

**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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## **1.0 Purpose & Introduction**

This document provides guidance to designers, maintenance providers and contractors engaged in the repair, renovation, construction and modernization of Air Force Medical Service (AFMS) properties worldwide.

### **1.1 Intent**

This guide is not intended to serve as complete specification in and of itself, but rather compliment already published industry standard practices, the Uniform Building Codes, the Unified Design Facilities Criteria (UFC 4-510-01), applicable codes and requirements published by NFPA, AIA, NESC, NRCA, IBC, SMACNA, ASHRAE, ASPE, DHA 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 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**

The published codes and standards mentioned in paragraph 1.1 above establish the minimum requirements for construction. It is the intent of this guide to establish criteria and require features that are above the minimum basic requirements for construction and performance to provide a more efficient, reliable, maintainable, comfortable and healing environment for patients and staff. In the event of conflict, the more 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 documents 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 Whole Building Design Guide and can be viewed at [WBDG.org](http://WBDG.org).

## 2.0 Mechanical Infrastructure Systems

When making repairs, alterations or renovating existing mechanical infrastructure requiring 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 analytical calculations and simulations. 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

- 2.1.1.1 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 connection of a temporary chiller. The pipe connections at the system shall be so designed 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. Size piping and electric power to match the largest indoor chiller.
- 2.1.1.2 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.
- 2.1.1.3 Single chiller installations shall be at least dual compressor, dual circuit design sized with each circuit at 60% of peak cooling load (Sum of AHU capacities). Multiple chiller designs shall include same basis of design in that the system will provide at least 60% of the peak cooling load with the failure of any one circuit. At forty total system tons and greater, provide at least two chillers.
- 2.1.1.4 Any space requiring “special” environmental conditions that are less than 70°F and 50% relative humidity shall require a dedicated cooling system.
- 2.1.1.5 The condenser water design shall provide freeze protection (both operating and idle) and control of chiller condenser pressure.
- 2.1.1.6 Antifreeze shall NOT be used in chilled water systems in ASHRAE Climate Zone 4 or less. Antifreeze may only be used with AFMSA/SG8F concurrence in ASHRAE Climate Zone 5.

#### 2.1.2 Heating Water/Steam Systems

- 2.1.2.1 Where a natural gas utility service to the building is available, the basis of design for heating hot water systems shall include natural gas fired, high efficiency or condensing, packaged, hot water, boilers.
- 2.1.2.2 Provide dilution accessory to prevent acidic effluent from entering sewer system.
- 2.1.2.3 Designer shall eliminate or minimize steam based systems – where economically feasible.
- 2.1.2.4 Boiler design shall include a dedicated constant volume boiler primary pump to ensure proper water flow at boiler and secondary loop pumps with variable frequency drives.
- 2.1.2.5 Select pump motors with 120% of selected brake horsepower (HP) 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

- 2.1.3.1** Continuous cooling loads such as laboratories, pharmacies, and 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.
- 2.1.3.2** Heat recovery systems shall be provided for all 100% Outside Air (O/A) systems; heat wheels shall NOT be used.
- 2.1.3.3** 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% O/A systems to accommodate as much return air as allowable by code.
- 2.1.3.4** 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 needed 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.
- 2.1.3.5** When a space requires a pressure relationship to an adjacent space, the design of the supply and exhaust air flow rates for the space requiring the pressure relationship shall utilize a minimum of 20% differential between the two flow rates. The contractor shall be responsible for any corrections or changes required for achieving space pressure differentials.
- 2.1.3.6** The room by room ventilation analysis shall be totaled to provide an overall minimum outside air supply rate for the entire zone. Provide an 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.
- 2.1.3.7** One Variable Air Volume (VAV) terminal shall not serve more than six (6) rooms or 2,000 square feet. Designer shall not mix spaces with different occupant density or outside wall exposures on a common VAV terminal. Each conference room, DIPC, or CIPC room shall be a dedicated zone.
- 2.1.3.8** 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. On a fan-array with multiple fans, the motor HP shall be the sum of the motor HP to determine safety factor. Provide grounding rings on motors served by VFDs.
- 2.1.3.9** Field assembled systems with fan/s, coil/s, and filter/s constitute an air handling unit and shall conform to Section 2.2.5 of this guide. Duct mounted cooling coils are not acceptable.
- 2.1.3.10** For air handlers designated with air side economizer cycles, the outside air duct must be sized to allow full design airflow.
- 2.1.3.11** Exhaust fans serving critical or hazardous spaces shall not be interlocked with associated air-handling units for automatic shutdown.
- 2.1.3.12** Air Handling units mounted outdoors shall have a factory painted finish coordinated with Base Architectural standards, and a sloped roof.
- 2.1.3.13** All AHU cooling coils shall have copper fins and copper tubes.

## 2.2 Equipment Physical Characteristics

### 2.2.1 Chillers

- 2.2.1.1 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.
- 2.2.1.2 Provide a new refrigerant monitoring and alarm safety system having all features currently required by ASHRAE Std. 15. 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.
- 2.2.1.3 Air-Cooled Chillers located in coastal environments shall have copper fins and/or baked epoxy coating.
- 2.2.1.4 Furnish manufacturers louvered panels over the coil surface and the lower equipment enclosure areas on air cooled chillers.
- 2.2.1.5 Open drive chillers shall not be used. Chillers utilizing scroll compressors may not exceed 60 tons total capacity.
- 2.2.1.6 If a refrigerant compressor fails for any reason, the contractor shall perform an acid test and record the results. Further clean up and repair shall be performed per the 2014 ASHRAE Refrigeration Handbook Chapter 7 and new compressors shall be installed per the manufacturer's recommendations.

### 2.2.2 Boilers

- 2.2.2.1 Fully modulating boilers are required and must demonstrate stable operation without vibration or excessive noise throughout the full range of modulation.
- 2.2.2.2 When new steam boilers MUST be used in a design, 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.
- 2.2.2.3 Steam boilers shall utilize flow control devices (e.g. orifices) to restrict flow to no more than designed package capacity.
- 2.2.2.4 Utilize Lo-NOX boiler (or ultra-Lo-NOX, as required by local authorities) firing controls.

### 2.2.3 Pumps

- 2.2.3.1 Use only TEFC NEMA premium efficiency motors.
- 2.2.3.2 Where pump motors will be controlled by VFDs, they will be so designed for continuous use/duty with VFDs. Provide grounding rings on motors served by VFDs.
- 2.2.3.3 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.
- 2.2.3.4 All pump bases shall be grouted with a self-leveling epoxy grout after alignment is complete. All pump assemblies shall be laser aligned.

### 2.2.4 Cooling Towers

- 2.2.4.1 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.
- 2.2.4.2 Use Variable Frequency Drive (VFD) and motors designed specifically for use with VFDs on tower fans.

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Provide grounding rings on motors served by VFDs.

- 2.2.4.3 Provide side filtration and a basin cleaning system to remove solids from the basin and condenser water.
- 2.2.4.4 Provide automatic water make-up control with separate metering. Meter shall be of type that can provide data to the Building Automation System (BAS). Meters shall be connected to BAS. High and low water level alarms shall also be provided to the BAS.
- 2.2.4.5 Provide basin equalization piping on towers serving a common system.
- 2.2.4.6 Tower installation shall provide sufficient height for required condenser pump NPSH.
- 2.2.4.7 New cooling towers shall be of the induced draft cross flow design with TEFC (or TEAO) motors.
- 2.2.4.8 Design cooling towers according to ambient temperatures listed in UFC 4-510-01. Select towers for not more than a 10° F approach temperature at design conditions.
- 2.2.4.9 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.
- 2.2.4.10 Water Treatment system shall measure conductivity and pH and automatically apply chemicals by requirement not time. System shall conform to UFGS Specification Section 23 25 00 – Chemical Treatment of Water for Mechanical Systems. At a minimum, water conductivity and pH shall be sensed and reported to the BAS.

## 2.2.5 Air Handlers

- 2.2.5.1 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.
- 2.2.5.2 Cooling coils (chilled water) shall be ARI listed for performance. Coils shall have copper fins on copper tubes and shall have no more than 12 fins per inch; serrated fins are not acceptable. The minimum design entering water temperature shall be 2° F above system chilled water supply temperature as documented in latest official project plans with a water temperature differential across the coil of 12° F. Provide stainless steel coil casings and intermittent supports. Coil fins shall be no less than 0.0075" 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 in depth, 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.
- 2.2.5.3 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. AHUs in ASHRAE climate zone 3 or higher shall be provided with preheat coils of s The use of **steam coils should be minimized and shall NOT be used for outside air preheat applications.**
- 2.2.5.4 Provide 200,000 hour (L10) rated bearings on shafts and motors 5 HP and larger. Provide TEFC (Totally Enclosed, Fan Cooled and NEMA premium efficiency) motors for fans. Provide grounding rings on motors served by VFDs.
- 2.2.5.5 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.
- 2.2.5.6 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

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- pin and sleeve hinge for removal. Each module shall have a vision panel and interior lighting with switching at exterior of AHU. Doors shall swing into the space with higher pressure or doors shall be equipped with latches that prevent violent opening due to pressure.
- 2.2.5.7** 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.
- 2.2.5.8** 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.
- 2.2.5.9** 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.
- 2.2.5.10** 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 chrome 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.
- 2.2.5.11** Provide a dedicated casing section with moisture eliminators for humidifier dispersion tubes. See UFC 4-510-01 for more additional requirements relating to humidification.
- 2.2.5.12** 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 (COTS) product. **Filter Boxes shall conform to the UFGS 23 73 13.**
- 2.2.5.13** 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 (when 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 O/A streams shall be moisture resistant 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.
- 2.2.5.14** 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.
- 2.2.5.15** 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.
- 2.2.5.16** 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 operable fan in the failed mode. The loss of any single fan shall not reduce AHU CFM below 60% of design airflow.
- 2.2.5.17** Air Handling Units shall deliver minimum required outside air at area ten year minimum outside air temperature without tripping the unit freeze stat. Closing the outside air dampers is not an acceptable



### 2.2.6 Variable Air Volume Terminals

- 2.2.6.1 All Variable Air Volume (VAV) terminal boxes shall be pressure independent type.
- 2.2.6.2 Heating water coils in VAV terminals serving exterior zones in heating dominant climates shall be two row design.
- 2.2.6.3 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.
- 2.2.6.4 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

- 2.2.7.1 All motors controlled by Variable Frequency Drives (VFD) 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.
- 2.2.7.2 Stencil or label all finished pipe surfaces to clearly label content and normal flow direction pursuant with ANSI/ASME A13.1. Provide identification at a maximum 20 ft. interval.
- 2.2.7.3 For roof top mounted equipment, 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 shall 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.
- 2.2.7.4 When using existing concrete housekeeping pad for mechanical equipment, the contractor must verify the pad size to determine adequate clearance beyond the equipment. See section 8.0.6 Equipment Mounts and Foundations, for further guidance.
- 2.2.7.5 Isolation valves, flow measuring ports and balance valves shall be installed on all coils and all components requiring Test, Adjust & Balance (TAB). Strainers required ahead of all control valves and pumps.
- 2.2.7.6 Deleted.
- 2.2.7.7 Above ceiling spaces shall not be used as return air plenum (See [Attachment 1](#)).
- 2.2.7.8 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.
- 2.2.7.9 Provide all stainless steel (SS) 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.
- 2.2.7.10 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 all old / existing flex duct with new. This includes all flex

duct on systems serving the area and those flex ducts that only pass through the area.

- 2.2.7.11** Ductwork design shall use long radius elbows.
- 2.2.7.12** Supply, return and outdoor air ductwork shall be sealed with water based mastic at all joints and externally insulated. Test all new ductwork per SMACNA standard.
- 2.2.7.13** All branch ducts shall have manual balancing dampers. This includes branch ducts on various floor levels connected to a vertical riser.
- 2.2.7.14** 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.
- 2.2.7.15** 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.
- 2.2.7.16** 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).
- 2.2.7.17** All outside air (OA) duct in coastal locations shall be 316 or better stainless steel to the AHU inlet.
- 2.2.7.18** All pipe and duct insulation shall meet or exceed ASHRAE 90.1 and National Insulation Association (NIA) guidelines as prescribed by Whole Building Design Guide and “Federal High Performance & Sustainable Buildings.”
- 2.2.7.19** All chilled water pipes shall be insulated with cellular glass material. Mineral fiber or unicellular insulation is not acceptable.
- 2.2.7.20** All indoor piping insulation in mechanical rooms or where exposed shall be covered with PVC jacketing with a thickness of that least 30 mil. PVC shall match local fluid color schemes or if no color scheme, may be white. 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 per ANSI/NFPA requirements. Provide identification at intervals not exceeding twenty feet. Insulate all piping specialties per UFGS 23.07.00.
- 2.2.7.21** All outdoor mechanical insulation shall utilize metallic jacketing to protect such insulation from exposure and elements.
- 2.2.7.22** All supply, return, and outside air ductwork shall be insulated. Exhaust duct shall be insulated from the exterior penetration to the backdraft damper.
- 2.2.7.23** In areas of known or anticipated “climbing” on/over of the insulated component by personnel, grated steel walkways or catwalks 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.
- 2.2.7.24** Leave no insulation exposed to the air stream in any ductwork or equipment.
- 2.2.7.25** Contractor shall make all repair/replacements as to maintain any in-place manufacturer's or contractor's warranties. In the event that the item removed leaves a penetration/hole in the exterior cladding and/or structure framing of the assembly, the Contractor shall properly reconstruct the assembly (both substrate and cladding) to match the surrounding construction and finish. Structural capacity, weather-tightness and aesthetics shall all be essential elements of the work. An engineer shall be utilized to design the structure for in-filled load-bearing systems on openings larger than 24”

- 2.2.7.26** All chilled water lines shall utilize a compartmentalized vapor seal. Vapor seals shall be no more than four (4) insulation joints in length.
- 2.2.7.27** Insulating materials containing polyisocyanurate with a smoke index greater than 50 shall NOT be utilized in AFMS facilities.
- 2.2.7.28** For closed loop hydronic systems provide weld-o-lets, feeders and other devices to accommodate chemical treatment. Include corrosion test coupon assembly.
- 2.2.7.29** For systems without glycol, include water meter with pulse counter contactor on make-up water line, and connect to the BAS. For systems with glycol provide a glycol feed pump, pre-mix glycol tank, pressure feed contact, and low glycol level alarm on the glycol makeup system. Glycol systems shall not have domestic water makeup connections to closed loop. Connect glycol feed system to BAS.
- 2.2.7.30** 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.
- 2.2.7.31** 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.
- 2.2.7.32** Install corrosion test coupon assembly on the cooling tower circulation loop.
- 2.2.7.33** Water Treatment System shall conform to UFGS Specification Section 23 25 00 - Chemical Treatment of Water for Mechanical Systems. Non-chemical based systems (such as ozone or magnets) are not acceptable.
- 2.2.7.34** All isolation valves 1/2" through 3" shall be full port ball valves.
- 2.2.7.35** IT room designs shall be based on a room temperature of 75°F. Cooling equipment shall not be sized for more than the existing connected load in the space. The cooling system shall be capable of cooling and controlling humidity in the space without reheat under the existing load conditions.
- 2.2.7.36** The failure of any single component shall not prevent the lag equipment (pumps, boilers, water heaters, etc.) from being enabled under manual (hand) control. No wiring, programming or other changes will be allowed to enable the lag equipment.
- 2.2.7.37** When chillers are equally sized, chillers shall be piped so that any chilled water pump or condenser water pump can serve any chiller.
- 2.2.7.38** Strainers shall have drain valve with hose bib.

