adhesive odors, paints, dust, debris, water damage and/or any other construction activity that would cause damage to the facility, its contents, building structure, building components or its occupants.
B. Roofing submittals shall contain a letter of transmittal, all technical product data sheets for all materials, project schedule, shop drawings, MSDS sheets, and samples of all materials. Also, a letter of acceptance from the manufacturer stating their product is acceptable for this applied system, design uplift calculations and other structural loads, copy of warranties, color charts, installation specifications, and certifications for kettle tenders, welders, and documentation of contractor’s experience for product application.
C. Set up work site to minimize damage to the buildings and grounds. Protect sidewalks, grass, and all other building and site components. Restore the site to preconstruction conditions, unless specified for enhancement in the contract. Damaged materials and equipment must be replaced and repaired by professional skilled trade-persons of that field/discipline (electrical, mechanical, plumbing, concrete and framing, etc.). Final inspection and acceptance shall be accomplished by the contracting officer’s technical representative.
D. Repair all components and associated defects in direct connection with areas to be repaired or replaced.
E. Provide for the safety of all construction workers, building occupants and passersby. Suitable protection and security must be provided during all phases of construction process, both during and after normal duty (business) periods.
F. Material Safety Data Sheets (MSDS) must be on location at all times during the transportation, storage and application of building materials.
G. Complete daily clean-up of site to include all construction debris.
H. Ensure employees are trained and certified to operate all equipment. When operating equipment, all employees must have proper documentation to demonstrate their qualifications to safely operate the particular equipment/tools being used. All operators of asphalt kettles, aerial lifts, forklifts, construction elevators or other equipment must be able to communicate with building personnel, fire and safety personnel, and other interested parties.
I. The design engineer shall conduct a vapor drive analysis for all building envelope systems scheduled to be replaced or renovated.
J. Ensure all building system components that penetrate the building envelope system are properly sealed and flashed to prevent moisture infiltration into the building (e.g. mechanical penetrations, roof flashings, window sealants, metal soffits, gutters, through-wall flashings, door sealants, terminations and transitions and all other
components.) Materials not previously approved for use through the submittal process shall not be used and should not be on the site.

K. Only new materials should be installed and shall have matching lot/batch numbers.

L. Wet and damaged materials must be discarded and removed from the site immediately. Wet or damaged materials found on the site staged for installation will be an issue of concern reported to the Contracting Officer (KO).

M. After leaks have occurred, the contractor shall replace all wet materials as necessary to restore the integrity of the building system and maintain a warrantable status by the manufacturer.

N. No new products or systems shall be installed over decayed, rotten, unsound or wet building systems. Building materials are but not limited to; concrete, mortar, EIFS, stucco, brick, metal, block wood or dry-board products.

O. The contractor shall be responsible for the removal and disposal of all obsolete penetrations and equipment including but not limited to roof curbs, vents, HVAC equipment, conduits, satellite dishes, antennas and cables, unless prior written variance from AFMSA/SG8FE is acquired by the contractor.

P. All repairs/replacements of building envelope system shall match the surrounding structure and building envelope components including but not limited to framing, decking, insulation, membrane, surfacing, color, etc. Contractor shall blend repair area's in appearance to match surroundings.

Q. Contractor shall make all repair/replacements as to maintain any in-place manufacturer's or contractor's warranties.

R. Building system components shall be designed at a minimum to withstand wind forces as calculated using the revision of ASCE-7 which is current at the time of award.

7.1 Structural Decks

A. All decks shall be inspected and repaired to except the new roofing system. Repairs shall not affect the slope or drainage of the new system. Use 5% of the square footage of the deck surface for all deck systems (excluding structural concrete) for a replacement allowance in the base price unless a different amount is specified in the proposed work scope.

B. Insure all decks have been thoroughly inspected and tested for defects. Fastener pull tests shall be performed per the ANSI/SPRI FX-1-2011 requirements for all concrete, lightweight concrete, wood, cementitious wood fiber, gypsum and metal decks when using mechanical fasteners to attach the new roof system to the deck. For mechanically attached building components, documented pull test data must be provided at 35% design.

C. All decks must be clean and dry before the application and installation of new materials. If it is necessary to protect building and begin work prior to drying, additional venting must be provided and protection sheets added as needed.

D. Replacement of damaged or deteriorated decking shall be of like type, material, thickness and profile. Deck attachment shall meet all applicable structural load requirements including live load, dead load and current uplift requirements. Document repairs to decks with photos.

7.1.2 Concrete Decks

A. Concrete deck damage is considered but not limited to: thermal cracks, settling cracks, spalling, corrosion cracking, swelling, d-cracking, crazing, and deflection. All repairs shall be made to ensure proper adhesion,
application and drainage of roof system. Provide documentation of moisture content (by moisture meter) or
Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method ASTM D4263 -
83(2012), prior to installing materials. Document the testing procedures with photos.

B. Cast in place and structural concrete decks must be dry and free from dust and debris. Prior to priming, all
loose and deteriorated materials from the existing system must be removed from the deck in order to
establish a clean and stable surface acceptable to the manufacturer of the roof system to be installed. All
surfaces shall be fully primed. Primer shall be applied per the manufacturer’s recommendations.

7.1.3 Metal Decks
A. Metal deck damage is considered but not limited to; scaled, corroded, blistered and un-adhered paints and
finishes, unattached metal panels, bent or buckled metal panels, excessive deflection, and areas that would
prevent proper attachment and drainage of the roof system.
B. Rust repair shall include wire brushing, sanding, scrapping, sand blasting and preparing for proper application
of rust inhibiting paints and/or coatings. Apply a minimum of two coats of corrosion inhibiting finishes per
manufacturer’s recommendations.
C. Insure all metal decks are fastened securely to building structure. Visually inspect all welds and fasteners for
weaknesses, rust, corrosion and cracks. Replace deteriorated deck fasteners and clips with new.

7.1.4 Lightweight Concrete/Gypsum
A. Lightweight concrete and Gypsum decks shall be completely removed and replaced in areas found to be
saturated (moisture levels over 25% by weight) or deteriorated to a point where fastener pullout values do
not meet minimum requirements. Moisture survey results must be provided at 35% design submittals.
B. Lightweight concrete and Gypsum decks must be vented per roofing system manufacturer’s specifications for
a medical facility.

7.1.5 Wood
A. Plywood
   • Plywood sheathing shall be CDX grade, minimum 4 ply, and not less than 15/32 inch (12 mm) thick.
   • Install deck over joists spaced 24 inches (610 mm) o.c. or less. Install deck with all sides bearing on
     and secured to joist and cross blocking.
B. Plank / Heavy Timber
   • Wood boards shall be at least 1 inch (25 mm) nominal thickness and have a nominal width of 4 feet
     - 6 inches (1372 mm).
   • All boards shall have a bearing on rafters at each end and be securely attached.
   • Cover knotholes or cracks in excess of 1/4 inch (6 mm) with securely nailed flat sheet metal.

7.1.6 Cementitious Wood Fiber and Gypsum Plank
A. Decks shall be protected from the weather during storage and application; any wet or deformed decking shall
be removed and replaced.
B. Anchor all panels against uplift and lateral movement.
C. Install deck level. Any deflection, irregularities, or otherwise damaged panels must be corrected or replaced.

7.2 Vapor Barrier
A. Moisture movement through the building envelope systems shall be controlled by a continuous vapor barrier when needed. The location of the vapor barrier shall be determined by the vapor drive analysis as described in the general requirements.
B. Installation shall be performed by a company specializing in vapor barrier application.
C. Perform work in strict adherence to the manufacturer’s instructions.
D. Obtain vapor barrier components from a single manufacturer.
E. Provide products which comply with all state and local regulations controlling the use of volatile organic compounds (VOC’s).

7.3 Wood Nailers
A. Wood nailers must be at least 3-1/2 inches (89 mm) wide or 1 inch (25 mm) wider than adjacent metal flange. Thickness must equal that of insulation but not less than 3/4 inch (18 mm) thickness.