## **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 electronic automated control system.

- 2.3.1.1** Projects shall remove existing pneumatic HVAC control systems and replace them with direct digital programmable control systems.
- 2.3.1.2** When a control system is replaced, no existing control components are to be re-utilized unless approved prior to contract award. If the contractor reuses any component (even those noted to be reused), the contractor shall warranty parts and labor on the reused items as if they were new.

All firmware and software being proposed for projects in AFMSA properties must be compliant with HQ AFCEC Engineering Technical Letter (ETL) 11-1 dated 30 Mar 2011 titled "Civil Engineering Industrial Control Information Assurance Compliance," and be approved for use on DOD / Air Force distributed networks (refer to UFC 4-010-06). The software must be most recent version at time of proposal, with a remaining application life and compatibility with future systems for at least five (5)

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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.

- 2.3.1.3** Include a desk top computer with the latest operating system and 21 inch flat screen monitor (minimum), and an ink jet printer.
- 2.3.1.3.1** The BAS graphical user interface (GUI) shall be user friendly, incorporate high-definition 3D 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:
  - 2.3.1.3.2** Floor plans with room numbers, temperature sensors, terminal boxes and AHU's accurately located.
  - 2.3.1.3.3** VAV boxes with CFM (feedback), damper position (percentage), space temperature (feedback), space temperature set point, discharge air temperature (feedback) and reheat valve position (percentage).
  - 2.3.1.3.4** 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).
  - 2.3.1.3.5** 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.
  - 2.3.1.3.6** 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. On all components which have moving elements (e.g. fan blades, pump impellers, etc.), animation will be provided to depict said movement/flow whether on or stopped.
  - 2.3.1.3.7** All control systems (such as but not limited to steam boilers, boiler feed water systems, air compressors, vacuum pumps, med gas systems, generators, automatic transfer switches, load control systems, domestic hot water heaters, VFDs, etc.) shall report to the BAS via a native BACnet card (shall be used when available) or a translator (black box) to BACnet at the individual equipment.
- 2.3.1.4** 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.
- 2.3.1.5** 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

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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”.

- 2.3.1.6** 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.
- 2.3.1.7** 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. Spaces that have temperature and/or humidity ranges specified in UFC 4-510 shall not have night set backs outside of those requirements. Sequences of Operation must be submitted with the 65% design submittal and accepted by AFMSA/SG8FE.
- 2.3.1.8** Provide Control Schematics for all controlled equipment and systems. Identify control points with the same designator used above in the BACnet Object List.
- 2.3.1.9** All new systems shall utilize a BACnet/IP “backbone” for connection to system level panels and computer access terminals, as a minimum.
  - 2.3.1.9.1** As a minimum, use BACnet communications protocol at the system level and provide for data access and sharing with other BACnet compatible vendors.
  - 2.3.1.9.2** All devices below the system level (end device unit controllers) shall communicate in open (non-proprietary) protocol
- 2.3.1.10** 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.
- 2.3.1.11** Provide lightning and transient voltage protection for system level panels.
- 2.3.1.12** Provide auto archiving/back-up software program for routine back-up of the programs, including historical trending.
- 2.3.1.13** Provide one hour minimum UPS for system level programmable controllers mounted securely off of the floor.
- 2.3.1.14** All controllers are to utilize non-volatile memory.
- 2.3.1.15** When an emergency power source is available at a facility, all BAS components serving critical areas, including all actuators, shall be connected to the “essential equipment” bus of the emergency power system. All other BAS components shall be connected to the “essential equipment” bus if sufficient generator capacity exists or the BAS components shall fail to an appropriate position to minimize impact to the facility operations. 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.”
- 2.3.1.16** All points shall be trended. Analog points shall be trended at a maximum interval of 15 minutes. Binary point shall record change of state. BAS shall be capable of storing all trends for a minimum of 1 year.
- 2.3.1.17** In spaces where tight control of relative humidity is mission critical and required (e.g., Operating Rooms, Laboratories, Pharmacies, Instrument Sterilization Centers and Sterile Storage) provide high quality temperature/humidistats in the space which sense and report back to the building automation system where precise space temperature and relative humidity can be trended in real time and user adjustable intervals.
- 2.3.1.18** A complete set of trend logs of system operation shall be submitted to the government 10 business days prior to functional performance testing and final commissioning to demonstrate system

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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 seven (7) consecutive days of trends two of which are weekends or holiday. AHU trend logs shall be submitted in spreadsheet and graphical form and shall include the following:

- 2.3.1.18.1** Outside Air Temperature
- 2.3.1.18.2** Return Air Temperature
- 2.3.1.18.3** Mixed Air Temperature
- 2.3.1.18.4** Supply Air Temperature
- 2.3.1.18.5** Mixed Air Damper Position
- 2.3.1.18.6** Chilled Water Coil Valve Position
- 2.3.1.18.7** Fan Speeds
- 2.3.1.18.8** Supply, Return, and Exhaust Duct Static Pressure
- 2.3.1.18.9** Preheat Coil Valve Position
- 2.3.1.17.10** Reheat Coil Valve Position
- 2.3.1.17.11** Space Relative Humidity
- 2.3.1.17.12** Outside Air CFM
- 2.3.1.17.13** For VAV boxes the trend log shall include:
  - 2.3.1.17.14** Inlet Air Temperature
  - 2.3.1.17.15** Discharge Air Temperature,
  - 2.3.1.17.16** Reheat Valve Position
  - 2.3.1.17.17** Air Damper Position
  - 2.3.1.17.18** Air Volume
- 2.3.1.18** During Unoccupied Periods (period of non-use for procedures or when vacant), operating room air volume shall be reduced to 6 air changes per hour, while maintaining a positive pressure in the surgery room of 0.02" minimum (documented 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.
- 2.3.1.19** 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 6.16.2 for additional information for lighting control).
- 2.3.1.20** 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.
- 2.3.1.21** Provide open protocol BACnet access to the chiller and boiler local controls. Written site specific exemptions for LonTalk may be requested from AFMSA/SG8FE.
- 2.3.1.22** Control valves 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 a shut off pressure rating adequate to close off

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against pump maximum discharge pressure. No three-way valves are allowed. If a bypass is required to maintain a minimum flow, a two-way valve shall be utilized and shall only open at minimum flow rates.

- 2.3.1.23** Design systems to maintain water flow through coils, heat exchangers, towers, pumps, piping, exposed to temperatures below 32<sup>o</sup> F. Provide thermostatically controlled heat trace or other freeze protection for exposed utilities as required.
- 2.3.1.24** Heating water system supply temperature set point shall utilize an outside air reset schedule to maximize efficiency. Refer to ASHRAE 90.1.
- 2.3.1.25** Hydronic systems shall reset differential pressure setpoint based on valve positions. Refer to ASRAE 90.1.
- 2.3.1.26** When an AHU is renovated or replaced, provide outside air (OA) flow measuring stations to control and monitor OA flows. Return air duct mounted CO<sub>2</sub> sensors shall NOT be used for OA controls. Provide OA flow stations that are not subject to clogging.
- 2.3.1.27** For spaces where relative humidity requirements are not specifically prescribed under UFC 4-510-01 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 20% 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.
- 2.3.1.28** All humidifiers shall have duct mounted high limit humidity sensors to prevent relative humidity above 80% in the supply air duct.
- 2.3.1.29** All exhaust fans shall be controlled and monitored by BAS.
- 2.3.1.30** All VFD drives will report KW back to the BAS system and be recorded. Chiller plant shall also report kW/Ton.
- 2.3.1.31** If the outside air levels are reduced below the minimums required in order to protect the system from freezing conditions but to keep the system operational, a audible and visual alarm shall be provided separate from the BAS alarm indicating the system is operating outside of design conditions. The alarm shall not be able to be silenced.

### **3.0 Testing Adjusting and Balancing of Air and Water Systems**

- 3.0.1** All new or renovated HVAC systems shall be tested and balanced pursuant to National Environmental Balancing Bureau (NEBB) standards.
- 3.0.2** Balancing tolerance shall be +10% to -0%, rather than +/- 5% (per UFC3-4100-01)

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

- 3.1.1** 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.

### **3.2 TAB Definitions**

- 3.2.1** 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**

- 3.3.1** TAB shall be accomplished for any system downstream of the equipment modified.

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**3.3.2** 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. All TAB work shall be executed and reported according to the NEBB.

**3.3.3** The ASHRAE Applications Text, Chapter 37 – Testing, Adjusting, and Balancing, 2007 Edition is the reference document for development of all Performance Work Statements (PWS).

### **3.4 TAB Submittals and Approvals**

**3.4.1** 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.

**3.4.2** The submittal shall follow NEBB standards.

### **3.5 TAB Preplanning Requirements**

**3.5.1** 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.

**3.5.2** 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**

**3.6.1** 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.

**3.6.2** 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**

**4.0.1** The functional testing (also referred to as "Commissioning" or "Cx") shall be performed in accordance with ASHRAE Standard 202.

### **4.1 Functional Performance Testing Prerequisites**

**4.1.1** The contractor shall provide to the accepting government representative at time of request for the scheduling of the final government acceptance functional test and no sooner than 10 business days in advance of the actual test date. If the completion of a task or availability of any document or component is questionable, the final government acceptance test must be postponed and rescheduled.

**4.1.2** The FINAL Test and Balance (TAB) report with design engineer's written review and approval (including seal).



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- 4.1.3** The final construction documents. This includes the final drawings, specifications, SOW, and “Best and Final” accepted proposal.
- 4.1.4** The written controls sequence of operation. This 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.
- 4.1.5** A minimum of seven (7) days of trend logs for each system modified or installed in the contract shall be provided. The seven 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 (5) minutes. For a minimum of five (5) VAV boxes per individual system trend logs shall include: inlet air temperature, discharge air temperature, heat valve position, air damper position, space temperature, and space temperature set point. For water cooled chillers the points 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 accepting government representative prior to setting up trends.
- 4.1.6** 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
- 4.1.7** 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.
- 4.1.8** Owner Training documents to include written Training Agenda and sign-in sheets for each system for which training was provided. All training shall be recorded in video format.
- 4.1.9** Operation and Maintenance manuals.
- 4.1.10** Final As-Built drawings.
- 4.1.11** 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**

- 4.2.1** 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.
- 4.2.2** 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 government acceptance functional test process for group viewing of the system commissioning.

## **4.3 Functional Testing On-Site Review Steps**

- 4.3.1** The first day will include the review of documentation described above.
- 4.3.2** The second step of the acceptance testing process will be the site inspection of the systems and equipment modified and installed in the project scope. The government accepting representative will

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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.

- 4.3.3** The third step of the testing process will be the validation of the TAB report. The government accepting representative will randomly select a sample of the TAB readings from the final TAB report for this function.
- 4.3.4** The fourth and final step of the government acceptance 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 government accepting representative.
- 4.3.5** Items found to be deficient during this process will be documented and included in a government acceptance 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 government acceptance representative 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.
- 4.3.6** 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.**

- 5.1.1.1** Plumbing systems shall comply with ASHRAE Standard 188.
- 5.1.1.2** Sanitary sewer piping handling high temperature effluent shall be cast iron.
- 5.1.1.3** Supply piping shall be Type L Copper.
- 5.1.1.4** 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.
- 5.1.1.5** Design shall eliminate domestic hot water storage, tube and shell heat exchangers, and steam to water converters as much as possible. Multiple parallel, condensing, high efficiency, rapid recovery water heaters shall be the basis of design.
- 5.1.1.6** Design purified water systems with polyethylene or schedule 80 PVC pipe and fittings. No glass pipe is allowed.
- 5.1.1.7** Natural gas piping shall be schedule 40 steel.
- 5.1.1.8** All new water and gas meters shall communicate with energy monitoring system and are subject to

- 5.1.1.9** 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.
- 5.1.1.10** Provide thermostatic mixing valves for each separate hot water temperature supply system. Monitor supply water at discharge of mixing valve with BAS connection.
- 5.1.1.11** Plumbing supply pipe shall be insulated with preformed fiberglass pipe insulation with FSK jacket. Label all pipe as described in section 2.
- 5.1.1.12** 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**

- 5.1.2.1** Waterless urinals are NOT allowed.
- 5.1.2.2** All flush valves shall have a mechanical manual override flush function.