7.4 Insulation / Cover Board
A. All insulations must be checked and documented for moisture upon delivery, unwrapped and stored according to manufacturer’s recommendations and approved industry standards. Store products on pallet supports in areas where no water will pond underneath the product, come in contact with and/or wick up into the materials. Re-wrap materials with approved breathable covers for optimal protection from water, sun and physical damage. Moisture content shall be checked and documented before application on the day of application. Wet or damaged; (damaged being warped, bent, cracked and wet), boards must be discarded and removed from the site immediately.
B. Uneven decks and obstructions must be removed and or repaired prior to installing base insulation.
C. The ideal method of attachment is a mechanically attached first layer (metal decks) with subsequent layers installed using hot asphalt or adhesives. Simultaneous attachment of all layers may be used in cold process and single ply applications. Engineered high wind area zone calculations will take precedence over this standard.
D. Insure all subsequent layers are properly bonded before proceeding to the next layer.
E. Rigid insulation board shall be installed in multiple layers, if thickness is greater than two (2) inches, with joints staggered in both directions. Joints shall be staggered minimum of twelve (12) inches. When installing with hot asphalt, no pieces larger than 4’ by 4’ ft. shall be used. When mechanically attached, 4’ by 8’ sheets may be utilized. No pieces smaller than four (4) square feet shall be installed. Provide for insulation stagger at all night time dry-in and cut offs.
F. Cover boards are noted as: plywood, perlite, gypsum board, asphalt coated HD fiberboard (coated on all sides), or any other boards designed to be used specifically for enhanced adhesion or compressive strength in a roof system.
G. All insulation and cover boards shall fit snugly to each other with no gaps over a ¼ inch; larger gaps cannot be filled and must be cut out to accommodate the minimum insulation board size.
H. Install crickets at all equipment, chimneys, penthouses and other roof top penetrations wider than 24 inches. Insure all crickets provide sufficient slope to maintain positive drainage.

I. Crickets are also required to provide sufficient slope to maintain positive drainage to internal drains and wall scuppers. Crickets are also required between wall and slope change interfaces or any other areas that may pond water.

J. All tapered insulation shall be installed to maintain a minimum of ¼ inch per foot slope. Where conditions may require more slopes, provide an engineered or digitally designed system for each roof area. Less than ¼ inch slope will need written approval from roofing manufacturer and AFMSA/SG8FE

K. Roof insulation “R” values are set at minimum of R-30 in zones 1-7. See the Zone chart in Attachment 1. Any deviations from this standard shall be approved by AFMSA/SG8FE and the roof system manufacturer.

L. Install crickets in between all drains, scuppers and overflow drains and scuppers to insure no ponding of water.

M. Miter and fill the edges of the insulation boards at ridges, valleys and other changes in plane to prevent open joints or irregular surfaces. Avoid breaking or crushing of the insulation at the corners.

N. Insure all roof top equipment has crickets with sufficient slope to allow water to flow around said equipment and away from flashings. Install crickets at all equipment, chimneys and penthouses 24 inches or wider. Crickets are also required at wall and pitch change interfaces that may pond water.

O. Only use cover boards specifically approved and tested in the roof system manufacturer’s assembly.

7.5 Types of Insulation

A. Polyisocyanurate
   - Rigid board with fiber reinforced facers on both sides, meeting or exceeding the requirements of ASTM C 1289
   - Compressive Strength (Polyisocyanurate): minimum 20 psi (138 kPa)
   - Polyisocyanurate insulation with a smoke index greater than 50 shall not be utilized in AFMS facilities.

B. EPS (Expanded Polystyrene)
   - Rigid, closed cell foam insulation meeting ASTM C 578.
   - Density: 1.25 Lb. min

C. Extruded Polystyrene
   - Rigid, closed-cell recovery board meeting ASTM C 578
   - Compressive Strength - 25 psi (1.75 kg/sq.cm.) minimum

D. Perlite
   - Avoid the use of perlite insulation within insulated assemblies

E. High Density Wood Fiber Board
   - Wood Fiber: Cellulose fiber board meeting the requirements of ASTM C 208
   - Compressive Strength: min 35 psi (241.5 kPa).
   - Shall be coated and sealed on all six sides.

7.5.1 Modified Bitumen Membrane Assemblies
A. All membrane flashing heights shall be a minimum of eight (8) inches in height as measured from the bottom of the right angle, to the top of flashing membrane.

B. Adhesive membrane wall flashings will be set flush to the cover wall or fascia and extend over the base sheet or underlayment unless otherwise specified by the roof system manufacturer in writing.

C. Membrane flashing material shall be applied tight to the wall and be totally free from wrinkles, air pockets and blisters.

D. Membrane sheets are to be installed wrinkle free and with no “eyebrows,” “fish mouths,” blisters, voids, or lifted edges at corners.

E. Membrane flashing shall be terminated with a mechanical fastening system separate from the sheet metal counter flashing, and the termination system shall be within two (2) inches from the top of membrane. Fastening system will be sealed and covered with approved sealants and membranes.

F. The membrane flashing shall extend a minimum of five (5) inches above top of any cant strip or change in slope or direction. Deviations of this requirement must be approved by AFMSA/SG8FE and the manufacturer of the roofing system.

G. Membrane shall be terminated on the horizontal and vertical edges.

H. Membrane flashing adhesives will be applied with proper tools (trowels, knives, rollers, mops etc.) and per the recommendations from the product manufacturer as required to maintain uniform and even thickness of adhesives and asphalt. Membranes shall be laid as continuously as possible.

I. Install all penetrations, nailers and curbs prior to installing membrane roofing materials.

J. All membrane wall flashings shall be sealed and membrane applied in three course fashion. Sealant, membrane, sealant.

K. Low sloped roofs shall require plies be installed so that the flow of water runoff will not be against (or in the direction of) the laps. “Strapping” maybe used on slopes of higher pitch or incline with AFMSA/SG8FE approval.

7.5.2 Modified Bitumen

A. Base and cap sheet rolls are to be stored on end at all times and protected from water, sun and cold. Use manufacturer approved protective coverings.

B. Cap sheets and base sheets shall be unrolled, cut into appropriate lengths and laid flat to allow for relaxation of the sheet for a minimum of one (1) hour; or longer, as necessary to insure it has relaxed to a point where there is no visual undulations in the surface and/or material memory roll.

C. Phased application (stop and start) must be reduced to the greatest extent possible. If the completed covering of membrane is not possible in one day; repair all blisters, fish mouths and then seal all penetrations (night time dry-in) on all roof covered that day before departing.

D. Proper bitumen temperature (per written manufacturer’s recommendations) shall be maintained to insure thorough, uniform and consistent lamination of all plies. Minimum temperature differential between Equiviscous Temperature (EVT) and flash point shall be a minimum 75 degrees F. Asphalt temperatures shall be monitored recorded through out the day and discussed with project manager, HFD and roof observer. Care shall be taken to watch all conditions that may require a change in EVT range.

E. All base, inter-ply and cap sheets shall be broomed or rolled into place immediately following application of asphalt and sheet goods to ensure full adhesion.
F. Membrane roofing systems shall have a minimum reflective value of 0.76 and thermal emittance of 0.84. These values shall not change more than 0.09 over a three year period, recoating is acceptable to maintain these values. Exceptions shall be approved by AFMSA/SG8FE.

G. All base sheets, intra-plies and caps sheets will be installed wrinkle free and applied smoothly to the base sheet and substrates.

H. All irregularities such as fish mouths, blisters and wrinkles must be removed and repaired before applying next membrane ply or cap.

I. Defects will be removed / cut out. A new layer(s) installed a minimum of twelve (12) inches past all affected areas in four directions (areas that were cut). Install base sheets under all drip edges, gravel stops and flashings unless provided differently through manufacturer’s written specifications.

J. No “back nailing” will be necessary for roof slopes under a 3:12 pitch unless so specified pursuant to the manufacturers’ or engineer’s recommendation using different asphalt types or adhesives.

K. Preferred method of attachment is low VOC hot asphalt or cold process adhesives.

L. Self-adhering underlayment shall be completely adhered to the substrate, insulations and cover boards. Self-adhering underlayment shall be completely tight to the cover board or substrate; lapped per manufacturer’s recommendations (minimum lap of 3 inches) no wrinkles, blisters, voids, or un-adhered areas will be accepted.

M. Materials must be tight to the preceding sheet. Sheets with wrinkles, blisters or eyebrows need to be removed and a new sheet installed. Additional criteria if this is an inner roll, the material must extend under the next exceeding sheet and over the preceding sheet. Quality control of final caps sheets is crucial.

N. Membrane wall flashings shall be separate from the cap sheet; continuous cap membrane running up the wall is unacceptable.

7.5.3 Cold Process

A. For optimum installation and longevity, all weather requirements must be met for cold process adhesion systems. Follow manufacturer’s recommendations for all cold weather applications.

B. Allow all materials to relax before complete installation in adhesive.

C. All surfaces must be smooth and dry prior to installing adhesive materials.

D. Roll out materials to be free from wrinkles and buckles.

E. Use manufacturer’s recommendations for leveling, sealing and applying adhesives and asphalts. Use proper equipment.

F. Phased applications must be planed to allow adhesives to bond properly and follow all manufacturers’ specifications.

7.5.4 BUR, with Gravel Surfacing

A. Gravel must be installed at minimum 90% embedment. After curing, un-adhered excess gravel must be vacuumed, swept and removed from the roof.