## **5.2 Medical Gas Systems**

### **5.2.1 General**

- 5.2.1.1** Design, install, test, and certify medical gas systems per latest edition of NFPA 99.
- 5.2.1.2** Provide zone valve boxes with a minimum of one spare space for future gas pipe and valve.
- 5.2.1.3** Provide area alarm panels with a minimum of one spare space for future gas alarm.
- 5.2.1.4** Main piping shall be sized one pipe size larger than calculated requirement.
- 5.2.1.5** 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.
- 5.2.1.6** Basis of design for medical vacuum pumps shall be rotary oil-less type.
- 5.2.1.7** 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**

- 5.3.1.1** Fire protection systems shall conform to all current versions of NFPA and UFC standards.
- 5.3.1.2** Wet pipe sprinkler piping shall be schedule 40 steel for all threaded pipe and schedule 10 steel for all grooved pipe. Preaction and dry pipe systems shall be schedule 40 steel for all piping. No plastic pipe is allowed.
- 5.3.1.3** Flexible stainless steel braided pipe may be used for connection to the fire sprinklers. Installation shall follow manufacturer installation requirements. The flexible pipe cannot be kinked.
- 5.3.1.4** Install new or modified sprinkler system sprinklers in the center of ceiling tiles +/- .5". Align sprinklers in the same row of ceiling tiles in corridors. .
- 5.3.1.5** The sprinkler piping shall not be installed directly above of the ceiling. Provide a minimum of 3" between the top of the ceiling and bottom of sprinkler piping.
- 5.3.1.6** All sprinkler piping installation shall be coordinated with the general contractor, mechanical contractor, electrical contractor and the project engineer before any pipe is installed.

## **6.0 Electrical Infrastructure Systems**

### **6.1 General Lighting Requirements**

- 6.1.1** LED lighting shall be provided to the maximum extent possible. Projects shall use all LED luminaires and conform to UFC 4-510-01 Change 2, and UFC 3 530 01 change 3. Retrofitting of current luminaires in interior spaces is not permitted and full system upgrades to include luminaries, controls replacements are required.
- 6.1.2** Interior Electrical Distribution (600 volts or less). Interior lighting and power loads shall be served at the highest voltage available.
- 6.1.3** Existing fluorescent light fixture type 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.
- 6.1.4** High bay LED lighting will be used in high ceiling areas (over 20') and mechanical machine rooms and warehouse areas in lieu of HID.
- 6.1.5** Interior Electrical Distribution (600 volts or less). Interior lighting and power loads shall be served at the highest voltage available.
- 6.1.6** 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.
- 6.1.7** 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.
- 6.1.8** 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 NEMA TP-1 compliant; K-rated based on non-linear load content and shall be wired and grounded as a separately derived system. NOTE; A separately derived dry type transformer shall be connected to a grounding electrode system located as near as practicable to and preferably in the same area as the transformer. The grounding electrode shall be comprised of the metal cold water pipe serving the area and grounded structural steel.
- 6.1.9** Switchgear and switchboards shall be listed as an assembly. NOTE: in OCONUS locations equipment shall comply with all local host-nation standards.
- 6.1.10** Medical hospital switchgear shall be configured incorporating a "Main/Tie/Main" configuration. Main and Bus Tie circuit breakers shall be electrically operated, of draw out design, with solid state overcurrent, time delay, instantaneous and ground fault adjustable trip devices (if required). Feeder circuit breakers are not required to be electrically operated but shall be of draw out design with solid state overcurrent, time delay, instantaneous and ground fault (if required) adjustable trip devices.
- 6.1.11** 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. Load center type power panels with snap in type circuit breakers are not allowed.
- 6.1.12** Protective device coordination shall be coordinated for selective overload, short-circuit and ground fault protection.
- 6.1.13** Bus-in switchboards, panel boards and transformer windings shall be copper. Aluminum bus are not allowed.
- 6.1.14** New electrical meters shall have "Modbus RTU Communication" capability for future energy consumption monitoring applications.
- 6.1.15** In addition to UFC required panelboard labeling, all panelboards will be labeled with incoming panelboard source name/location all of the way upstream back to building service entrance panelboard

**6.1.16** All conduit and electrical equipment within the electrical distribution system will be installed in accordance with the good workmanship definition in NFPA 70 and NECA-1, 2015 edition.

## **6.2 Location and Space Requirements**

**6.2.1** Switchgear and switchboards shall be listed as an assembly. NOTE: in OCONUS locations equipment shall comply with all local host-nation standards.

**6.2.2** Medical hospital switchgear shall be configured incorporating a “Main/Tie/Main” configuration. Assembly shall be installed on a concrete house pad with a three-foot wide rubber mat, with a 30kV rating, full length in front of the switchgear for the working space. Main and Bus Tie circuit breakers shall be electrically operated, of draw out design, with solid state overcurrent, time delay, instantaneous and ground fault adjustable trip devices (if required). Connect to BAS in order to monitor the position of each Main-Tie-Main circuit breaker. Provide a mobile circuit breaker lifter. Feeder circuit breakers are not required to be electrically operated but shall be of the draw out design with solid state overcurrent, time delay, instantaneous and ground fault (if required) adjustable trip devices.

**6.2.3** 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. Load center type power panels with snap in type circuit breakers are not allowed.

**6.2.4** Protective device coordination shall be coordinated for selective overload, short-circuit and ground fault protection.

**6.2.5** Bus-in switchboards, panel boards and transformer windings shall be copper. Aluminum bus are not allowed.

**6.2.6** New electrical meters shall have "Modbus RTU Communication" capability for future energy consumption monitoring applications.

**6.2.7** In addition to UFC required panelboard labeling, all panelboards will be labeled with incoming panelboard source name/location all of the way upstream to building service entrance panelboard.

**6.2.8** All conduit and electrical equipment within the electrical distribution system will be installed in accordance with the good workmanship definition in NFPA 70 and NECA-1, 2015 edition.

**6.2.9** 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 meet clearance standards and 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.

**6.2.10** Critical Care Panel Board – Branch circuit panels serving critical care areas shall be located in the close proximity of their loads served. Under no circumstance shall a critical care panel-board be placed in a hallway.

## **6.3 Wire, Conduit, and Cable Tray.**

**6.3.1** All wiring shall be insulated copper in conduits and installed per NFPA 70 and UFC 4-510-01. Copper metal enclosed feeders, plug-in bus-ways or surface metal raceway may be used.

**6.3.2** All wiring should be loomed neatly in vertical or horizontal trays or bundles on the perimeters and center aisles of panel.

**6.3.3** In addition to the grounded conductor (Neutral) being white (or grey) in color, the grounding conductor is to be green. The contractor must use Black/Red/Blue for 120/208 VAC three-phase, Brown/Orange/Yellow for 277/480 VAC. \*\*NOTE: Conductors larger than #6AWG can be taped to meet requirement. \*\*\*NOTE: The

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voltages listed are only for CONUS locations and the following OCONUS locations: Republic of Korea and Kadena AB, JP. All other locations shall conform to local requirements.

- 6.3.4** Grounding conductors will be a green insulated copper ground conductor and be run with all branch circuits. A clearly marked and identified grounding conductor shall be installed with each feeder.
- 6.3.5** All conductor phasing shall be labeled and identified on the incoming service equipment distribution feeder panel or switchboard, each subsequent distribution panels; and maintain consistency throughout the system.
- 6.3.6** Critical Care wiring - : 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
- 6.3.7** Conduit fittings for Electrical Metallic Tubing (EMT) shall be compression steel type.
- 6.3.8** Conduits 1-14" trade size and larger shall have grounding bushings. All others have plastic or fiber bushings.
- 6.3.9** All conduits and other wall penetrations shall be sleeved and fire stopped using third party contractor specializing and certified by the manufacturer in completing fire penetration recovery and/or installation.
- 6.3.10** All conduits terminating at vibrating equipment shall utilize water-tight, flexible, metal conduit; the flexible, metal, water-tight conduit shall not exceed 36".
- 6.3.11** All Emergency Power Supply System (EPSS) conduit will be color coded to coincide with the circuits within. Life Safety circuits will be installed in orange conduit, critical care circuits will be installed in yellow conduit and equipment branch circuits in green conduit.
- 6.3.12** Any splicing of wire size #4 AWG and above for circuits of 600 volts or less, shall be compression type splices and insulated with both; 125-mil thick, premium grade Vinyl Mastic Pads that are self-fusing, pre-cut pad insulates, sealing out moisture for connections up to 600 volts, with Polyvinyl backing, rated for 0°F (-18°C) to 100°F (38°C) and RoHS 2011/65/EU Compliant and a 7-mil thick, premium grade vinyl-insulating tape that is resistant to abrasion, moisture, alkalis, acids, corrosion and varying weather conditions (including ultraviolet exposure). Also have a combination of elastic backing and aggressive adhesive that provides moisture-tight electrical and mechanical protection with minimum bulk while able to perform continuously in ambient temperatures rated from 0°F (-18°C) to 220°F(105°C), UL listed, Canadian Standards Association (CSA) certified.
- 6.3.13** All exterior conduit installed outdoors in substations, electrical yards, etc. shall be installed underground in accordance with this design guide. All conduit terminations that pass through the metal cabinet roof of any electrical panel, switchgear, etc. shall be installed utilizing a threaded watertight and gasketed hub; no screw-tight or non-water tight compression box connector fittings shall be allowed to terminate conduit into the enclosure.
- 6.3.14** Contractor shall make all repair/replacements as to maintain any in-place manufacturer's or contractor's warranties. In the event that the item removed leaves a penetration/hole in the exterior cladding and/or structure framing of the assembly, the Contractor shall properly reconstruct the assembly (both substrate and cladding) to match the surrounding construction and finish. Structural capacity, weather-tightness and aesthetics shall all be essential elements of the work. An engineer shall be utilized to design the structure for in-filled load-bearing systems on openings larger than 24" in any dimension.

## **6.4 Grounding Conductors**

**6.4.1** 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**

**6.5.1** Branch circuit panels serving critical care areas shall be located in the close proximity of their loads served. Under no circumstances shall a panel-board be placed in a hallway.

## **6.6 Critical Care Wiring**

**6.6.1** 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 to 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**

**6.7.1** Hospital grade receptacles shall be tamper resistant and provided in the following areas and annotated as "HG" receptacles on the final as-built drawings:

**6.7.1.1** General care patient bed locations.

**6.7.1.2** Critical care patient bed locations.

**6.7.1.3** Any location where a patient bed or patient care service console is located.

**6.7.1.4** 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)**

**6.8.1** 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**

**6.9.1** 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.

**6.10.1** Surgery, Operating and Delivery rooms shall be provided with at least thirty-six (36) each simplex or duplex receptacles. Twelve (12) receptacles shall be located in each service column with 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

- 6.10.2** 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.
- 6.10.3** 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.
- 6.10.4** 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)**

- 6.11.1** 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 NEMA TP-1 compliant; K-rated based on non-linear load content and shall be wired and grounded as a separately derived system. NOTE; A separately derived dry type transformer shall be connected to a grounding electrode system located as near as practicable to and preferably in the same area as the transformer. The grounding electrode shall be comprised of the metal cold water pipe serving the area and grounded structural steel. All medium voltage switchgear enclosures shall have site glasses installed that provide visibility of 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.
- 6.11.2** 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.
- 6.11.3 Transformers shall be:**
  - 6.11.3.1** Fused protected on the primary (H) side of the coils
  - 6.11.3.2** Equipped with a load break on/off switch
  - 6.11.3.3** Non-PCB, mineral oil or silicone oil filled
  - 6.11.3.4** Loop feed-through load-break elbow connected with parking stands and arresters.
  - 6.11.3.5** Equipped with no-load tap changers with two +2.5% taps and two -2.5% taps.
  - 6.11.3.6** 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 pads.
- 6.11.4** Medium voltage electrical cable shall be 133% BIL insulation, Type MV-105, EPR, ribbon shielded unless otherwise directed by base requirements.
- 6.11.5** Medium voltage underground conduit shall be schedule 40 PVC, except for 90° elbows, which shall be long radius rigid conduit or Kevlar reinforced fiberglass. Four (4) inch trade size minimum and shall comply with any local base standards.
- 6.11.6** 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 "buried cable" marking tape placed not less than 12" above the concrete encasement which marks the hazard. NOTE: All 600 volt and below underground conduits shall be installed at a minimum depth of 24" and encased in concrete and shall have a traceable "buried cable" marking tape placed not less than 12" above the concrete encasement which marks the hazard. All underground conduit



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shall be schedule 40 PVC, except for 90 degree elbows, which shall be radius rigid conduit or Kevlar reinforced fiberglass. The conduit trade size shall comply with published standards and any local base requirements.