B. Pea gravel shall be applied at a rate of 300 lbs. per 100 sq. ft.

C. Minimum gravel size shall be ½” round pea gravel. Chipped and sharp edged “fines” will not be acceptable.

D. Gravel must meet ASTM 1863 as minimum. Samples and testing may be performed to verify compliance as a prerequisite to final acceptance of the delivered roof system.
E. Gravel stops must be of sufficient height to prevent water and wind “flushing” the gravel over the edges. This is particularly important when there are entrance doors, equipment, vehicles and other roofs that may be damaged.
F. Install walk-pads prior to installing gravel. Insure they are installed above the gravel height.
G. Gravel must be clean and free of moisture and organic materials for proper adhesion. Fill grade gravel is unacceptable. Only round gravel that is washed, dried and white in color will be accepted.

7.5.6 Thermoplastic Membrane
A. PVC
   • Approved Membrane Attachment: Mechanically Attached or Fully Adhered.
   • Membrane Thickness: 60 mil nominal.
   • Seam Spicing. Hot-air weld.
     Overlay all splice intersections with T-Joint Covers.

B. TPO Membrane
   • Approved Membrane Attachment: Mechanically Attached or Fully Adhered.
   • Membrane Thickness: 60 mil nominal. Minimum.
   • Seam Spicing. Hot-air weld.
   • Overlay all splice intersections with T-Joint Covers.

C. Thermoset Membrane
   • EPDM
   • Approved Membrane Attachment: Fully adhered.
   • Membrane Thickness: 90 mil nominal. Minimum.
   • Tape splicing is the only acceptable membrane splice method.

D. Coatings
   • Application of roof coatings will strictly follow manufacturer’s written instructions.
   • Roof coatings will be installed and neatly applied to all edges, terminations and transitions to ensure a neat and clean appearance. Avoid contaminating nearby equipment and building components.
   • New coating shall be installed in two coats, one primer coat and one top coat or as recommended by manufacture or whichever is more stringent.
   • Primer coat to be tinted different color from top coat to help insure full coverage of top coat.
   • Designated walkways shall be a contrasting color to the field of the roof.
   • New coating shall meet at reflective value of .81 and a solar index of 98.

7.6 Steep Slope Roofing
7.6.1 Metal
A. All metal panels and accessories to be installed in such a fashion that they are free from wrinkles, cracks, scratches and buckles. Where such conditions exist following installation, they are considered to have failed,
are damaged and must be replaced as required before acceptance (or as a warranty repair) if already accepted.

B. Erect metal roofing straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than .32 cm in 12.2 m 1/8 inch in 40 feet. Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials and as recommended by the metal roof panel manufacturer. Finished repaired surfaces must be uniform and free from variations of color and surface texture. Repaired metal surfaces that are not acceptable to the project requirements are to be immediately removed and replaced with new material.

C. Panels that indicate color changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Government.

D. Touch up scratches in panel finish with manufacturer supplied touch-up paint system to match panel finish.

E. Use fasteners and clips that allow panels to float without thermal stress and pinned only in one (1) single location. The pinned location shall be identified on the as-built drawings.

F. Metal roofs shall not be installed on less than a 3:12 pitch roof without fully adhered water proofing underlayment, engineered design calculations and specifications approved in advance by the AFMSA/SG8FE.

G. Design and install metal roof systems to approved industry standards which eliminate or reduce the opportunity for “oil canning” and/or damages due to thermal stress.

H. Manufactured panels shall not be less than 22 gauge, 16 inches wide with a 2 inch double lock seam.

I. Follow all manufacturers’ pre-design criteria as needed to accept live loads, dead loads and construction loads. Use concealed one piece clips and pin roof only as recommended by manufacturer’s written instruction for the intended application. Insure that all openings are of sufficient size to prevent inadvertent pinning around all pipes fixtures and penetrations.

J. Maximum spacing of retrofit purlins, hat channels and supports for metal roofing is forty-eight (48) inches or less, regardless of type of metal being used (structural or architectural).

K. Proper handling of materials is critical in transportation and installation activities.

L. All mechanical and hand seaming on standing seam metal roofs must be fully complete on the preceding panel(s) before completing succeeding panels to ensure proper integrity of the completed assembly. Insure crimping is completed to the end of panel. Whereas it is always preferable that the full panel be mechanically crimped, hand crimping is allowable in order to complete the ends or otherwise inaccessible areas.

M. Store all materials on flat and supported surfaces as needed to prevent twisting and bending. Keep materials dry and free from debris.

N. Install all underlayment to extend up walls, skylights, curbs and flashing details to insure water tightness. Underlayment should be free from wrinkles and buckles. Fasteners must be covered to protect panels or install a slip sheet (protection sheet).

O. Immediately repair all scratches and cut edges in metal panels. Prolonged rusting on panels will warrant the need to replace the affected panel.

P. All roofs 3:12 and under must use a hydrostatic seam and be installed over an underlayment.

Q. Snow retention systems must be of rail type and installed per written manufacturer’s specifications. Minimum of two complete rails with a stop installed at every seam. In areas where rail systems are too large (as determined by AFMSA/SG8FE), a single stop may be attached with two sided tapes or adhesives. They also may be soldered on copper roofs and unpainted galvanized roofs.
R. Metal roofing shall have reflective value of 0.70 as a minimum.

7.6.2 Shingles

A. Underlayment: Install in accordance with the manufacturer's instructions.
B. A company specializing in performing work of this section.
C. Perform work in strict adherence to the manufacturer's instructions.
D. Obtain components from a single manufacturer.
E. Provide products which comply with all state and local regulations controlling the use of volatile organic compounds (VOC's).
F. Fasteners: Standard round wire shingle type, zinc-coated steel; 12 gauge (2.657 mm), barbed or ring shank, with heads 3/8 inch (9.5 mm) in diameter minimum. Fasteners shall penetrate deck a minimum 3/4 inch (19 mm).

7.6.3 Tile

A. Underlayment: Install in accordance with the manufacturer's instructions.
B. For roof slopes less than 4:12, two layers of underlayment are required.
C. For pitches of 4/12 and greater: Minimum one layer is required.
D. Valleys and drip edges will require an additional layer of self-adhering underlayment installed
E. Roofing tile materials and installation shall conform to the requirements of ICBO Report No. 3523 - Clay Roofing Tiles.
F. Prefabricated Rake and Ridge tile. Choose to match tile profile and color.
G. Fasteners: Fasteners shall penetrate deck a minimum 3/4 inch (19 mm).

7.6.4 Sheet Metal Flashing and Trim

A. All flashings shall be tight to receiving components (walls, base flashings, roof flashings, counter flashings) without fillers. Fillers on metal roof seams and laps to associated materials are acceptable with approved two sided tapes and sealants.
B. Flashings will be of like materials. If dissimilar materials are in contact with one another from existing or previous work, then special protection procedures must be taken to eliminate corrosion and/or the effects of non-uniform thermal expansion and contraction.
C. All flashing and metal work shall be performed by a qualified specialist/craftsman with a minimum of five (5) years verifiable experience in fabricating flashings, metal work, metal bending and modifications.
D. When painting of dissimilar metals is required, the surfaces will be prepared, evenly coated with an approved primer, and then followed by an evenly coated protective and durable final coating.
E. Metal flashing shall be installed at all roofs to wall intersections, at gutters, and wherever there is a change in roof slope or direction. Where flashing is metal, it shall be corrosion resistant with a minimum thickness of 22-gauge for galvanized painted steel, 24-gauge stainless steel with 2-d finish and 050-aluminum or copper at 1 Lb. per square foot. Cleats shall be 18 gauge for steel, .063 for aluminum and 24 gauge for stainless steel.
F. Flashings shall be terminated and fastened to the wall with approved fasteners. Approved fasteners are pins or screws.

G. Aluminum flashings shall not be used as an in–wall embedded flashing in masonry/concrete walls except as approved by AFSMSA/HFD Engineering in writing. Approved uses of aluminum flashing will always include the use of a bituminous layer and/or separating material that protects the flashing from contaminants of the masonry corrosive alkaline and acids.

H. Insure all counter flashings are secured properly into all walls, curbs, rooftop units and coverage at a minimum height of three (3) inches below the lowest fastener or top edge of base flashing material.

I. Preferred flashing material is stainless steel and factory coil-coated steel with a high quality finish. Contractor shall obtain an approval in writing from AFMSA/SG8FE for any other flashing materials.

J. Drip edge and gravel stop flashings are to be installed with a continuous cleat. The cleat must be fastened tight, level or plumb to the receiving material as necessary to avoid wrinkles or bows in the flashing material. The preferred method is cleated on two sides.

K. Cap flashings are to be installed with a continuous cleat. The cleat must be fastened tight, level or plumb to the receiving material as necessary to avoid wrinkles or bows in the flashing material. The preferred method of attachment is cleated on two sides.

L. Prime all flashings that will be sealed to ASPHALT, TPO, PVC, KEE and other similar material products. Prime both sides on all drip edge and wall flashings that are utilizing a base sheet installed under or over the seam with mastic and membrane, unless otherwise specified by manufactures written specifications.

M. Exposed (visible) flashing details at eves and rakes should be comprised of lengths necessary to avoid widespread use of small pieces (“small” is defined as less than 48 inches in length)

N. All flashing shall be installed per NRCA recommendations or manufacturer’s recommendations, whichever is the most stringent design in water proofing the system. Custom fabricate sheet metal flashing and trim to comply with recommendations within the SMACNA Manual that apply to design, dimensions, metal type, and other characteristics of design indicated. Custom fabricate items to the greatest extent possible. Obtain and verify field measurements for accurate fit prior to shop fabrication. Fabricate flashing and trim without excessive oil canning, buckling, and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

O. Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

7.7 Drainage

A. All gutters, drains and scuppers shall be designed to carry maximum water flow for removal of water, with the ability to hold weight of water when full and meet above metal characteristics. Gutters, drains and scuppers shall be sized in accordance with the International Plumbing Code.

B. When re-covering and/or re-roofing, do not diminish the size, nor reduce in the number of the drains, scuppers or outlets. All size changes must be carefully designed to provide ample drainage and flow based on local rain fall rates and applicable plumbing codes.

C. Verify that all overflow drain or scupper heights are adequate and meet appropriate building code, and are not functioning as a main drainage point.
7.7.1 Roof Drains

A. Drains must remain functional throughout the construction process or provide alternative method of draining water in the event of rain.
B. Protect all drains from construction debris and clogging. Cover all drains prior to beginning tear off. Verify all drains are open, functioning and free of debris before work commences. Contractor will be responsible for all plugged and inoperable drains at the completion and testing of drains for final commissioning.
C. Replace all broken drain bolts by drilling out broken bolt, re-tapping and replacing with a stainless steel bolt.
D. Replace all drain bolts and install new drain bolts in anti-seizing compound.
E. Replace all damaged rings: damaged rings noted as cracked, broken, and heavily rusted to prevent water tight seal. Repaint all rings prior to reinstalling. Replace all damaged and missing drain bowl covers. Repaint the remainder of drain covers with two coats of rust inhibitive industrial enamel paint.

7.7.2 Gutters and Downspouts

A. No fasteners shall penetrate the inside of gutters or downspouts more than ¼ inch. Ensure fasteners are sized appropriately.

7.7.3 Scuppers

A. All collector heads shall have overflow capabilities.

7.7.4 Expansion Joints

A. Expansion joints in the roof system shall either be metal or conform to NRCA and SMACNA standard details and guidelines. Pre-manufactured assemblies are acceptable but shall be included within the manufacturer’s system warranty.

7.8 Accessories

A. Do not install condensate lines or gutter discharges within one foot of roof flashing details. Where existing lines and penetrations are too close to the flashing, relocate the line as necessary to meet the twelve (12) inch separation requirement.
B. All roof mounted equipment devices (roof mounted HVAC units, pipes and pipe supports and other equipment) associated with roof assembly shall be designed, installed, and fastened securely to meet wind loading set forth by the most current ASCE-7 guidelines.
C. If non-mechanical vents and pipes and flashings are not replaced, they must be painted and resealed to appear and perform as a new and warranted product.
D. All roof top equipment must be installed per the equipment manufacturer’s recommendation. The curb, base anchoring point and/or manufacturer equipment stand shall be securely anchored to the underlying structural members and meet the requirements for wind loading and uplift for the geographical area. Curbs should be installed per NRCA recommendations unless otherwise designed by a professional structural engineer as needed to meet special unique requirements specific to the site or region. Treated wooden skids, timbers and similar materials used for curbs and mounting platforms shall be coated, covered and flashed as necessary to
eliminate exposure to UV and the elements, and shall present a seamless matching appearance consistent with the roof system.

E. Roof hatches shall be primed and painted with two coats of rust inhibitive industrial enamel paint, painted to match exterior sheet metal.

7.8.1 Skylights
A. Consult with AFMSA/SG8FE on skylight work specific to the existing facility.

7.8.2 Lightning Protection
A. See Section 6.15 of the electrical section

7.8.3 Walk-pads
A. Install walkways at all traffic concentration points (such as roof hatches, access doors, rooftop ladders, pathways to equipment, etc...)
B. Adhere walkway-pads to the membrane in accordance with the manufacturer's current application guidelines leaving space between pads for drainage.

7.8.4 Ladders
A. Consult with AFMSA/SG8FE on fixed ladders specific to the existing facility.

7.8.5 Solar Panels
A. Solar panels shall not be installed or reinstalled on roof systems unless written approval has been received from AFMSA/SG8FE.

7.9 Wall Systems
7.9.1 Structural Framing
A. The structural framing components of new walls to be clad with an EIFS or stucco system shall be of light-gauge metal framing with a minimum stud width of 3-1/2 inches and a minimum thickness of .0329 inches (20 gauge), spaced no more than 24 inches apart. If the substrate is masonry block, refer to the masonry section for minimum requirements.

7.9.2 Insulation
A. For future use

7.9.3 Masonry Walls
A. Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.
B. Lay masonry with full head and bed joints.
C. Provide weep holes in head joints of the first brick course immediately above flashing by placing weeps no more than 24 inches (610 mm) on center horizontally.
D. Where fresh mortar joins partially set mortar, remove loose masonry and mortar, and lightly wet exposed surface of set masonry.
E. When adjustment is necessary to be made after mortar begins to harden, remove hardened mortar and replace with fresh mortar.
F. Joint Profile: Tool mortar joints to a concave appearance. Unless otherwise specified in the PWS or Base Architectural Design Guide.
G. Tool exposed joints when "thumb-print" hard.
H. Keep cavity free from mortar.
I. Flush cut all joints that are not tooled.

7.9.4 CMU (Concrete Masonry Unit)
   A. For future use.

7.9.5 Brick
   A. For future use.

7.9.6 Stone
   A. For future use.

7.9.7 Stucco
   A. Three-coat stucco systems shall be used over sheathed construction, masonry and concrete substrates: (1) scratch coat, (2) brown coat, (3) finish coat.
   B. Self-furring metal lath shall be used for the attachment of the base coat to the moisture barrier and substrate.
   C. Aluminum or non-corrosive metal trim and accessories shall be incorporated into the system, as acceptable to the manufacturer.
   D. The total thickness of the base coat (scratch and brown) shall be 3/4 inch to 7/8 inch thick. The base coat mix shall contain 1/2 inch long, alkali resistant fibers to improve cohesiveness and provide crack and impact-resistant qualities to the system.
   E. The first (scratch) coat shall be moist cured for a minimum of 48 hours before application of the second (brown) coat. Assure that the scratch coat is still moist (not saturated) just prior to the application of the brown coat. Trowel float the brown coat surface uniformly.
   F. Allow entire base coat to cure for a minimum of seven (7) days prior to starting finish coat application.
   G. Tolerances for levelness of the stucco plaster shall be 1/4 inch in 10 feet for flat surfaces.
   H. The finish coat shall be 1/8 inch thick and applied to a moist base coat. Textured and colored finishes shall be as selected by the Government.

7.9.8 Metal Wall Panels
   A. For future use

7.9.9 Glass Curtain Walls
A. For future use

7.9.10 Translucent Panels
A. For future use

7.9.11 Through-wall Flashing
A. Clean surface of masonry from projections, which might puncture flashing.
B. Place through-wall flashing on bed of mortar.
C. Cover flashing with mortar on the masonry shelf. Lay brick dry on shelf angles and lintels.
D. Lap flashing a minimum of 6 inches (150 mm).
E. Leave flashing projecting from face of wall approximately 1 inch (25 mm). Flashing shall be cut back to the face of the wall after inspection.

7.9.12 Mortar
A. Masonry Cement: Complying with ASTM C 91: Type S.
B. Portland Cement: Complying with ASTM C150: Type I.
C. Mortar Aggregate: Complying with ASTM C144, standard masonry type. For joints narrower than 1/4 inch (6 mm), use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent the No. 16 sieve.
D. Do not use anti-freeze compounds to lower freezing point of mortar.
E. Mix mortar ingredients in accordance with ASTM C 270. Mix only in quantities needed for immediate use.

7.9.13 Masonry Expansion Joints
A. Keep clean from all mortar and debris.
B. Prime surfaces if necessary.

7.9.14 Penetration Sealants
A. For future use

7.9.15 Weep holes
A. Weep holes shall be cleaned out and made functional during all exterior wall restoration / renovation projects.

7.9.16 Re-pointing Joints
A. When re-pointing, rake mortar joints to a depth of not less than 1/2 inch (12 mm). Fill solidly with pointing mortar in 1/4 inch layers. Tool joints.

7.9.17 Tuck-pointing
A. Cut out all defective mortar joints and holes in exposed masonry and repoint with new mortar. Remove excess mortar and mortar smears as work progresses.

7.9.18 Cleaning
A. Do not use cleaning materials or processes which could change the character of the exposed finishes.
B. All cleaning practices and product used shall be in accordance with cleaning products manufacturer's printed instructions.