- 6.11.7** All conduits emerging from grade shall be rigid metal conduit (RMC) or intermediate metallic conduit (IMC) shall protrude a minimum of 12" (309 mm) from grade/floor; and either corrosion wrapped or PVC coated.
- 6.11.8** All conduit terminated at the concrete pad shall have a grounded bushing installed.
- 6.11.9** 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**

- 6.12.1** 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.
- 6.12.2** All medium voltage switchgear enclosures shall have site glasses installed that provide visibility of 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
- 6.12.3** 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.
- 6.12.4 Transformers shall be:**
  - 6.12.4.1** Fused protected on the primary (H) side of the coils
  - 6.12.4.2** Equipped with a load break on/off switch
  - 6.12.4.3** Non-PCB, mineral oil or silicone oil filled
  - 6.12.4.4** Loop feed-through load-break elbow connected with parking stands and arresters.
  - 6.12.4.5** Equipped with no-load tap changers with two +2.5% taps and two -2.5% taps.
  - 6.12.4.6** 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 pads.
- 6.12.5** Medium voltage electrical cable shall be 133% BIL insulation, Type MV-105, EPR, ribbon shielded unless otherwise directed by base requirements.
- 6.12.6** Medium voltage underground conduit shall be schedule 40 PVC, except for 90° elbows, which shall be long radius rigid conduit or Kevlar reinforced fiberglass. Four (4) inch trade size minimum and shall comply with any local base standards.
- 6.12.7** 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 "buried cable" marking tape placed not less than 12" above the concrete encasement which marks the hazard. NOTE: All 600 volt and below underground conduits shall be installed at a minimum depth of 24" and encased in concrete and shall have a traceable "buried cable" marking tape placed not less than 12" above the concrete encasement which marks the hazard. All underground conduit shall be schedule 40 PVC, except for 90 degree elbows, which shall be radius rigid conduit or Kevlar reinforced fiberglass. The conduit trade size shall comply with published standards and any local base requirements.
- 6.12.8** All conduits emerging from grade shall be rigid metal conduit (RMC) or intermediate metallic conduit (IMC) shall protrude a minimum of 12" (309 mm) from grade/floor; and either corrosion wrapped or PVC coated.
- 6.12.9** All conduit terminated at the concrete pad shall have a grounded bushing installed.

**6.12.10** 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.

### **6.13 Main Utility Room, Generator and EES Room Lighting.**

**6.13.1** Hospitals shall require more than one (1) utility feeder (from different utility sources at the military Installation service point) and Main-Tie-Main, best-source, auto-throw over switchgear.

#### **6.13.2 Hospital low voltage main service entrance switchgear**

**6.13.2.1** 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.

#### **6.13.3 "Best Source Select" Controls**

**6.13.3.1** 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.

#### **6.13.4 Status Display**

**6.13.4.1** 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).

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

**6.13.4.3** 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.

**6.14 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.

### **6.15 Essential Electrical Systems for Healthcare Occupancies**

**6.15.1** 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. Paralleling switchgear shall have vertical separation

for the Life Safety, Critical Care, Equipment and Optional loads.

- 6.15.2** The essential electrical system shall not be equipped 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.

## **6.16 Diesel Engine Generator Sets.**

- 6.16.1** Generator sets and auxiliaries shall be sized and approved in accordance with AFI 32-1062, dated 14 June 2017 and positioned as close as possible in proximity 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 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.
- 6.16.1.1** Standby generator emissions shall meet the minimum requirements of Tier II requirements unless local published standards are more stringent.
- 6.16.1.2** 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.
- 6.16.1.3** Fuel supply in the day tank shall be sized to provide 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 AFI 32-1062, dated 14 June 2017.
- 6.16.1.4** All raceways/conduits within the generator room shall be Intermediate Metallic Conduit (IMC) or Rigid Metallic Conduit (RMC). Transitions for terminations shall be water-tight flexible metal conduit and of lengths no greater than 24 “ (610 mm).
- 6.16.1.5** The generators shall be electric start, contain jacket water heaters and pre-lube pumps as necessary to provide fast and reliable start response.
- 6.16.1.6** 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.
- 6.16.1.7** 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.
- 6.16.1.8** Where engine generator assemblies are being totally replaced, it is the contractor’s responsibility to initiate and obtain the appropriate air quality permit for the respective location of installation.

### **6.16.2 Generator Paralleling Switchgear**

- 6.16.2.1** Generator switchgear shall be listed and tested by Underwriters Laboratory (UL) as a complete assembly and controlled by a non-proprietary Programmable Logic Controller (PLC). In OCONUS locations, electrical apparatus shall be listed, tested and certified by European Committee for Electro-technical Standardization in addition to the UL listing. The PLC circuitry shall be powered by an uninterruptable 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 UFC 3-540-01.
- 6.16.2.2** The control board shall provide individual flat screen illuminated color graphical displays for each

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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.

- 6.16.2.3** 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.
- 6.16.2.4** 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.

### **6.16.3 Automatic Transfer Switches (ATS)**

- 6.16.3.1** 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.
- 6.16.3.2** All Life Safety and Critical Care loads shall have ATS equipped with a no load break by-pass isolation switch and must be initiated with not 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.
- 6.16.3.3** Load by-pass must be achieved with no load interruption.
- 6.16.3.4** 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.
- 6.16.3.5** 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.
- 6.16.3.6** 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.

- 6.16.3.7** Pre-Transfer Signals for Sensitive Loads-Every transfer switch serving elevator loads, shall be equipped with Pre-Transfer Signal controls with delays to notify each elevator bank master controller(s) of pending transfer of power.

#### **6.16.4 EES Remote Alarm Annunciation Panel.**

- 6.16.4.1** 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:

- 6.16.4.1.1** Battery and battery charger malfunction.

- 6.16.4.1.2** Engine generator run status.

- 6.16.4.1.3** Engine generator warnings and alarms.

- 6.16.4.1.4** 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 alarm signal shall be appropriately labeled but need not display individual alarm conditions.

#### **6.16.5 General Emergency Electrical Systems Requirements**

- 6.16.5.1** When converting a 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 AFI 32-1062, dated 14 June 2017. The emergency electrical load shall be installed into two (2) separate automatic transfer switches, one switch shall be sized for the Life Safety circuit load without a diversity factor and designated as the Life Safety branch, and the other switch shall be sized (without diversity factors) for the other authorized loads and be designated as the Required branch.

- 6.16.5.2** 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:

- 6.16.5.2.1** Battery operated egress lights and Exit lights shall be installed in accordance to NFPA 101 Life Safety Code in office spaces, corridors and stairwells.

- 6.16.5.2.2** 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.

**6.16.5.2.3** 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.

**6.16.5.2.3.1** Pharmacy refrigeration equipment.

**6.16.5.2.3.2** Laboratory (mission critical) refrigeration equipment.

**6.16.5.2.3.3** Immunizations clinic refrigeration equipment.

**6.16.5.2.3.4** Logistic (war reserve material) refrigeration equipment.

**6.16.5.2.3.5** 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.

## **6.16 Energy Conservation and Sustainable Requirements.**

**6.16.1** 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.

**6.16.2** Lighting controls systems shall be provided to turnoff lights automatically when the space is not in use. Provide dual 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.

**6.16.3** 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](http://www.eren.doe.gov/femp/procurement) for recommended efficiencies).

**6.16.4** 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.

**6.16.5** 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:

**6.16.5.1** Buildings of up to four floors having elevator or stairwell penthouses or other similar projections above roof.

**6.16.5.2** Buildings of five floors or more with or without projections above roof.

**6.16.5.3** 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.

**6.16.6** 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.

## **6.17 Fire Alarm System**

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- 6.17.1** 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.
- 6.17.2** 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
- 6.17.3** The Fire Alarm System Installer shall be a qualified and licensed fire protection technician.
- 6.17.4** The signaling devices shall be installed in accordance with UFC 3-600-01, dated 26 Sep 2006.
- 6.17.5** Pull stations shall conform to ADA height and location requirements.
- 6.17.6** Prior to reutilizing any existing fire alarm conduits, the full length of the conduits and condulets must be inspected for damage, loose connections and loose straps
- 6.17.7** All existing but unused or abandoned wiring and raceways within the space where work is being done must be removed, regardless if the abandoned wiring is part of the project or not. Demolition and removal of wiring and conduit shall be to the nearest wall or partition where the wiring or raceway can be properly terminated in a condulet or box with cover. Any additional conduits attached to the existing conduit run must conform to this design guide section 4.3 Conduit, Cable Tray and Wire.
- 6.17.8** All conduit, paneling, associated equipment with system and subsystem will be red. Any additional conduits attached to the existing conduit run must conform to this design guide section 6.3 Conduit, Cable Tray and Wire.
- 6.17.9** All new Fire Alarm systems will required an integrated Mass Notification System that will be a combined system integrated with the building fire alarm control panel to form one system that performs both functions as outlined in UFC 4-021-01 and NFPA 72.

## **6.18 Metering**

- 6.18.1** All Automatic Transfer Switches (ATS) require voltage and current metering on the load side of the switch and connectivity to the building control automation system (BCAS) to capture/share historical trend analysis.

## **7.0 Building Envelope/ Roofing Systems**

### **7.1 General Requirements**

- 7.1.1** The contractor shall protect the interior of facility from asphalt, 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.
- 7.1.2** Project 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. The submittal shall also contain a Letter of Acceptance from the manufacturer stating their product is acceptable for this applied system, design uplift calculations and other structural loads, 3<sup>rd</sup> party lab testing certificates for the system, copy of warranties, color charts, installation specifications, and certifications for kettle tenders, welders, and documentation of contractor's experience for product application.
- 7.1.3** 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.
- 7.1.4** Repair all components and associated defects in direct connection with areas to be repaired or replaced.

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- 7.1.5** Prior to beginning work activities, provide for the safety of all construction workers, building occupants and passersbys. Suitable protection and security must be provided during all phases of construction process, both during and after normal duty (business) periods.
- 7.1.6** Complete daily cleanup of site to include all construction debris.
- 7.1.7** 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.
- 7.1.8** The design engineer shall conduct a vapor drive analysis for all building envelope systems scheduled to be replaced or renovated.
- 7.1.9** 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.
- 7.1.10** Only new materials shall be installed and shall have matching lot/batch numbers.
- 7.1.11** 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).
- 7.1.12** 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.
- 7.1.13** No new products or systems shall be installed over decayed, rotten, unsound, corroded or wet building materials.
- 7.1.14** The Contractor Superintendent must acquire site data and maintain a typed daily log of the ambient conditions experienced at the jobsite. Readings shall be taken a minimum of three times during a normal construction day. If nighttime work takes place, additional readings shall be taken and recorded at the same frequency as daytime work. The daily log shall be considered a live project record and shall be accessible to AFMSA/SG8FE, USACE and Facility Management at all times.
- 7.1.15** 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.
- 7.1.16** All repairs/replacements of building envelope system shall match the surrounding structure and building envelope components from an aesthetics standpoint. Contractor shall make their best effort to blend the repair area's appearance to match surroundings.
- 7.1.17** Contractor shall make all repair/replacements as to maintain any in-place manufacturer's or contractor's warranties. In the event that the item removed leaves a penetration/hole in the exterior cladding and/or structure framing of the assembly, the Contractor shall properly reconstruct the assembly (both substrate and cladding) to match the surrounding construction and finish. Structural capacity, weather-tightness and aesthetics shall all be essential elements of the work. An engineer shall be utilized to design the structure for in-filled load-bearing systems on openings larger than 24" in any dimension.
- 7.1.18** Building system components and cladding shall be designed to withstand 1.25 times the wind forces as calculated using the current version of ASCE-7 at the time of award. All Medical Facilities shall be considered as a Category IV Facility for design purposes.
- 7.1.19** Do not use cleaning materials or processes which could change the character of the exposed finishes. If



unknown, always test the products in an inconspicuous location to determine results.

- 7.1.20** All cleaning practices and product used shall be in accordance with cleaning products manufacturer's printed instructions.
- 7.1.21** The contractor shall repair or replace all existing vapor air barriers when installing new or removing existing penetrations through building envelope components. Repairs shall match existing material and maintain in place warranties.
- 7.1.22** Depending on the wall construction and its ability to withstand such, use of a paint scraper, wire brush, sandpaper, power washer and eco-friendly cleaning chemicals are allowed to remove all surface contamination, such as oil, grease, loose paint, dirt, foreign matter, rust, mold, mildew, mortar and efflorescence.
- 7.1.23** A manufacturer's technical representative shall perform a minimum of two quality assurance inspections during the construction phase plus a final inspection. This requirement is for all major roof, exterior wall, air/moisture barrier, and waterproofing systems.
- 7.1.24** Drainage saddles and crickets shall have a minimum of a 3:1 length to width ratio for adequate slope in the valleys.
- 7.1.25** The use of rotary saws and abrasive wheels shall not be used to cut ferrous metal of any kind which will be exposed to the exterior. Only shear-type cutting tools are allowed.

## **7.2 Structural Decks**

- 7.2.0.1** All decks shall be inspected and repaired to accept the new roofing system. Repairs shall not affect the slope or drainage of the new system. Use 2% 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. Provide unit pricing (cost/sq) for any repairs after the 2% allowance.
- 7.2.0.2** Ensure 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.
- 7.2.0.3** 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.
- 7.2.0.4** 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. Plywood shall not be used to patch or cover holes in non-wood structural decks.

### **7.2.1 Concrete Decks**

- 7.2.1.1** 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.
- 7.2.1.2** 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.
- 7.2.1.3** 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.

## **7.2.2 Metal Decks**

- 7.2.2.1** 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.
- 7.2.2.2** Rust repair shall include wire brushing, sanding, scraping, 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.
- 7.2.2.3** 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.

## **7.2.3 Lightweight Concrete/Poured Gypsum Decks**

- 7.2.3.1** 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.
- 7.2.3.2** Lightweight concrete and Gypsum decks must be vented per roofing system manufacturer's specifications for a medical facility.

## **7.2.4 Wood Decks**

### **7.2.4.1 Plywood**

- 7.2.4.1.1** Plywood sheathing shall be CDX grade, minimum 4 ply, and not less than 15/32 inch (12 mm) thick.

### **7.2.4.2 Plank / Heavy Timber**

- 7.2.4.2.1** Wood boards shall be at least 1 inch (25 mm) nominal thickness and have a nominal width of 4 feet - 6 inches (1372 mm).
- 7.2.4.2.2** All boards shall have a bearing on rafters at each end and be securely attached.
- 7.2.4.2.3** Cover knotholes or cracks in excess of 1/4 inch (6 mm) with securely nailed flat sheet metal.