C. The use of non-metallic tools in cleaning operations is recommended when possible.

D. Contractor shall clean the areas using high-pressure water and or cleaners not to exceed 2500 pounds per square inch (PSI).

E. Use a paint scraper, wire brush, sandpaper, power washer and cleaning chemicals to remove all surface contamination, such as oil, grease, loose paint, dirt, foreign matter, rust, mold, mildew, mortar and efflorescence.

7.10 EIFS

A. Exterior gypsum sheathing boards shall be used on all metal and wood framed substrates, with a fiberglass facer on both sides for mold and moisture resistance and with a minimum thickness of ½ inch. Use fire-rated material when applicable. Sheathing shall be installed with stainless steel screws. Stagger board joints; fit ends and edges tightly together.

B. Fluid-applied, flexible, seamless waterproofing coating shall be used to form the moisture/vapor barrier system on the exterior of the sheathing or masonry substrate. All penetrations through the substrate shall be properly flashed and incorporated into the barrier system. The waterproofing material shall be approved by the manufacturer of the EIFS or stucco system, as well as the exterior sheathing manufacturer if applicable. A polymer based (PB) drainable system is preferred for all EIFS systems. The intent is for the wall to have a mechanism to manage water that penetrates through the outer skin, as well as the ability to discharge the moisture out, similar to absorptive masonry wall systems.

C. EPS (expanded polystyrene) insulation to be used in the PB system shall have a minimum thickness of 1” for buffering differential movement between the substrate and the EIFS lamina (surface). Adhesives or mechanical fastening may be used.

D. High/heavy impact-resistance mesh shall be incorporated into the system when at all possible.

E. Aluminum or non-corrosive metal trim and accessories shall be incorporated into the system, as acceptable to the manufacturer.

F. The completed base coat with reinforcing mesh shall be at least 1.5 times the thickness of the mesh, with the mesh completely encapsulated.

G. The finish coat shall not be applied until the base coat has cured for 24 hours. Apply finish coat without cold joints and protect from the elements for 24 hours until fully cured. Textured and colored finishes shall be as selected by the Government.

7.11 Joints Sealants

A. Thoroughly clean all surfaces of the joint. Joints must be sound, clean, dry, and free from oils and all loose aggregates. Ensure compatibility of sealant with the proposed application considering size of joint, building movement and designed expansion and contraction. Joint preparation is paramount in successful application and shall be photographed.

B. Avoid air entrapment in sealants by using proven industry standards of application.

C. Joint size shall allow maximum expansion and contraction. Proper joint design of: 2:1 width to depth ratio.
D. Install backing system to properly control depth of sealants and prevent three sided adhesion. Ensure proper joint shape and design. Secondary backer system shall be used on all deep joints or problematic joints with proper depth.

E. Place a high quality structural caulking between dissimilar materials (water based acrylic is not acceptable)

7.12 Wall Expansion Joints
   A. For future use

7.13 Waterproof Coatings
   A. The applicator shall be approved by the manufacturer to install the product.
   B. Do not install new products over decayed, rotten, unsound, degraded, damaged or wet building materials.
   C. Existing substrates shall be pre-tested to determine the current absorption rates in random areas, in which minimum application rates will be established for the project.

7.14 Fenestrations
7.14.1 General
   A. All exterior wall fenestrations shall be compliant with ATFP UFC 4.010.01 protocols
   B. A blast engineer or consultant must do a report based upon the threat level and determine the blast loads that will be imposed upon the components of the building.
   C. A structural engineer shall verify that the existing structure a will be adequate to support the loading and accept the new blast loads imposed upon it with the installation of new or replacement of existing building components

7.14.2 Windows
   A. For future use

7.14.3 Doors
   A. For future use

7.14.4 Louvers /Vents
   A. For future use

7.14.5 Overhead Doors
   A. For future use

7.14.6 Penetrations
   A. For future use

7.14.7 Below Grade Waterproofing Systems
   A. For future use

7.14.8 Foundation Walls
7.14.9 Floor Slab
A. For future use

7.14.10 Plaza Decks
A. For future use

7.15 Warranties
A. Roof warranties are to be for full replacement and to have a 20 year No Dollar Limit (NDL) from date of final inspection/acceptance by the Government. No proration (NDL) warranties permitted.
B. The installing roofing contractor shall warranty the roof application for a period of five (5) years to be leak free. This coverage shall include flashing details which leak, and blistering. With regard to blistering, an area is to be considered as failed where there are more than two blisters per 100 sq. ft. contiguous surface. Also, any blisters that surface area exceeds 1 sq. ft. are required to be repaired.
C. All roofs must be inspected by a factory trained person who is familiar not only with the manufacturer’s product, but familiar with the engineered design of the roof system being installed, and possess certification or endorsement by the roof designer as qualified to verify quality work and adherence to the system design. This quality assurance representative (QAR) shall perform inspections and tests throughout the installation process. The QAR shall certify that the roof system was installed pursuant the manufacturer’s design requirements and approved installation practices; and that the system is warrantable.
D. Warranty repair coverage to include replacement of all wet substrate materials. The contractor shall cut back into at least six (6) inches of dry substrate in all directions on the repair perimeter to ensure that the transition of the new substrate is affixed to an acceptably dry existing substrate.
E. No disclaimer for ponding water is acceptable. All systems must be designed for positive drainage.
F. Installing contractor shall provide written manufacturer’s warranties on all building envelope components including roofing, coatings, water proofing, sealants, paints, and masonry sealants. Installing contractor shall warranty the installation of all materials for minimum of five years.

7.16 Commissioning
A. Ensure that the MDG Facility Manager and maintenance provider have been fully trained in roof maintenance care and maintenance procedures. Provide inspection frequencies to the DMLSS Clerk for input into the DMLSS maintenance program.
B. Provide all project support documentation (warranties, warranty service contact numbers, as-built, red lines drawings and O&M manuals etc.) are provided to the Facility Manager.
C. Performance testing of drains shall be required on all new and repaired drains at final commissioning. The test method shall be to plug the drains with air expandable test ball and flood roof areas around drains, visually inspect the underside of the drains, and then observe the flow and evacuation of the water when the plug is removed. Any leaks experienced around the drain, may require the total replacement of the drain assembly.
D. Water test all problematic areas identified as suspect during the initial pre-construction site visit and building history, prior to submission for final acceptance by the government. The water testing shall follow AAMA 501.2, and AAMA 502 or ASTM E 1105 if necessary.

8.0 GENERAL REQUIREMENTS APPLICABLE TO ALL DISCIPLINES

A. Removal of Abandoned Infrastructure (Mechanical, Electrical and Structural) – The AFMS desires to leverage any opportunity to clean its physical plants of abandoned infrastructure which includes but is not limited to old wiring, conduits, pneumatic control tubing, junction boxes, pipes, flues, housekeeping pads, supports and hangers, etc.). Where a contractor is to perform work in a mechanical space (Mechanical Room, Utility Plant, Air Handler Room, Electrical Closet, etc.) that contractor shall include as a separate feature the removal and disposal of ALL abandoned equipment, piping, ductwork, electrical wiring and pneumatic lines or devices within the spaces where work takes place under the proposed contract. This is to include the removal and disposal of all abandoned infrastructure that is found within the spaces prior to the start of work. Typically, the conduit, race, tubing or wiring shall be removed back to either the first usable junction box or point where it enters the space.

B. Junction Boxes and Control Panel Boxes - Old large pneumatic control panels or large inappropriately sized junction boxes are to be removed and either not used as junction boxes or “right sized” to a smaller boxes more suited for the requirements going forward. Large EP control boxes that have been abandoned shall be removed and not used as a feed-through pull box for control wiring. Where wiring passes through such a panel, the panel is to be replaced with an appropriately sized electrical junction box, conduit extended to connect said junction box and the wiring re-pulled through the junction box.

C. Electrical Infrastructure - Old electrical raceways and bus work where the circuits are/were no longer required following your work and thus de-energized shall be removed back to the most upstream point. (discipline determine verbiage) At this point, the conductors shall be terminated in an approved method, the termination box shall be made safe and provide suitable protection and the terminated circuits shall be marked as de-energized both at the point of termination and at the service point (breaker, fused disconnect, or switch feeding the circuit). Wire ends shall be terminated as to present a neat and safe appearance without hanging strands or insulation.

D. Pneumatic Control Infrastructure - Old pneumatic control, mechanical utility infrastructure piping (CHW, HW, Steam, etc.) and plumbing which are/were no longer required following your work and thus drained and disconnected, shall be removed back to the most upstream point of disconnect within the room or space. The PVC and copper control tubing shall be cut in an approved manner within 6” of where it enters the mechanical room or space and the ends of the tubing shall be plugged or capped with a rubber plug or cap, marked appropriately and secured neatly in a in an approved professional appearing manner. Similarly, all ferrous metal piping that is no longer required as a result of work performed shall terminated back to within 12” of the wall or partition where it enters the mechanical space, cut and sealed in an approved manner. On pipes 1” or smaller, the ends will be cut, threaded and an approved pipe cap installed (exception is PVC where a glued slip-on cap will be accepted). On pipes 1 1/4” or larger, the ends of the pipe shall be cut smooth and either a blind flange or a solid metal pipe cap shall be welded onto the end of the pipe. All weldments shall be painted as required to provide corrosion control. The pipes shall be marked at
the point of termination and point of service to indicate that the pipe is abandoned and the location of the opposite end.

E. **Structural Supports** - Old hangers, brackets, all-thread suspension and saddles for all infrastructure systems removed by the contractor shall also be removed back to the point of anchor. Any damage (damage is considered but not limited to; holes, divots, cracks, voids, water infiltration) to the structure must be repaired to match existing and surrounding materials in size, texture and color. Equipment Mounts and Foundations - Old housekeeping pads, floor mounts, catch trays/basins and raised isolation blocks for equipment removed by the contractor shall be removed to the original floor surface grade. New housekeeping pads shall be six-inch (6”) high as a minimum. (Covered by UFC/AFI)

### 8.1 Corrosion Control of Exterior Mounted Packaged Assemblies and Enclosures

**A. General Finishes** - All exposed exterior metal surfaces on mechanical, electrical equipment and structural systems / assemblies shall be UV resilient anodized, factory electrostatic applied thermally set powder coat painted or hot-dipped galvanized. Finishes shall be either matte or semi-gloss. Color shall be light and unless concealed by visual barrier, it shall match or compliment the aesthetics of the nearby building primary or trim color. Where the local Base Civil Engineer has established and published base architectural plan, the equipment shall comply to the greatest extent possible with said plan.

**B. Corrosion Control of Exterior Exposed Heat Transfer Coils (Air cooled chillers and roof-top unit condensers, generator radiators, etc.)** - Where the MDG is located within 50 nautical miles of an ocean or industrial area where the air is laden with corrosive vapors, all exterior located heat transfer system coils (aluminum, copper, brass) shall be coated with manufacturer applied baked-phenolic (or approved equivalent) corrosion-preventative coating as necessary to extend the life of the coils and protect against advance deterioration due to salt spray or other corrosives in the local air.

**C. Field applied sprayed/brushed paint and/or cold application galvanize is not acceptable and only authorized on pipe weldments and threaded connections that could not be pre-assembled at the factory. All weldments shall be cleaned, primed and painted with a finished color that either matches the main assembly, or of the appropriate color where required by local statute or safety code. All assembly bolts and hardware (unless factory painted during assembly) shall be either zinc plated or hot dip galvanized. In exterior applications, use only stainless steel assembly bolts and hardware.

### 8.2 Warranty

**A. Equipment & Materials:** All materials and equipment shall carry a 24 month full-service warrantee from the contractor for manufacturer defect, failure to perform in terms of reliability, efficiency, safe operation by classification (continuous or intermittent use), and its ability to maintain steady-state performance at a sustained load level as prescribed in the system design, and/or as prescribed by the equipment manufacturer.

**B. Workmanship:** The contractor shall provide a 12 month full service warranty for defect due to poor workmanship from the date of acceptance. The definition of poor workmanship is: “Any work performed in part or in full by the contractor or sub-contractor installers, trades personnel or general employees that does not meet acceptable trade standards or applicable codes in terms of appearance, performance, reliability, strength and durability as determined by the COR and validated through a review and
endorsement by the COTR. Early acceptance for beneficial use does not apply to workmanship warranties which are to commence on the date of acceptance of the fully completed project.

C. Warranty Response: Where equipment, materials or roof systems are part of a system that supports a facility that has Critical Care, Surgical operation or is bedded, the contractor shall provide emergency warranty service response having qualified technicians ON SITE within two (2) hours of notification by the Facility Manager. Where a system or component failure has a direct impact on the sustainment of a critical mission, the contractor will remain engaged until such time as the system is repaired and on-line, or until the contractor has provided interim temporary service as needed to sustain the mission until permanent repairs can be made and service restored permanently.

D. Acceptance for Beneficial Use: The contractor may submit equipment and sub-systems to the government for acceptance as ready for Beneficial Use. Where such equipment and sub-systems are to be submitted for acceptance prior to the completion of the total project, the contractor shall identify said equipment as a critical milestone on their project schedule and provide a commissioning and functional test plan for that piece of equipment to the HFD at least 60 days prior to the proposed functional test and Beneficial Use acceptance date. A piece of equipment or component of a sub-system that is not capable of production of a utility on its own may not be submitted for acceptance as ready for Beneficial Use. (Example: a pump, a motor, or a motor starter may be a component of a chilled water system but without a serviceable chiller connected and available for use by the facility, it is not capable of delivering a product, therefore is not considered capable of production.)

E. Equipment: The contractor may submit certain large and high cost pieces of equipment to the Government for acceptance for beneficial use and initiation of the equipment’s warranty period once said piece of equipment is fully installed, made fully operational and capable of production at full rated capacity, and is capable of being operated by maintenance personnel without limitations or special instructions that are outside the normal scope of operations. When the aforementioned conditions are met, the contractor will submit a DD Form 250 Request for Government Acceptance stating the specific components with product serial numbers that are being submitted for acceptance. Whereas the warranty period of a specific piece of equipment may be started prior to the completion of the commissioning of the full system design and subsequent final acceptance of the project, at no time shall the warranty of that piece of equipment be less than 14 months following the completion and final acceptance of the project.

F. Acceptance of Automated System Controls: Early acceptance for beneficial use does NOT apply to warranties for any automated system controls (for mechanical and electrical, and power generation systems) which employ programmable automated logic, software, firmware, computerized networking systems, or sophisticated electronic controls which possess ladder or electronic logic that is established by the installer to meet the requirements of a system sequence of operation uniquely prescribed by the designer for system control. Such systems are only to be tested and considered ready for acceptance once all sub-systems and down-stream controlled have been commissioned, proven to be fully functional and accepted by the government. Should it be necessary for the installer to perform a modification to the system logic (regardless of the size and scope of the modification) to overcome a deficiency in the control logic or sequence of operation during the testing of the system automation, the system shall undergo a complete re-test (the testing shall not be allowed to commence from the point in which the discrepancy was
noted) as to assure that any change to the program does not pose an adverse impact to already tested system functionality.

9.0 Infection Control

9.1 Interim Infection Control Measures (IICM)

A. Interim Infection Control Measures (IICM) is required. The Contractor shall comply with the following requirements:

B. An Infection Control Risk Assessment (ICRA) shall be performed prior to the start of any construction, renovation or repair activity. The ICRA will determine what preventive control measures are required. Based on Risk Assessment, the Contractor is responsible for dust partitions, filtered negative air machines, tacky mats, cleaning, etc.

C. Government may provide baseline particle counts and conduct periodic air sampling of Protection Areas during construction to monitor effectiveness of IICM.

D. The Contractor is responsible for administering the IICM and ICRA required by this Section.

E. Contractors shall comply with applicable codes and referenced IICM, and use installation procedures and methods that satisfy applicable code requirements and procedures.

F. Contractors shall protect indoor air, absorbent materials, and mechanical systems from contamination in accordance with ASHRAE-62.1-2004, Chapter 7. Unfinished duct openings shall be covered by plastic sheeting during construction. AHU’s in construction areas shall not be used without a formal approval by the facility manager. Provide temporary filter media (aka “socks”) in construction area over return ductwork and MERV-8 filter in AHU’s during construction. Replace or clean media on a weekly basis.

G. After the completion of construction and prior to the beneficial occupancy, the contractor shall flush out the construction area with 100% outside air for a minimum of 72 consecutive hours. During the flush out period, temperature and humidity shall be controlled at 78°F/50%-60% RH for cooling and 60°F/40%-50% RH for heating, or as approved by the facility manager. The contractor shall remove all temporary media, and thoroughly clean the interior of the air handling unit and all associated equipment including filter racks, fan wheels, monitoring and controls probes and sensors, etc. All pre and final filters shall be changed after construction.

H. For minor renovation projects, with a Government approval, a flush out requirement may be reduced to a shorter period or may be waved.

I. Stored materials, such as piping, ductwork sheet metal, insulation, drywall, plywood etc., shall be stored in a weather resistant environment, elevated off the floor and covered at all times during construction.

J. Contractor will verify the maintenance of negative air pressure in Containment Area relative to Protection Areas on a continuous basis by use of differential pressure monitors.

9.2 Contractor’s failure to maintain IICM can result in the following:

A. Contracting Officer may issue written warning or Non-conformance Notice. Contractor shall correct non-conformance immediately.

B. If situation is not corrected within eight (8) hours of receipt of warning or Non-conformance Notice, Contracting Officer will have cause to stop Work as provided in Task Order Documents.
C. Failure of Contractor to correct deficiencies may result in corrective action taken by Contracting Officer. All cost associated with Owner correction of Contact contractor deficiencies will be deducted from the Task Order Amount.