## **7.2.5 Cementitious Wood Fiber and Gypsum Plank**

- 7.2.5.1** Decks shall be protected from the weather during storage and application; any wet or deformed decking shall be removed and replaced.
- 7.2.5.2** Anchor all panels against uplift and lateral movement.
- 7.2.5.3** Install the deck flat at the proper slope/fall. Any deflection, irregularities, or otherwise damaged panels must be corrected or replaced.

## **7.3 Vapor Barrier**

- 7.3.1** 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 section general requirements.
- 7.3.2** Obtain vapor barrier components from a single manufacturer; a single-source manufacturer's warranty is

- 7.3.3** Provide products which comply with all state and local regulations controlling the use of volatile organic compounds (VOC's).

#### **7.4 Wood Nailers/Blocking**

- 7.4.1** 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.
- 7.4.2** Contractor shall utilize Borate treated wood for wood blocking and nailers that are encapsulated within the building envelope system (not exposed to the exterior).

#### **7.5 Roof Insulation & Cover Boards**

- 7.5.1** All insulations must be checked 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 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.
- 7.5.2** Uneven decks and obstructions must be removed and or repaired prior to installing base insulation.
- 7.5.3** For insulation system designs, ensure against fastening methods that will provide a thermal bridge through the roofing system.
- 7.5.4** Insure all subsequent layers are properly bonded before proceeding to the next layer.
- 7.5.5** 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, or foam adhesive, no pieces larger than 4' by 4' 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 nighttime dry-in and cut offs.
- 7.5.6** All insulation and cover boards shall fit tight to each other with no gaps over a 1/8 inch; larger gaps cannot be filled and must be cut out to accommodate the minimum insulation board size
- 7.5.7** Install crickets at all equipment, chimneys, penthouses and other roof top penetrations wider than 12 inches. Insure all crickets provide sufficient slope to maintain positive drainage.
- 7.5.8** Crickets are also required to provide sufficient slope to maintain positive drainage to internal drains and wall scuppers. Crickets shall be installed between wall and slope change interfaces or any other areas that may pond water.
- 7.5.9** All tapered insulation shall be installed to maintain a minimum of ¼ inch per foot slope. Provide an engineered or digitally designed layout for each roof area. Less than ¼ inch slope will need written approval from roofing manufacturer and AFMSA/SG8FE.
- 7.5.10** Roof insulation "R" values shall be a minimum of R-30. Any deviations from this requirement must be approved by AFMSA/SG8FE.
- 7.5.11** 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.
- 7.5.12** Only use cover boards specifically approved and tested in the roof system manufacturer's assembly.
- 7.5.13** At roof access areas such as roof hatches, fixed ladders and penthouse access doors, the landing area immediately adjacent to the access point shall incorporate a minimum area of 4' x 4' "fire rated" plywood cover board to provide additional rigidity in that area for pounding foot traffic and heavy tools and equipment.

Thickness of plywood shall match the roof system cover board.

## **7.6 Types of Insulation and Cover Board**

### **7.6.1 Polyisocyanurate**

**7.6.1.1** Rigid board with fiber reinforced facers on both sides, meeting or exceeding the requirements of ASTM C 1289

**7.6.1.2** Compressive Strength (Polyisocyanurate): Against UFC 2-5.2.3

**7.6.1.3** Polyisocyanurate insulation with a smoke index greater than 50 shall not be utilized in AFMS facilities.

### **7.6.2 EPS (Expanded Polystyrene)**

**7.6.2.1** Rigid, closed cell foam insulation meeting ASTM C 578.

**7.6.2.2** Density: 1.25 Lb. min

### **7.6.3 Extruded Polystyrene**

**7.6.3.1** Rigid, closed-cell recovery board meeting ASTM C 578

**7.6.3.2** Compressive Strength - 25 psi (1.75 kg/sq.cm.) minimum

### **7.6.4 Perlite**

**7.6.4.1** The use of perlite insulation within insulated assemblies is not permitted, with the exception of perlite cant strips.

### **7.6.5 High Density Wood Fiber Board**

**7.6.5.1** Wood Fiber: Cellulose fiber board meeting the requirements of ASTM C 208

**7.6.5.2** Compressive Strength: min 35 psi (241.5 kPa).

**7.6.5.3** Shall be coated and sealed on all six sides.

### **7.6.6 Gypsum-based Roof Cover Boards**

**7.6.6.1** Meeting mold-resistance standard ASTM D3273

**7.6.6.2** Class A fire rating in accordance with UL 790

**7.6.6.3** Prime as necessary according to manufacturer's requirements and testing assembly certs

## **7.7 Low-sloped Membrane Assemblies - General**

**7.7.1.1** 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

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

**7.7.1.3** Membrane sheets are to be installed wrinkle free and with no "eyebrows," "fish mouths," blisters, voids, or lifted edges at corners.

**7.7.1.4** Membrane flashing shall be terminated with a continuous termination bar separate from the sheet metal counter flashing, and the term bar shall be installed at the edge of the membrane at both the horizontal and vertical exposed edges.

**7.7.1.5** 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.

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

**7.7.1.7** 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.

**7.7.1.8** All booted pipe flashings shall incorporate stainless steel clamping rings and an umbrella rain collar counter flashing.

**7.7.1.9** Contractor shall verify with the Government that load certifications are available prior to submitting a proposal if the use of existing structural tie-off points / anchors are to be utilized during any phase of the work. If the tie-off points do not have a current load certification, the Contractor is responsible for certifying the load points prior to using them.

### **7.7.1 Modified Bitumen**

**7.7.1.1** All modified bitumen membrane roof systems should incorporate 2 layers of smooth surfaced membrane and a granular surfaced cap sheet for a 3-ply modified bitumen system.

**7.7.1.2** Cap sheets mid-ply, 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.

**7.7.1.3** Proper bitumen temperature (per written manufacturer's recommendations) shall be maintained to insure thorough, uniform and consistent lamination of all plies.

**7.7.1.4** Asphalt temperatures shall be monitored and recorded throughout the day and discussed with Superintendent and QA representative. Care shall be taken to watch all conditions that may require a change in EVT range.

**7.7.1.5** 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.

**7.7.1.6** 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).

**7.7.1.7** Install base sheets under all drip edges, gravel stops and flashings unless provided differently through manufacturer's written specifications.

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

**7.7.1.9** 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" may be used on slopes of higher pitch or incline with AMFSA/SG8FE approval.

**7.7.1.10** Penetration flashings shall be installed such that they are included within the manufacturer's roof system warranty.

### **7.7.2 Built Up Roof (BUR), with Gravel Surfacing**

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

**7.7.2.2** ~~Pea gravel shall be applied at a rate of 300 lbs. per 100 sq. ft. Deleted-~~

**7.7.2.3** Minimum gravel size shall be ½" round pea gravel. Chipped and sharp edged "fines" will not be acceptable. 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.

**7.7.2.4** 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.

**7.7.2.5** Install walk-pads prior to installing gravel. Insure they are installed above the gravel height.

### **7.7.3 Thermoplastic Membrane**

#### **7.7.3.1 PVC/Elvaloy Blends**

**7.7.3.1.1** Approved Membrane Attachment: Mechanically Attached or Fully Adhered.

**7.7.3.1.2** Membrane Thickness: 60 mil nominal.

**7.7.3.1.3** Seam Spicing: Hot-air weld.

**7.7.3.1.4** Overlay all splice intersections with T-Joint Covers.

#### **7.7.3.2 TPO Membrane**

**7.7.3.2.1** Approved Membrane Attachment: Mechanically Attached or Fully Adhered.

**7.7.3.2.2** Membrane Thickness: 72 mil nominal. Minimum.

**7.7.3.2.3** Seam Spicing. Hot-air weld.

**7.7.3.2.4** Overlay all splice intersections with T-Joint Covers.

### **7.7.4 Thermoset Membranes**

#### **7.7.4.1 EPDM**

**7.7.4.1.1** Approved Membrane Attachment: Fully adhered.

**7.7.4.1.2** Membrane Minimum Thickness: 90 mil.

**7.7.4.1.3** Tape splicing is the only acceptable splice method.

## **7.8 Steep Slope Roofing**

### **7.8.1 Metal Roofing**

**7.8.1.1** All metal panels and accessories to be installed in such a fashion that they are free from wrinkles, splits, buckles and oil canning. Where such conditions exist following installation, item(s) installed is considered to have failed, or damaged and must be replaced as required before acceptance (or as a warranty repair) if already accepted.

**7.8.1.2** 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 .64 cm in 12.2 m 1/4 inch in 40 feet.

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

**7.8.1.4** 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 the new material.

**7.8.1.5** Metal panels with scratches in excess of 24" in length and penetrate the protective coating shall be replaced.

**7.8.1.6** 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.

**7.8.1.7** Metal roof system shall incorporate a "hidden fastening system" with components that allow for expansion and contraction. The pinned location shall be identified on the as-built drawings. Pin location shall be at the ridge or eave, not in the field of the roof.

**7.8.1.8** Metal roofs shall not be designed or installed on slopes less than 3:12 without prior approval in advance of AFMSA/SG8FE.

**7.8.1.9** All metal roof systems installed over solid decking shall utilize a high-temperature, self-sealing fully adhered waterproofing underlayment.

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- 7.8.1.10** 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.
- 7.8.1.11** Manufactured steel panels shall not be less than 22 gauge, 16 inches wide with a 2 inch double lock seam. Manufacturer aluminum panels shall not be less than .032” thick.
- 7.8.1.12** Insure that all openings are of sufficient size to allow for movement around all pipes, fixtures and penetrations.
- 7.8.1.13** Maximum spacing of retrofit purlins, hat channels and supports for metal roofing shall be forty-eight (48) inches or less, regardless of type of metal being used (structural or architectural).
- 7.8.1.14** Whereas it is always preferable that the full panel be mechanically crimped, hand crimping will be allowed in order to complete the ends or otherwise inaccessible areas.
- 7.8.1.15** Snow retention systems must be of rail type. Minimum of two complete rails with a clamp installed at every seam.
- 7.8.1.16** All roof curbs over 12 inches in width shall have integral metal crickets and be mechanically seamed into the metal roof panel system in compliance NRCA detail STM-19 (2012) and be covered under the metal roof panel manufacturer’s warranty. The cricket will have a minimum slope of two times the slope of the roof system to insure proper drainage and be covered under the metal roof panel manufacturer’s warranty.

## **7.8.2 Shingle Roofing**

- 7.8.2.1** Must use self-adhering bituminous membrane that is capable of sealing around fasteners which penetrate the membrane self-sealing underlayment. Shall be dimensional architectural style shingles. No three tab shingles allowed
- 7.8.2.2** Fasteners: Standard round wire shingle type, zinc-coated steel; 12 gauge (2.657mm), ring shank, with heads 3/8 inch (9.5 mm) in diameter minimum.
- 7.8.2.3** All shingles shall have a minimum of six fasteners per shingle.
- 7.8.2.4** All fasteners shall be installed by hand with hammers, no pneumatic nail guns are allowed.

## **7.8.3 Tile Roofing**

- 7.8.3.1** ~~Two layers of underlayment are required to be installed under tile system.~~ All tile roof systems installed over solid decking shall utilize two layers of high-temperature, self-sealing fully adhered waterproofing underlayment over the entire roof deck.
- 7.8.3.2** Valleys and drip edges will require an additional layer of self-adhering underlayment installed.
- 7.8.3.3** Roofing tile materials and installation shall conform to the requirements of [ICBO Report No. 3523] – Clay Roofing Tiles.
- 7.8.3.4** Prefabricated Rake and Ridge tiles: Match tile profile and color.
- 7.8.3.5** Fasteners: Fasteners shall penetrate deck a minimum ¾ inch (19mm).
- 7.8.3.6** In high velocity wind zones or where design pressures exceed 40 psf, foam adhesive shall be used for attachment.

## **7.9 Elastomeric Coatings**

- 7.9.1** 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.
- 7.9.2** New coating shall be installed with a minimum of two coats, base coat and top coat or as recommended by manufacturer or whichever is more stringent. Base coat to be tinted different color from top coat to help insure

full coverage of top coat. Prime substrate as required by manufacture prior to installation.

- 7.9.3** Coating systems shall incorporate integrated reinforcement mesh at all flashings, penetrations and areas that experience expansion and contraction.
- 7.9.4** Designated walkways shall be a contrasting color to the field of the roof.
- 7.9.5** New coating shall at minimum have a reflective value of .81 and a solar index of 98. Reflective roof coatings shall be algae-resistant. At drain sump areas and any other roof area where water may collect and pond for 24 hours, a urethane or silicone coating shall be installed in lieu of water-based acrylic coating.

## **7.10 Sheet Metal Flashing and Trim**

- 7.10.1** Metal 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
- 7.10.2** Sheet metal flashing shall be installed over the waterproofing membrane at all roofs to wall intersections, at gutters, eaves, expansion joints and wherever there is a changed in roof slope or direction. The sheet metal shall be corrosion resistant with a minimum thickness of 22-gauge for galvanized painted steel, 24-gauge stainless steel, .050-aluminum or copper at 1 Lb. per square foot. Cleats shall be 18-gauge for steel, .063 for aluminum and 22-gauge for stainless steel, but no less than the thickness determined by design loads.
- 7.10.3** Counter flashings shall be fabricated and installed to extend a minimum of three (3) inches below the lowest fastener or top edge of base flashing material.
- 7.10.4** Flashing material must be either stainless steel, factory coil-coated steel or aluminum with Kynar 500 or Hylar 5000 finish. Contractor shall obtain an approval in writing from AFMSA/SG8FE for any other flashing materials.
- 7.10.5** Coping and metal roof edge flashing shall be installed with a concealed cleat.
- 7.10.6** Roof edge flashing, coping, gutters, etc., shall be comprised of lengths necessary to avoid widespread use of small pieces ("small" is defined as less than 48 inches in length).
- 7.10.7** Expansion joints in the roof system shall be metal and conform to NRCA and SMACNA standard details and guidelines.
- 7.10.8** 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, oil canning, and damage to the finish coating.