9.3 Infection Control Risk Assessment (ICRA):
A. An assessment of health risks related to construction, renovation or repair activities to determine which Interim Infection Control Measures need to be implemented.
B. Airborne contaminant producing activities include, but are not limited to:
   - Demolition and removal of walls, floors, ceilings, and other finish materials.
   - Demolition of plumbing, mechanical and electrical systems and equipment.
   - Finish operations such as sanding, painting, and application of special surface coatings.
   - All other construction activity that may generate dust, smoke or fumes.
   - Site Work operations adjacent to occupied facilities.

9.4 Containment Areas
A. Includes areas of renovation construction within or additions to occupied facilities, adjacent staging and to construction storage areas, and passage areas for Contractors, supplies and waste; including ceiling spaces above and adjacent.

9.5 Protection Areas:
A. Interior occupied areas within facilities which are adjacent to Containment Area, either occupied or used for passage, as well as areas connected to construction area by mechanical system air intake, exhaust and ductwork.

9.6 Submittals.
A. The Contractor shall provide an IICM Draft Submittal at Design development stage and a Final Submittal at the Pre-final Design stage. Include the following information:
B. Drawings indicating Work areas and procedure for containment of airborne contaminants for Owner's review and approval. Indicate locations of necessary IICM, including temporary enclosures, barriers, isolation vestibules, negative air machines, exhaust fans, capped ductwork, etc.
C. Specific means and methods of achieving and maintaining control of airborne contaminants during construction for Contracting Officer's Representative (COR) review and approval.
D. Infection Control Construction Permit for each Work area for COR assessment and approval.
E. Submit Daily IICM Inspection Reports to COR.

10.0 Drawings and Project Documentation
A. Renovation projects must provide updated and complete system riser diagrams for the related MEP system(s) altered. These diagrams shall include but are not limited to electrical one-line diagrams, heating and cooling piping riser diagrams, steam and water distribution lines, plumbing system piping, fire detection, fire protection, smoke exhaust /evacuation /purging systems, EMS one-line diagram, schematics etc.
B. Renovation projects must provide complete updated fire damper and smoke damper schedules.

C. Real Property Acceptance Documentation. All real-property acceptances shall be performed on a DD Form 1354. The DD Form 1354 is used by government agencies that are responsible for the acceptance, life-cycle through disposal to record the capitalization and disposition of all Real Property and Real Property Installed Equipment (RPIE). The DD Form 1354 shall be completed in accordance with UFC 1-300-08, dated 16 April 2009 or later. An example of a completed 1354 is provided in Attachment 2 below.

D. The Prime/General Contractor is responsible for keeping track of all RPIE items removed, replaced or installed new on the project. The Contractor is also responsible to prepare a DD Form 1354 which accurately depicts the movement of all RPIE.

E. Through the execution of Infrastructure Repair Projects, the RPIE items removed and/or replaced will be documented on a DD Form 1354. Additionally, there is particular information that should be recorded on the form to assist the Database Sustainment Specialist (DSS) to load the new equipment information as well as removed old equipment information from Defense Medical Logistics Standard Support (DMLSS) system.

F. The following are the pertinent blocks of the DD Form 1354 that need particular attention. Refer to Attachment 2 for clarification.
   Corp of Engineers Address
   Date prepared
   Project #
   for multiple items leave this section blank
   Civil Engineering Address if known
   Installation Name
   AFMSA contract #
   Date Item was placed in service (for multiple items, date system was placed in service)
   Number of the item(s)
   Facility #
   Identify the part, include part 3 if available
   P=permanent , S=semi-permanent, T= temporary
   Unit of measure
   Quantity

11. Miscellaneous

11.1 Project Execution & Avoidance of Disruption to Mission during Construction

A. All designs, system modifications and installation of new equipment and materials must improve operations, reduce costs, increase reliability, provide for ease of maintenance, and extend the operational life of the system. Design and construction shall be in compliance with this guide. Under no circumstances shall any design modification diminish in any respect the functionality and/or quality of service being provided prior to the application of the design. It is the responsibility of the engineer of record to investigate to the fullest extent the existing conditions and requirements associated with healthcare system requirements and assure
that any planned modifications can meet and/or exceed these requirements with a comfortable margin of excess/redundant capacity. The recommendation(s) for each module must include conceptual drawing(s), narrative(s) of the proposed solution(s), estimate(s) of the execution timeline of the work (estimated phasing schedule, time of construction, etc.) and a plan to minimize the adverse impact of the work on the occupants and their operation. Additionally, designs and proposed solutions shall to the greatest extent possible incorporate features that are in line with and/or comply with LEED Silver qualification and Energy Star certification (where applicable).

11.2 Avoidance of Adverse Mission Impact.
   A. Construction and work that requires complete shutdown of operations or mission shall be performed on weekends, facility training days, during night time facility off-hours or recognized holidays. Temporary entrance shall be provided to mission critical equipment, laboratories, pharmacy, critical refrigeration equipment, security/alarm system, and any other identified critical areas during all construction disruptions to maintain mission integrity. All day time construction features shall be performed around facility activities and not interfere with the daily operations of the facility personnel or infrastructure. The contractor shall strategize with AFMSA, medical group leadership, Facility Management staff and others as appropriate to minimize impact and coordinate construction activities throughout the project.

   B. For Roofing Projects: When working on roofs or the building envelope, the contractor will install temporary closures, covers, etc, at the conclusion of each day’s work to ensure that water cannot penetrate to the interior of the building in the event of an overnight or evening rain or storm.

   C. Maintenance of Fire/Smoke Barriers during Construction: Contractors working inside the building shall ensure that all penetrations of fire/smoke barriers are either sealed permanently with the appropriate fire stop, or a UL listed temporary fire stop if the penetration is to be reopened later during the execution of the construction.

   D. Securing of Electrical Systems during Construction: At end of day and before departure, the electrical contractor shall make safe any electrical component, apparatus, enclosure or exposed energized conductors by reinstalling shields, covers, doors or installing appropriate temporary covers the eliminate the possibility of electrical shock or fire hazard. Similarly, if work is being performed on the aforementioned electrical systems where any energized components are exposed, it shall not be left unattended by the qualified technician even for very brief periods without replacing all covers restoring dead-front / arc-flash protection features and making it safe.

Attachment 1 - Roof Insulation Zone Chart

Attachment 2 – Sample DD Form 1354

Attachment 3 – HFD ETL 2010-01 HVAC Return Air

Attachment 4 – HFD ETL 2011-01 Emergency HVAC Shutdown
Memorandum From: AFMSA/SG8F
2510 Kennedy Circle
Brooks City-Base, TX 78235

Subject: Health Facilities Division (HFD) Engineering Technical Letter (ETL) 2010-1: Ducted Return/Exhaust Air in AFMS Medical Business Occupancies

1. **Purpose:** This Engineering Technical Letter (ETL) sets forth, and clarifies, design criterion for heating ventilation and air conditioning (HVAC) Return Air and Exhaust Air systems installed, repaired and altered in Air Force Medical Service (AFMS) facilities. This ETL shall become obsolete when said design criterion has been incorporated into revision 3.1 of the AFMSA HFD Quality Standards & Design Principles.

2. **General:** The use of ducted return air provides higher quality ventilation systems for healthcare facilities, increases the flexibility to convert spaces from Administrative (or business occupancy) to clinical functions with a minimum of investment, and therefore, provides an improved patient care environment for the Air Force. Other advantages of the use of ducted return include being easier to keep ventilation system clean; better controlled space pressurization, space isolation, and ventilation system encapsulation.

3. **Application:** Requirements published in this ETL are mandatory. Any deviation from the prescribed criterion requires written endorsement in advance from the HQ AFMSA/SG8F. This ETL is being published as interim policy and the criteria herein is to be implemented effective the date of ETL and applied in all Air Force Medical Service facilities, repairs, alterations, and construction thereof. Designs that have not progressed to the 95% level (Construction Documents) on the date that this document is published, shall be required to comply with the content of this ETL before proceeding to the 95% level.

4. **Authority:** This ETL is being issued by HQ AFMSA/SG8F Health Facilities Division (HFD) as an AFMS-wide design betterment to the Uniform Facilities Criteria 4-510-01.

5. **Referenced Publication(s):** Unified Facilities Criteria (UFC) 4-510-01 Design: Medical Military Facilities

6. **Background:** UFC 4-510-01 provides vague direction concerning the use of ceiling plenum as return air systems. Although the UFC indicates such systems should be avoided, it does allow for above ceiling plenum return designs in either new or renovation projects. See UFC 4-510-01, section 7-11.5.2 which states “Utilization of above-ceiling areas for return or exhaust air in portions of facilities not classified as healthcare occupancy is discouraged...” Whereas UFC does not specifically require the use of ducted return air systems in non-clinical space (Medical Business Occupancies), the HFD believes that the use of above ceiling plenum
return in lieu of fully ducted systems are suitable for service only to non-healthcare occupancies and therefore restrictive on the potential for use in such occupancies over the horizon. Such systems are also more difficult to control and adjust for appropriate segmented pressurization should portions of the greater space be re-designated. Ducted return systems provide higher quality of building functionality, the least cost alternative in the long term due to cost avoidance of having to install all other infrastructure with “plenum ratings,” as well as the valuable flexibility offered to re-designate the mission throughout the lifetime of the building asset.

7. Requirement: Unless otherwise exempted in writing by AFMSA/SG8F (Engineering) fully ducted supply air and return air systems are mandatory in all AFMS facility designs.
   a. For new construction, repairs, modernizations or alterations of HVAC infrastructure systems, the design of the return air and/or exhaust air systems must be fully ducted with metal ducting.
   b. For HVAC system replacements, repairs and renovations, where the existing systems are not fully ducted, the new return or exhaust systems shall be fully ducted.
   c. For minor repair, or renovation projects where the above ceiling space is to be exposed due to the renovation (i.e., lighting retrofits, remodels or ceiling replacements, etc.) and it is found that no return air duct exist, and/or the existing air ducting (return or supply) is internally insulated, the contractor/design engineer must identify this discrepant condition to the HFD such that the opportunity to replace, or install new ducting may be considered/leveraged by the HFD. NOTE: Unless properly notified and/or an exemption to deviate from this design policy is granted by the HFD, the HFD will conclude that the discrepant condition will be corrected by the contractor as part of the design proposal.
   d. All ductwork systems shall be made of sheet metal. Supply, Return and Outside Air ducts shall be appropriated insulated where passing through an unconditioned space, sound attenuated and installed per SMACNA standard. Ducts constructed of fiberglass duct board or ducts which are internally lined with insulation will NOT be permitted.

8. Office of Primary Responsibility (OPR): The office of primary responsibility for this ETL is AFMSA/SG8F. Please forward inquiries, questions or requests to:

   DAVID G. CHRISTIANSEN, DAF
   Chief, Engineering Branch
   Health Facilities Division
   Air Force Medical Support Agency (AFMSA)
   2810 Kennedy Circle
   Brooks City-Base TX,
   DSN: 240-3972 Commercial (210) 536-3972
   E-mail: david.christiansen@us.af.mil

   REX A. LANGSTON, Colonel, USAF, MSC
   Chief, Health Facilities Division
   Office of the Surgeon General
Memorandum From: AFMSA/SG8F  
601 Davy Crockett (Bldg 1534)  
San Antonio, TX 78226

Subject: Health Facilities Division (HFD) Engineering Technical Letter (ETL) 2011-1: Emergency Air Distribution Shutoff in Medical Facilities

1. Purpose: This Engineering Technical Letter (ETL) sets forth, and clarifies, design criterion for heating ventilation and air conditioning (HVAC) emergency shutdown systems in Air Force Medical Service (AFMS) facilities. This ETL shall become obsolete when said design criterion has been incorporated into UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings.

2. General: The use of an emergency air distributed shutoff in certain areas of the hospital such as critical care, isolation, infectious medical waste storage, sterilization and other procedure areas could pose a greater life threat to the occupants than the exterior environment for which the emergency shutdown of the air systems is intended. Caregivers, warriors and/or their families whom are on life support, in critical care or who have compromised immune systems are protected from harmful diseases that may already exist within the facility, but are controlled through building pressurization provided by these mechanical air systems. Further, not providing protection is in direct violation of airborne and nosocomial infection control procedures; and OSHA bloodborne pathogen regulations.

3. Definitions:

a. Non-Critical Care Areas: Those areas that are best described as administrative or medical business occupancies which do not have special requirements for positive or negative pressurization necessary to protection immune-compromised patients from infection, or to protect the general populous within the facility from patients whom have contagious disease and should be under isolation. The table included in Appendix A of UFC 4-510-01 under the column titled “BL” (Balance) sets forth the requirements for pressurization of specific spaces within a medical healthcare facility. Rooms and functions that under column BL in this table which have a “0” or a single “+” or single “-” can be deemed Non-Critical.

b. Critical Care Areas: Those areas that are best described as critical life preserving healthcare environments having special facilities which provide for positive or negative pressurization necessary to protect immune-compromised patients from infection, or to protect the general populous within the facility from patients whom have dangerous contagious diseases and should be under isolation. The table included in Appendix A of UFC 4-510-01 under the column titled “BL” (Balance) sets forth the requirements for pressurization of specific spaces within a medical healthcare facility. Rooms and
functions listed under column BL (indicating system Balance or pressurization) in this

table having a double positive "++" or a double negative "--" are considered Critical Care

areas due to special pressurization which must be maintained for both patient survivability

and infection control.

4. Application: Requirements published in this ETL are mandatory. This ETL is being

published as interim policy and the criteria herein is to be implemented effective the date of ETL

and applied in all Air Force Medical Service facilities, repairs, alterations, and construction

thereof. Designs that have not progressed to the 95% level (Construction Documents) on the

date that this document is published, shall be required to comply with the content of this ETL

before proceeding to the 95% level.

5. Authority: This ETL is being issued by HQ AFMSA/SG8F Health Facilities Division

(HFD) as an AFMS-wide design betterment to the Uniform Facilities Criteria UFC 4-010-01.

6. Referenced Publication(s): Unified Facilities Criteria UFC 4-010-01 DoD Minimum

Antiterrorism Standards for Buildings.

7. Background: UFC 4-010-01 B-4.3 Standard 18 Emergency Air Distribution Shutoff:

For all new and existing inhabited buildings, provide an emergency shutoff switch in the HVAC

control system that can immediately shut down the air distribution system throughout the

building except where interior pressure and airflow control would more efficiently prevent the

spread of airborne contaminants and/or ensure the safety of egress pathways. Locate the switch

(or switches) to be easily accessible by building occupants. Providing such a capability will

allow the facility manager or building security manager to limit the distribution of airborne

contaminants that may be introduced into the building.

8. Requirement:

a. Medical Clinics & Medical Business Occupancies: Comply with UFC 4-510-01 and install

Emergency Shutdown pushbuttons in both the Medical Command Center (MCC) and the

Facility Management Office. These pushbuttons must be capable of shutting off air

handlers, closing outside air dampers and turning off ALL exhaust fans simultaneously to

provide a neutral pressure environment within the facility.

b. Medical Centers, Hospitals, Ambulatory Surgery Centers and Healthcare Occupancies that

have Critical Care Areas (as defined herein): All hospital buildings (healthcare and

ambulatory healthcare occupancies having permanent facilities which support immune-

compromised or patients with dangerous contagious diseases) defined above as “critical

care areas” shall utilize a two step emergency air distribution shutoff. The reason for the

second step is to permit responsible personnel in executive leadership to weigh the risk

associated with intentionally degrading a life preserving internal environment to respond

to a possible terrorist attack (or other contingent situation having occurred) thus placing

patients and/or all occupant in a position of greater threat from within. The two step

shutdown process shall include the following features:

i. The design shall utilize 2 separate switches. One shall be a red mushroom that

controls the ventilation of all “non-critical care areas” of the hospital. The second

switch shall be a keyed switch that controls the ventilation systems serving the

“critical care areas” of the hospital. Due to the serious potential risk to Life Safety
and Infection Control that is associated with the activation of the second switch, this second switch shall be operated only at the direction of the Hospital Commander, Administrator or their delegate. These persons must possess a clear understanding the potential threat to patient life and other ramifications which will result from activating a shutdown of the air distribution systems serving “critical care areas.”

ii. Both switches shall be covered by a flip up plastic cover that is designed to prevent accidental activation.

iii. The red mushroom pushbutton shall have the following signage “Emergency Use Only! Mechanical HVAC System Shutdown.” The second keyed switch shall have the following signage “Danger! Critical Care HVAC Shutdown, exposure hazard”. Signage shall be red background with white letters and will be placed above plastic covering for each individual button.

iv. For Hospitals & Medical Centers, the emergency air distribution shutoff pushbutton and the keyed Critical Care HVAC Shutdown switch shall be located in the Medical Command Center (MCC) that becomes active in the event of an emergency. A second panel having both the red pushbutton and keyed switch shall be located in the Facility Management Office to provide an alternate location where both levels of shutdown can be initiated by authorized persons.

v. For Medical Clinics there will be a single red emergency air distribution shutoff pushbutton (labeled as stated in paragraph iii above) installed in both the Facility Management Office and the MCC.

vi. For Dental Clinics and other AFMS facilities where there is neither a Facility Management Office nor a MCC, there shall be a single red emergency air distribution shutoff button (labeled as stated in paragraph iii above) installed behind the front entrance reception desk.

9. Office of Primary Responsibility (OPR): The office of primary responsibility for this ETL is AFMSA/SG8F. Please forward inquiries, questions or requests to:

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