## **7.11 Drainage**

- 7.11.1** When recovering 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 rainfall rates and applicable plumbing codes.
- 7.11.2** Verify that quantity of overflow drain or scupper as well as their heights and size are adequate and meet appropriate building code, and are not functioning as a main drainage point.

## **7.12 Roof Drains**

- 7.12.1** Drains must remain functional throughout the construction process or provide alternative method of draining water in the event of rain.
- 7.12.2** 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.



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**7.12.3** Replace all broken drain bolts with a stainless steel bolt.

**7.12.4** 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.

### **7.13 Gutters and Downspouts**

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

**7.13.2** Downspouts shall be of square design unless prior approval received in writing from AFMSA. Downspouts shall be of open faced design in cold weather climates.

### **7.14 Scuppers**

**7.14.1** All collector heads shall have overflow capabilities.

### **7.15 Roof Accessories/Features**

**7.15.0.1** 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.

**7.15.0.2** 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.

**7.15.0.3** If roof vents, pipes and flashings are not replaced, they must be painted and resealed to appear and perform as a new and warranted product.

**7.15.0.4** 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.

**7.15.0.5** All roof mounted equipment devices (roof mounted HVAC units, pipes and pipe supports and other equipment) shall be designed, installed, and fastened securely to meet wind loading set forth by the most current ASCE-7 guidelines.

**7.15.0.6** New and existing roof hatches shall be primed and painted with two coats of rust inhibitive industrial enamel paint, painted to match exterior sheet metal.

#### **7.15.1 Skylights**

**7.15.1.1** Consult with AFMSA/SG8FE on skylight work specific to an existing facility.

#### **7.15.2 Lightning Protection**

**7.15.2.1** See Electrical Section 6.

#### **7.15.3 Walk-pads/Walkways**

**7.15.3.1** For all single-ply membrane systems, pre-manufactured walk-pads shall be used to establish protective walkways on the roof.

**7.15.3.2** Modified bitumen and Built-up roof systems require an additional layer of 36" membrane or other protective walking surface shall be installed for designated walkways across selected roof areas to connect roof hatch and ladder access locations to and around equipment. The walkways shall be a contrasting color to the field of the finished roof. Adhere walkway-pads to the membrane in accordance with the manufacturer's current application guidelines leaving space between pads for drainage.

#### **7.15.4 Fixed Access Ladders**

**7.15.4.1** Ladder will have landings installed at top in compliance with OSHA 1910.27.

**7.15.4.2** Ladders will have walk-through section at top with fixed handrails 42" above landing.

**7.15.4.3** Ladders runs exceeding 15' in height shall be of caged ladder construction.

**7.15.4.4** All fixed ladders with ground level access points shall contain components to limit unauthorized access.

**7.15.4.5** All roof access ladders shall have a minimum load rating of 300 lbs.

**7.15.4.6** Attachment points and underlying structure shall be evaluated by a structural engineer licensed in state or country for capability to meet load requirements.

#### **7.15.6 Solar Panels**

**7.15.6.1** Solar panels shall not be installed or reinstalled on roof systems without written endorsement from AFMSA/SG8FE.

### **7.16 Exterior Wall Systems and Components**

**7.16.0.1** A structural engineer shall verify that the existing structure will be adequate to support the loading and accept the new blast loads imposed upon it with the installation of new or the replacement of existing building components. All wall substrates shall be inspected and repaired to accept the new waterproofing and cladding system.

#### **7.16.1 Structural Framing and Sheathing**

**7.16.1.1** The structural framing components of new exterior walls shall be 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. No wood framing is allowed.

**7.16.1.2** Exterior wall sheathing shall be either fiberglass faced gypsum sheathing or APA rated plywood but shall depend on the established fire rating of the wall. No Oriented Strand Board (OSB) sheathing is allowed.

#### **7.16.2 Wall Insulation**

**7.16.2.1** New exterior wall assemblies around conditioned interior spaces shall be insulated to achieve a minimum R-19 thermal resistance value unless greater values are required by project.

#### **7.16.3 Through-wall Flashing**

**7.16.3.1** Clean surface of substrate from projections, which might puncture membrane flashing material.

**7.16.3.2** Lap membrane flashing a minimum of 6 inches at end laps (150mm).

**7.16.3.3** Leave membrane flashing projecting from face of wall approximately 1 inch (25mm). Flashing shall be

cut back to the face of the wall after inspection.

- 7.16.3.4** Aluminum flashings shall not be used as an in-wall embedded flashing in masonry/concrete walls except as approved by AFMSA/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.

#### **7.16.4 Masonry Walls**

- 7.16.4.1** Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.
- 7.16.4.2** Lay masonry with fully buttered (mortar) head and bed joints.
- 7.16.4.3** Provide weep holes in head joints of the first brick course immediately above the through-wall flashing by placing weeps no more than 24 inches (610 mm) on center horizontally.
- 7.16.4.4** Where fresh mortar joins partially set mortar, remove loose masonry and mortar, and lightly wet exposed surface of set masonry.
- 7.16.4.5** When adjustment is necessary to be made after mortar begins to harden, remove hardened mortar and replace with fresh mortar.
- 7.16.4.6** Joint Profile: Tool mortar joints to a concave appearance. Unless otherwise specified in the PWS or Base Architectural Design Guide.
- 7.16.4.7** Tool exposed joints when "thumb-print" hard.
- 7.16.4.8** Keep the drainage cavity free from mortar. Install mortar netting at the through-wall flashing to prevent the blockage of drainage within the wall cavity.
- 7.16.4.9** Flush cut all joints that are not tooled.
- 7.16.4.10 Mortar**
- 7.16.4.10.1** Masonry Cement: Complying with ASTM C91: Type S.
- 7.16.4.10.2** Portland Cement: Complying with ASTM C150: Type I.
- 7.16.4.10.3** Mortar Aggregate: Complying with ASTM C144, standard masonry type. For joints narrower than ¼ inch (6mm), use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent with the No. 16 sieve.
- 7.16.4.10.4** Do not use anti-freeze compounds to lower freezing point of mortar.
- 7.16.4.10.5** Mix mortar ingredients in accordance with ASTM C270. Mix only in quantities needed for immediate use.
- 7.16.4.11** Existing weep holes shall be cleaned out and made functional during all exterior wall restoration/renovation projects.
- 7.16.4.12** When re-pointing, rake mortar joints to a depth of not less than ½ inch (12mm). Fill solidly with pointing mortar in ¼ inch layers. Tool joints.
- 7.16.4.13** When tuck pointing joints, cut out all defective mortar joints and holes in masonry and repoint with new mortar. Remove excess mortar smears as work progresses.
- 7.16.4.14 Water-repellant Coatings**
- 7.16.4.14.1** The applicator shall be approved by the manufacturer to install the product.
- 7.16.4.14.2** Do not install new products over decayed, rotten, unsound, degraded, damaged or wet building materials.
- 7.16.4.14.3** Existing substrates shall be pre-tested with RILEM tube to determine the current absorption

rates in random areas, in which minimum application rates will be established for the project. A minimum of three (3) tests or one (1) per 1000 sf of surface type, whichever is greater. Post-testing at the same frequency is also required to assure proper coverage.

### **7.16.5 Stucco**

- 7.16.5.1** Three-coat stucco systems shall be used over sheathed construction, masonry and concrete substrates: (1) scratch coat, (2) brown coat, (3) finish coat.
- 7.16.5.2** Self-furring metal lath shall be used for the attachment of the base coat to the moisture barrier and substrate.
- 7.16.5.3** Plastic or non-corrosive metal trim and accessories shall be incorporated into the system, as acceptable to the manufacturer.
- 7.16.5.4** The total thickness of the base coat (scratch and brown) shall be  $\frac{3}{4}$  inch to  $\frac{7}{8}$  inch thick. The base coat mix shall contain  $\frac{1}{2}$  inch long, alkali resistant fibers to improve cohesiveness and provide crack and impact-resistant qualities to the system.
- 7.16.5.5** 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.
- 7.16.5.6** Allow entire base coat to cure for a minimum of seven (7) days prior to starting finish coat application.
- 7.16.5.7** Tolerances for levelness of the stucco plaster shall be  $\frac{1}{4}$  inch in 10 feet for flat surfaces.
- 7.16.5.8** The finish coat shall be  $\frac{1}{8}$  inch thick and applied to a moist base coat. Textured and colored finishes shall be as selected by the Government.

### **7.16.6 EIFS**

- 7.16.6.1** All new or replacement EIFS designs shall incorporate water managing and drainage capabilities within the system.
- 7.16.6.2** Exterior gypsum sheathing boards shall be used as the substrate 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  $\frac{1}{2}$  inch. Use fire-rated material when applicable. Sheathing shall be installed with stainless steel screws. Stagger board joints; fit ends and edges tightly together.
- 7.16.6.3** 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.
- 7.16.6.4** A high-impact resistant, drainable system is required for all EIFS systems.
- 7.16.6.5** Insulation used in the EIFS system shall have a minimum thickness of 1" for buffering differential movement between the substrate and the EIFS lamina (surface). Total insulation thickness shall be determined by the desired R-value for the exterior wall assembly on a per project basis.
- 7.16.6.6** Plastic or non-corrosive metal trim and accessories shall be incorporated into the system, as acceptable to the manufacturer.
- 7.16.6.7** The finish coat shall not be applied until the base coat has cured for 24 hours or per manufacturer's requirements, whichever is longer. 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.

### **7.16.7 Metal Wall Panels**

- 7.16.7.1** All metal panels and accessories to be installed in such a fashion that they are free from wrinkles, splits, buckles and oil canning. Where such conditions exist following installation, item(s) installed is considered to have failed or damaged and must be replaced as required before acceptance (or as a warranty repair) if already accepted.
- 7.16.7.2** 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. Immediately repair all scratches and cut edges in metal panel. Prolonged rusting on panels will warrant the need to replace the affected panel.
- 7.16.7.3** 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 the new material.
- 7.16.7.4** Metal panels with scratches in excess of 24" in length and penetrate the protective coating shall be replaced.
- 7.16.7.5** 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.
- 7.16.7.6** Design and install metal wall panels to approved industry standards which eliminate or reduce the opportunity for "oil canning" and/or damages due to thermal stress. Ensure that all openings are of sufficient size to allow for movement around all pipes, fixtures and fenestrations.

### **7.16.8 Glass Curtain Walls and Storefronts**

- 7.16.8.1** Design consultant with expertise in custom curtain wall systems should be hired for projects that incorporate these systems.
- 7.16.8.2** Special consideration shall be given to design and the specifications to achieve, at minimum: (a) Durability; (b) Moisture Protection and condensation; (c) Thermal Performance; (d) Acoustics .

### **7.17 Joints Sealants**

- 7.17.1** 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. Prime substrate when necessary.
- 7.17.2** A minimum of three (3) adhesion tests or one (1) per 150 lf of joint for each surface type shall be performed, whichever is greater. Tests shall be performed per ASTM C1521.
- 7.17.3** Avoid air entrapment in sealants by using proven industry standards of application.
- 7.17.4** Joint size shall allow maximum expansion and contraction. Proper joint design of: 2:1 width to depth ratio.
- 7.17.5** Install backing system to properly control depth of sealants and prevent three sided adhesion. Use only manufacturer approved backing materials. Ensure proper joint shape and design. Secondary backer system shall be used on all deep joints or problematic joints with proper depth.
- 7.17.6** For joints larger than 1" in width, gun-grade sealant is not permitted. Designs shall incorporate pre-molded materials.
- 7.17.7** The use of in-organic silicone sealant material is required for all exterior building joints and wet-glazing unless a necessary design issue requires the use of polyurethane or other material.
- 7.17.8** All items within this section shall be applicable to sealant joints around wall fenestrations.

## 7.18 Fenestrations

### 7.18.1 General

- 7.18.1.1 All exterior wall fenestrations shall be compliant with ATFP UFC 4.010.01 protocols (see General Exterior Wall comments).
- 7.18.1.2 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.

### 7.18.2 Windows

- 7.18.2.1 All new window and glazing shall meet AT/FP standard and below is the minimum glazing performance requirement:
  - 7.18.2.1.1 The double-pane laminated glass
  - 7.18.2.1.2 SHGC = min. 0.27
  - 7.18.2.1.3 U = min. 0.35
  - 7.18.2.1.4 Low e-coating on number 2 surface in the glass pane. Low e-coating shall be exposed to the air space between glazings.
- 7.18.2.2 Independent stainless steel window sill pans shall be incorporated into all window installation projects. The sill pan profile shall incorporate fully welded end-dam and rear flange joints. Flange height shall be determined by the window size and capacity design, but no less than 1". Sill pans shall be flashed into the exterior water-resistant barrier at the jambs and sill.

### 7.18.3 Doors

- 7.18.3.1 *For future use*

### 7.18.4 Louvers /Vents

- 7.18.4.1 All new louvers and vents that are installed on the exterior shall have bird/insect screens installed on the interior side of the openings.

## 7.19 Warranties

- 7.19.1 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. Protective roof coatings shall carry a manufacturer's ten year material warranty. No proration (NDL) warranties permitted. All manufacturer warranties shall cover material and labor defects regardless if such defect has or has not caused a leak.
- 7.19.2 The installing roofing contractor shall warranty the roof application for a period of five (5) years to be leak free. This coverage shall include both leaks and defects. Air blisters 1 sq. ft. or larger will be considered a defect in the attachment of the membrane, and shall be repaired regardless of size. If the number of blisters exceeds 5 in a 100 continuous sq. ft. area, all blister defects shall be investigated and repaired.
- 7.19.3 All building envelope systems must be inspected by a manufacturer's technical representative (MTR) and the designer of record (DOR) to certify that the new system is installed per the manufacturer's recommendations and that it is adherence with the new the system design. The MTR shall certify that the system was installed pursuant the manufacturer's design requirements and approved installation practices, and that the system is warrantable.
- 7.19.4 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.

- 7.19.5 No disclaimer for ponding water is acceptable. All systems must be designed for positive drainage.
- 7.19.6 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.

## 7.20 Building Envelope Commissioning

- 7.20.1 Ensure that the MDG Facility Manager and maintenance provider have been fully trained in maintenance care and maintenance procedures. Provide inspection frequencies to the DMLSS Clerk for input into the DMLSS maintenance program.
- 7.20.2 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.
- 7.20.3 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.
- 7.20.4 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

- 8.0.1 **Metering** – All metering devices capable of storing and/or sharing data will be connected to the building controller automation system (BCAS).
- 8.0.2 **Removal of Abandoned Infrastructure (Mechanical, Electrical and Structural)** – The AFMS desires to leverage any opportunity to clean it's 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.
- 8.0.3 **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.
- 8.0.4 **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

**8.0.5 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 an approved professional appearing manner. Similarly, all ferrous metal piping that is no longer required as a result of work performed shall be 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.

**8.0.6 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.

**8.0.7 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. If time restraints do not allow removal and installation of a new housekeeping pad, old pads can be extended but shall be at least 2 times large than the height of the existing pad and must be epoxy dialed in. Once housekeeping pad is cure, must epoxy coat the entire housekeeping pad. New housekeeping pads shall be 3 1/2 inches high as a minimum concrete housekeeping pads and equipment bases for the following: outdoor equipment on grade, indoor floor mounted equipment in mechanical rooms and penthouse equipment rooms. Housekeeping pads shall extend a minimum 6 inches beyond the equipment or supported member in all directions. Provide pads with one-inch chamfer on all exposed edges, placed and finished smooth and level to ensure proper and continuous support for the bearing surfaces of equipment. If a piece of equipment must be replaced during a period of time from shutdown to start up that is less than 80 hours or three working days, that the contractor may utilize steel equipment supports rather than installing a new concrete equipment pad. The steel support structure must be constructed of steel that is welded together, must be cleaned and primed with a rust inhibitor spray, and must include continuous equipment support along the entire length of the equipment as well as along the entire width of the unit at every section or module as well as at the manufacturer's recommended support points. The steel members shall be I beam or similar material. The total height of an existing housekeeping pad with steel supports for air handling equipment shall be sufficient to provide required condensate trap depth. (Covered by UFC/AFI)

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

**8.1.1 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.

**8.1.2 Corrosion Control of Exterior Exposed Heat Transfer Coils** (Air cooled chillers and roof-top unit condensers,



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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.

- 8.1.3** 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

- 8.2.1 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.
- 8.2.2 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.
- 8.2.3 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.
- 8.2.4 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.)
- 8.2.5 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. Contractor must provide O&M manuals, documented training and product specific

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information to the DMLSS Clerk for upload into DMLSS to allow the maintenance provider to begin preventive maintenance at time of beneficial use. 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.

**8.2.6 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)** Contractors shall protect indoor air, absorbent materials, and mechanical systems from contamination in accordance with ASHRAE-62.1-2016 and local medical group infection control operating instructions.

## 10.0 Drawings and Project Documentation

**10.1 For the purpose of this document “Drawings” are defined as diagrams, schematics, one-lines, and other graphic presentations used to provide additional details of a project.**

**10.2 Standard Naming Convention: All drawing file names shall conform to the following convention:**

**10.2.1** A-93-TRAV-01776-FP-F1-A2.13.dwg\*

10.2.1.1 - A is discipline designator

10.2.1.2 - 93 is the modification year

10.2.1.3 - TRAV is the installation name - denotes Travis AFB

10.2.1.4 - Use the first four letters of the base name

10.2.1.5 - 01776 is the building number

10.2.1.6 - FP is the model type - FP denotes floorplan

10.2.1.7 - F1 is the floor level – or designator for Mezzanine, Penthouse, Basement or Pad

10.2.1.8 - Sheet number

\*See [attachment 6 AFMSA/SG8F Drawing File Name Convention Guide](#)

**10.3 The contractor shall provide completed project modifiable DWGs (designer As Builts) and Signed PDF with Designer of Record (DOR) seal for each discipline.**

**10.3.1** Along with the deliverable .dwgs and BIM Models, the contractor shall include all Xref, TIFF, JPEG, and pdf files associated with the drawings.

**10.3.2** The contractor shall provide a drawing index of the deliverable drawings, i.e., a line item list.

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- 10.3.3** The contractor will use if available the Engineering Project DWG provided by the government to establish a new baseline DWG to reflect updates as a result of project completion.
- 10.3.4** On the base line DWG, the contractor shall HIGHLIGHT areas modified with what, who, and when e.g. using a bubble blowup/callout.
- 10.3.5** Where there are BIM Model deliverables and additional BIM requirement information, designers and contractors of all AFMS projects shall comply with the most current version of the USACE policy on BIM, Advanced Modeling Requirements for USACE projects.
- 10.3.6** In the case the contractor does not deliver complete BIM model, the contractor shall extract, convert and rename all BIM/Revit drawing files into AutoCad .dwg format using the standard naming convention.

**10.4 The contractor 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.

**10.5 The contractor must provide complete updated fire damper and smoke damper schedules.**

**10.6 The contractor shall prepare 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 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. The contractor shall provide the completed DD 1354 to the contracting agent e.g. the Corps of Engineers and AFMSA/SG8F engineering project manager an example of a completed 1354 is provided as an [Attachment 5](#).

**10.7 The Prime/General Contractor is responsible for keeping track of all RPIE items removed, replaced or installed new on Infrastructure Repair Projects.** The RPIE items removed and/or replaced will be documented on a DD Form 1354.

**10.7.1 Prior to removal of RPIE:**

**10.7.1.1** The contractor shall obtain from the Government a Defense Medical Logistics Standard Support (DMLSS) RPIE report to determine equipment on record being removed or replaced

**10.7.1.2** The contractor shall document the RPIE ID of the equipment being removed or replaced found on the DMLSS RPIE report

**10.7.2 Installation of RPIE**

**10.7.2.1 The contractor shall provide a list to the Government of all RPIE being installed to include the following data elements:**

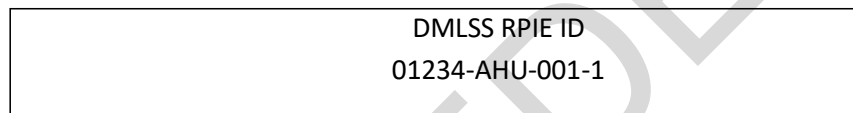
1. Manufacturer
2. Model Number
3. Serial Number
4. Capacity
5. Specifications
6. Date of installation
7. Room number
8. Rooms supported

**10.7.2.2** The contractor shall obtain from the Government the RPIE ID and place a label on all newly install RPIE

**10.7.2.3** All equipment shall be labeled with a self-adhesive, white label and black font. All labels shall reflect

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the Index number as facility number, nomenclature acronym, unique item identifier, and location identifier (i.e., floor number, room number or zone). For small items **such as fire** alarm system (pull stations, heat detectors, etc.), exit lights, emergency lights, etc., ½” tape should be used and shall include a QR Code containing the RPIE ID, Manufacturer, Model and Serial numbers. For everything else, 1” tape should be used and include a QR Code containing RPIE ID, Manufacturer, Model and Serial number, Capacity, and Specifications. The Contractor shall not use a company name or logo on the labels. Labels shall be placed in a neat and uniform manner across RPIE Systems i.e. left corner outside fire cabinet for fire extinguishers. All labels shall be placed directly on the equipment; exception shall be approved by AFMSA/SG8F and the FM. Equipment located above the ceiling grid, a label shall be placed on the equipment and on the ceiling grid directly below the equipment. The contractor shall remove all previous versions of DMLSS labels identifying the RPIE item. All labels shall match the format provided in example 1.1.



**Example 1.1**

**10.7.3 BIM** - Where there are BIM Model deliverables and additional BIM requirement information, refer to the USACE Engineering and Construction Bulletin (ECB) 2016-03 Advanced Modeling Requirements for USACE projects. This ECB is applicable for AFMS projects.

**10.8 The following are the pertinent blocks of the DD Form 1354 that need particular attention. Refer to [Attachment 5](#) for clarification.**

**10.8.1** Corp of Engineers Address

**10.8.2** Date prepared

**10.8.3** Project #

**10.8.4** for multiple items leave this section blank

**10.8.5** Civil Engineering Address if known

**10.8.6** Installation Name

**10.8.7** AFMSA contract #

**10.8.8** Date Item was placed in service (for multiple items, date system was placed in service)

**10.8.9** Number of the item(s)

**10.8.10** Facility #

**10.8.11** Identify the part, include part 3 if available

**10.8.12** P=permanent , S=semi-permanent, T= temporary

**10.8.13** Unit of measure

**10.8.14** Quantity

**10.9 The contractor shall provide bi-weekly Risk Reports for Infrastructure Repair Projects with the following information**

**10.9.1** Name of Contractor

**10.9.2** Installation

- 10.9.3** Task Order #
- 10.9.4** RFP #
- 10.9.5** Project Title
- 10.9.6** Project Description
- 10.9.7** Status Milestone
- 10.9.8** Estimated Completion date
- 10.9.9** Green, Yellow, Red indicator
- 10.9.10** General Concerns
- 10.9.11** Items removed

## **11.1 Miscellaneous**

### **11.2 Project Execution & Avoidance of Disruption to Mission during Construction**

**11.2.1** 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).

### **11.3 Avoidance of Adverse Mission Impact.**

**11.3.1** 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.

**11.3.2 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.

**11.3.3 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.

**11.3.4 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

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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.

SUPERSEDED

## ATTACHMENTS

[Attachment 1](#) – Return Air HVAC Ducts

[Attachment 2](#) – Emergency HVAC shutdown

[Attachment 3](#) – Roof Insulation Zone Chart

[Attachment 4](#) - SG8F Drawing File Name Convention

[Attachment 5](#) – Sample DD Form 1354

[Attachment 6](#) - SG8F Drawing File Name Convention Guide

SUPERSEDED

## Attachment 1 –Return Air HVAC Ducts



**DEPARTMENT OF THE AIR FORCE**  
**AIR FORCE MEDICAL SUPPORT AGENCY (AFMSA)**  
**BROOKS CITY-BASE TEXAS 78235-5121**

1 June, 2010

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

- 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.
- 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.
- 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.
- 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.
- Referenced Publication(s):** Unified Facilities Criteria (UFC) 4-510-01 Design: Medical Military Facilities
- 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](mailto:david.christiansen@us.af.mil)



REX A. LANGSTON, Colonel, USAF, MSC  
Chief, Health Facilities Division  
Office of the Surgeon General

## Attachment 2 –Emergency HVAC shutdown



**DEPARTMENT OF THE AIR FORCE**  
HEADQUARTERS AIR FORCE MEDICAL SUPPORT AGENCY  
LACKLAND AFB, TEXAS 78226-1885

1 June 2011

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/possibly 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.

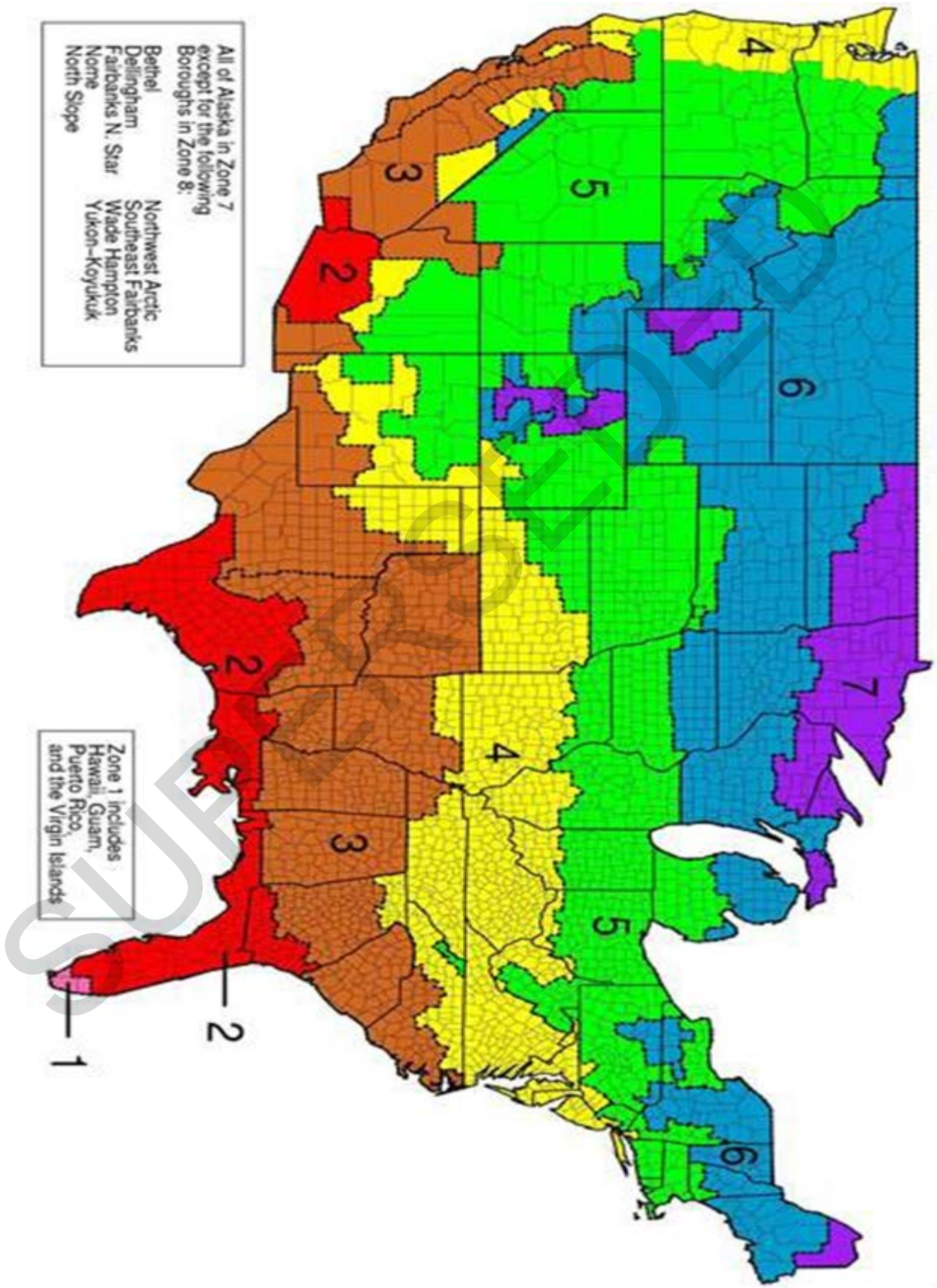
**9. Office of Primary Responsibility (OPR):** The office of primary responsibility for this ETL is AFMSA/SG8F. Please forward inquiries, questions or requests to:

DAVID G. CHRISTIANSEN, GS-13  
Chief, Facilities Operations & Engineering Branch  
Health Facilities Division  
Air Force Medical Support Agency (AFMSA)  
601 Davy Crockett, Bldg 1534  
San Antonio TX, 78226  
DSN: 945-1027 Commercial (210) 925-1027  
E-mail: [david.christiansen@us.af.mil](mailto:david.christiansen@us.af.mil)

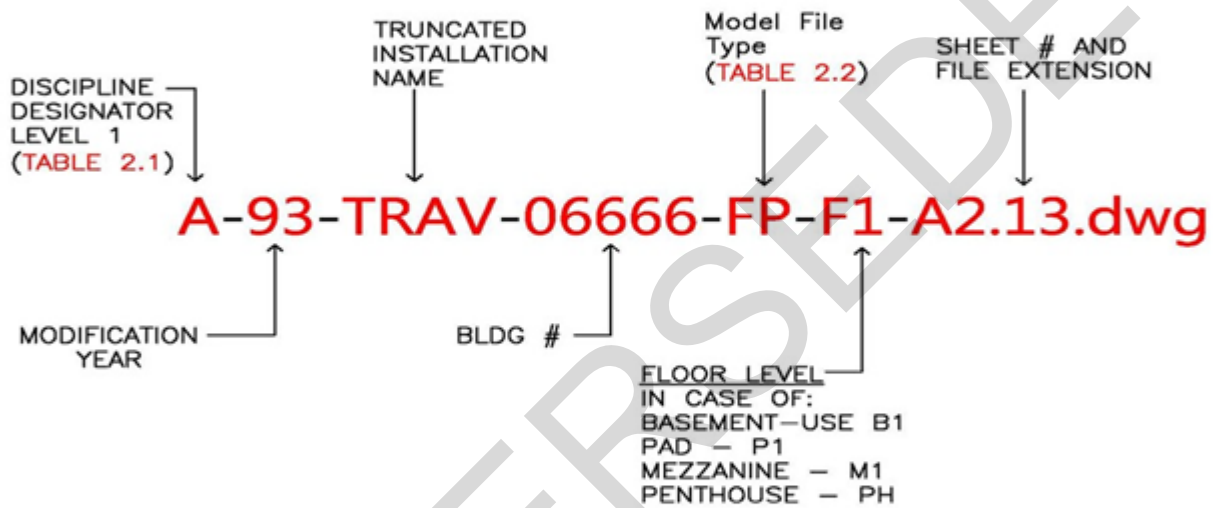


REX A. LANGSTON, Colonel, USAF, MSC  
Chief, Health Facilities Division  
Office of the Surgeon General

### Attachment 3 - Roof Insulation Zone Chart



**Attachment 4 – SG8F Drawing File Name**



Attachment 5 – Sample DD Form 1354

**TRANSFER AND ACCEPTANCE OF DOD REAL PROPERTY**

Form Approved  
OAE No. 0704-0189

PAGE **01** OF **01** PAGES

The above reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Information Management Division, 1215 Jefferson Davis Highway, Washington, DC 20304-1155 (2024-0189). Responses should be written that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

**PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE ABOVE ORGANIZATION.**

**1. FROM (Organization Name)**  
Corp of Engineers address

**2. DATE PREPARED**  
(YYYYMMDD)  
20121111

**3. PROJECT/DJR NUMBER**  
0012456789

**4. SERIAL NUMBER**  
W91275-11-00000

**5. TO (Organization - Installation Code and Name)**  
Civil Engineering Address

**6. RP/UD/ST/NAME/ INST/OCE/INS/TNAME**  
Installation Name

**7. CONTRACT NUMBER(S)**  
W91275-11-00000

**7E. PLACED-IN-SERVICE DATE**  
(YYYYMMDD)  
20121012

**8. TRANSACTION DETAILS**

**A. METHOD (X of all that apply)**

ACQUISITION BY CONSTRUCTION

TRANSFER BETWEEN SERVICES

CAPITAL IMPROVEMENT

INVENTORY ADJUSTMENT

**B. WHEN/EVENT (X of one)**

TOTAL ASSET PLACED-IN-SERVICE

PARTIAL ASSET PLACED-IN-SERVICE

**9. TYPE (X ONE)**

DISALT  FINAL  INTERIM

8. ITEM NO.	10A. FACILITY NO.	10B. RP/UD CODE	11. CATEGORY CODE	12. CATCODE DESCRIPTION	13. TYPE CODE	AREA		OTHER		18. COST	19. FUND SOURCE	20. FUND ORIG	21. INTER-EST CODE	22. ITEM REMARKS
						14. PRIMARY UM	16. PRIMARY UM QUANTITY	15. SECONDARY UM	17. SECONDARY UM QUANTITY					
1	194	N/A	N/A	Part #/ Model # 1234	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	ADD
2	194	N/A	N/A	Description of part	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	DEL-- 00194-AA-001-1
3	194	N/A	N/A	Description of part	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	DEL-- 00194-AA-002-1
4	194	N/A	N/A	MODEL # 1235	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	ADD
5	194	N/A	N/A	MODEL # 2345	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	DEL-- 00194-AA-003-1
6	194	N/A	N/A	PART # / MNO # 12345	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	ADD
7	194	N/A	N/A	Description of part	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	ADD
8	194	N/A	N/A	Description of part	P	N/A	N/A	EA	1.00	N/A	N/A	N/A	N/A	ADD

**23. STATEMENT OF COMPLETION.** The facilities listed hereon are in accordance with major drawings and specifications and change orders approved by the authorized representative of the using agency except for the deficiencies listed on the reverse side.

**A. TRANSFERRED BY (Typed Name and Signature)**  
Corps Representative Name (or Blank)

**B. DATE SIGNED**  
(YYYYMMDD)

**24. ACCEPTED BY (Typed Name and Signature)**  
Civil Engineering Name and Signature (or Blank)

**A. TITLE (Typed Name)**  
(Blank)

**B. DATE SIGNED**  
(YYYYMMDD)

**25. PROPERTY VOUCHER NUMBER**

DD FORM 1354, SEP 2009 PREVIOUS EDITION IS OBSOLETE

Air Force Medical Support Agency

**Attachment 6 – SG8F Drawing File Name Convention Guide**

MODEL FILE TYPES

**TABLE 2.2 - Model File Types**

Discipline	Code	Definition
Plumbing	PL	Plumbing Plan
	3D	Isometric/3D
	DG	Diagram
	DT	Detail Plan
	EL	Elevation
	EP	Enlarged Plan
	LG	Legend
	PP	Piping Plan
	SH	Schedule
	XD	Existing/Demolition Plan
	SY	Symbols & Abbreviation
	DR	Drainage System Plan
	MG	Medical Gas Plan
	Mechanical	3D
DG		Diagram
DT		Detail Plan
EL		Elevation
EP		Enlarged Plan
HP		HVAC Plan
AH		Air Handling Plan
HT		HTCW/Utilities Plan
LG		Legend & Symbols
ME		Mechanical Equipment Plan
MH		Mechanical HVAC
QP		Equipment Plan
SC		Section
SH		Schedule
MP		Mechanical Floorplan
VP		Ventilation Plan
SP		Specification Plan
HP		Heating Plan
RP		Roof Plan
PP		Piping Plan
XD		Existing/Demolition Plan
AD		Air Ductwork Plan

SUPERSEDED



Quality Design & Construction Standards for AFMS Infrastructure Systems

**TABLE 2.2 - Model File Types**

Discipline	Code	Definition
Civil	WM	Water Main Plan
	IP	Irrigation Plan
	XD	Existing/Demolition Plan
	AF	Airfield Plan
	BR	Beach Renourishment Plan
	DT	Detail Plan
	EL	Elevation
	ER	Eco-Restoration Plan
	FC	Flood Control Plan
	GP	Grading Plan
	IP	Installation Plan/Base Map
	JP	Joint Layout Plan
	KP	Staking Plan
	GN	General Notes
	SW	Sidewalk Layout Plan
	LG	Legend/General Notes
	NG	Navigation/Dredging Plan
	PL	Project Location Plan
	PR	Profile Plan
	SC	Section View
	SH	Schedule
	SP	Site Plan
	TS	Transportation Site Plan
	UP	Utilities Plan
	WD	Water Distribution Plan
	LO	Point Loads
	XD	Existing/Demolition Plan
	Structural	3D
BP		Bridge Plan
CP		Column Plan
CW		Misc. Small Civil Works Structures
DT		Detail
EL		Elevation Plan
EP		Enlarged Plan
GP		General Plan
NT		General Notes
LP		Load Plan
FP		Foundation Plan
RP	Roofing Plan	

**TABLE 2.1 - DISCIPLINE DESIGNATOR**

Architectural	A
Geotechnical	B
Civil	C
Process	D
Electrical	E
Fire Protection	F
General	G
Hazardous Materials	H
Interiors	I
Landscape	L
Mechanical	M
Operations	O
Plumbing	P
Equipment	Q
Resource	R
Structural	S
Telecommunications	R
Unknown	U
Survey/Mapping	V
Distributed Energy	W
Other Disciplines	X
Life Safety	Y
Contractor/Shop Drawing	Z

TABLE 2.2 - Model File Types		
Discipline	Code	Definition
Structural	FC	Flood Control Structures
	FP	Framing Plan
	LD	Locks & Dams Plan
	LG	Legend
	NP	Foundation Plan
	SC	Section
	SH	Schedule
	XD	Existing/Demolition Plan
Architectural	LS	Life Safety Plan
	SN	Signage Plan
	SP	Signal Plan
	CN	Connector Plan
	FU	Furniture Plan
	3D	Isometric/3D
	AC	Area Calculations/Occupancy Plan
	CP	Reflected Ceiling Plan
	DT	Detail
	EL	Elevation
	EP	Enlarged Plan
	FP	Floor Plan
	LG	Legend, Notes and Symbols
	QP	Equipment Plan
	RP	Roof Plan
	SC	Section
	MD	Modular Furniture Floor Plan
	SH	Schedule
	CD	Construction Dimension Plan
	XD	Existing/Demolition/New Work Plan
Fire Protection	HR	Hose Rack Plan
	DG	Diagram
	DT	Detail Plan
	FA	Fire Alarm/Detection Plan
	FP	Fire Suppression Plan
	LG	Legend and Notes
	SA	Safety Plan
	ST	Site Plan
	SP	Stand Pipe Plan
	CL	Connecting Link
	MN	Mass Notification/Fire Alarm Plan
	SL	SLC Device Location Plan
	CP	Control Plan
	SV	Section View
	DL	Device Layout Plan
	FS	Fire Sprinkler Plan
	C0	Co2 Systems Plan
	LP	Life Safety Plan
	SH	Schedule
	XD	Existing/Demolition Plan

TABLE 2.2 - Model File Types			
Discipline	Code	Definition	
Electrical	SB	Switch Board Plan	
	AP	Auxiliary Power Plan	
	CP	Exterior Communication Systems Plan	
	DG	Systems Diagram	
	DT	Detail Plan	
	EU	Electrical Utilities Plan	
	GP	Grounding System Plan	
	LG	Legend/General Notes	
	LP	Lighting/Control Plan	
	PP	Power & Signal Plan	
	PS	Panel Schedule	
	SH	Schedule	
	SS	Special Systems Plan	
	XD	Existing/Demolition Plan	
	SP	Signal Plan	
	PD	Power Distribution Plan	
	DD	Distribution Detail	
	EP	Electrical Plan	
	RD	Riser Detail	
	SL	Systems Layout	
	EL	Elevation	
	SY	Enlarged Plan	
	FE	Floor Plan	
	EN	Legend, Notes and Symbols	
	SV	Equipment Plan	
	RB	Roof Plan	
	ES	Electrical Site Plan	
	General	SP	Site Plan
		LP	Landscape Plan
		LD	Landscape Detail Plan
		ZP	Zoning Plan
		NO	General Notes & Project Description
IS		Index Sheet	
TB		Title Block	
EX		Fire and Exiting Plan	
CS		Cover Sheet	
HR		Handrail Plan	
Life Safety	AC	Access Control	
	CC	CCTV Device Plan	
	LG	Legends & General Notes	
	LS	Life Safety Plan	
	SE	Smoke Exhaust Plan	
	FZ	Fire Zone Plan	
	NC	Nurses Call Details & Symbols	
	SD	Nurses Call System Diagram	
	FP	Floor Plan	
	DT	Detail Plan	
MG	Medical Gas Plan		
PA	PA Device Plan		