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

Revision 6.2    1 Mar 2015

Engineering Branch. For questions regarding authority or content, please contact AFMSA/SGS8F, Mr. Christiansen, at DSN 945-1027 or Commercial (210) 925-1027.
## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Chapter / Section Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td>Purpose and Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Section 2</td>
<td>Mechanical Infrastructure Systems</td>
<td>4</td>
</tr>
<tr>
<td>Section 3</td>
<td>Testing and Balancing of HVAC Air &amp; Hydronic Systems</td>
<td>14</td>
</tr>
<tr>
<td>Section 4</td>
<td>Functional Performance Testing of HVAC Systems</td>
<td>15</td>
</tr>
<tr>
<td>Section 5</td>
<td>Plumbing Systems</td>
<td>17</td>
</tr>
<tr>
<td>Section 6</td>
<td>Electrical Infrastructure Systems</td>
<td>19</td>
</tr>
<tr>
<td>Section 7</td>
<td>Building Envelope &amp; Roofing Systems</td>
<td>28</td>
</tr>
<tr>
<td>Section 8</td>
<td>General Requirements Applicable to all Disciplines</td>
<td>44</td>
</tr>
<tr>
<td>Section 9</td>
<td>Infection Control</td>
<td>47</td>
</tr>
<tr>
<td>Section 10</td>
<td>Drawings and Project Documentation</td>
<td>49</td>
</tr>
<tr>
<td>Section 11</td>
<td>Miscellaneous</td>
<td>50</td>
</tr>
</tbody>
</table>
1. Purpose & Introduction
This document shall provide guidance to designers, maintenance providers and contractors engaged in the repair, renovation construction and modernization of Air Force Medical Service (AFMS) properties regardless of their location.

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

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

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

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

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

2.1 Basis and Theory of Design

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

2.1.1 Chilled and Condenser Water Systems

A. In-patient health care facilities (bedded hospitals) require chilled water systems with N+1 redundancy. A minimum of two chillers/pumps/towers with duty and backup capacity is required.
B. Chilled water system design for indoor mounted chillers shall include a piping arrangement that extends to the exterior of the facility with valved and flanged connections for use of a temporary chiller. The pipe connections at the system shall be so that a temporary chiller can be connected without requiring a temporary pump. Provide electric power and disconnect to the building exterior at the point of temporary connection. Size piping and electric power to match the largest indoor chiller.
C. Select chillers that will provide modulation or unloading down to the 20% range and remain under stable operation without surging with constant design entering condenser water temperature. Provide head pressure control for chillers as required by manufacturer’s application guide.
D. Single chiller installations shall be at least dual compressor, dual circuit design sized with each circuit at 60% of maximum cooling load. Multiple chiller designs shall include same basis of design in that each machine must be sized for at least 60% of the maximum cooling load.
E. New or Renovation projects that include modification of chilled water systems shall require Variable Volume Chilled Water Systems (VVCWS) – unless otherwise approved by AFMSA. The designer/contractor shall document the design to AFMSA during the proposal stage.
F. Any space requiring “special” environmental conditions that are less than 70 degrees Fahrenheit and 50% relative humidity shall require a dedicated cooling system.
G. The condenser water design shall provide freeze protection (both operating and idle) and control of chiller condenser pressure.
H. Hydronic Economizer systems require less than or equal to a 10 year return on investment.

2.1.2 Heating Water/Steam Systems

A. In-patient health care facilities (bedded hospitals) require heating water systems with N+1 redundancy. A minimum of two boilers/pumps with duty and backup capacity is required.
B. The basis of design shall include natural gas fired, high efficiency or condensing, finned tube forced draft, packaged, hot water, boilers.
C. Provide dilution accessory to prevent acidic effluent from entering sewer system.
D. Designer shall eliminate or minimize steam based systems – where economically feasible.
E. Boiler design shall include dedicated constant volume boiler primary pump to ensure proper water flow at boiler and secondary loop pumps with variable frequency drives.
F. Select pump motors with 120% of selected brake horsepower at the design condition up to 25 HP and 110% of selected brake horsepower for motors over 25 HP.

2.1.3 Air Distribution Systems
A. Continuous cooling loads such as laboratories, pharmacies, IT equipment areas with heat generation equipment in the space shall be cooled utilizing building cooling systems when available but operating independently when building system is not available.
B. Heat recovery systems shall be provided for all 100% Outside Air systems; heat wheels shall NOT be used.
C. In major renovation projects, the design team shall convert all constant volume or multi zone or dual duct HVAC systems to Variable Air Volume Single Duct type. Convert 100% Outside Air systems to accommodate as much return air as allowable by code.
D. The airflow design shall include a room by room ventilation analysis. If the cooling/heating load airflow requirement is greater than the airflow required to meet minimum ventilation requirements, then that load requirement shall dictate the ventilation of that space. When the airflow volume to meet minimum ventilation requirements is greater than the thermal load requirement, then that airflow rate shall dictate the design for that space. In NO circumstance shall the airflow volume design for any space be less than 110% of the calculated minimum air exchange rates. This practice will apply to all spaces in the clinic or hospital that have a published air exchange requirement. No diversity that reduces airflow from design values shall be used. Follow UFC 4-510-01 for air change reduction in unoccupied surgery suites.
E. When a space requires a pressure relationship to an adjacent space, the design of the supply and exhaust air flow rates for the space requiring the pressure relationship shall utilize a minimum of 20% differential between the two flow rates. More airflow differential may be required based on the construction of the space and the measurable pressure differential required.
F. The room by room ventilation analysis shall be totalized to provide an overall minimum outside air supply rate for the entire zone. Provide airflow measuring station at the outside air intake of the affected air handler to provide continuous monitoring and control of the outside air volume. The designer shall not use a “worst case scenario” percentage of outside air for a single room in the zone to base the total design flow rate of an air handler.
G. One Variable Air Volume (VAV) terminal shall not serve more than six (6) rooms or 2,000 square feet. Designer shall not mix occupancies or exposures on a common VAV terminal.
H. Select all fans for not greater than 80% of the maximum fan RPM rating (at 110% of design load). Provide all fan motors (up to 25 Horsepower) with nameplate rating that is 120% of selected brake Horsepower. For fan motors above 25 Horsepower provide motors with nameplate rating of 110% of selected brake Horsepower.
I. Select air handler fans with lowest possible speed to minimize noise. Use ARI listed AHU performance ratings.
J. All new or renovated HVAC systems shall include air and/or hydronic economizer cycles as permitted by local climate. Air side economizer capability shall be included only for projects located in Climate Zones 3 – 7 of the ASHRAE Zone Map included as Attachment 1.
K. For any Air Handler with no airside economizer cycle, eliminate the return/relief air fan if design calculations demonstrate it is not required to overcome return duct static pressure and building pressure control can be maintained.

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

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

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

2.2 Equipment Physical Characteristics

2.2.1 Chillers

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

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

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

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

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

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

2.2.2 Boilers

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

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

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

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

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

2.2.3 Pumps

A. Use only motors with a rated speed of 1,750 RPM or lower with TEFC NEMA premium efficiency.

B. Where pump motors will be controlled by VFDs, they will be so designed for continuous use/duty with VFDs.
C. Provide testing ports at suction and discharge side of all new pumps. The discharge pressure fitting shall be at the discharge before any fitting or valve. On the suction side, the pressure port shall be no closer than one foot from any fitting or elbow.

D. All pump bases shall be grouted after alignment is complete. All pump assemblies shall be laser aligned.

2.2.4 Cooling Towers

A. Towers shall have manufacturer’s access ladders, access platforms, interior walkways, and hand rails around the top of the tower. The towers shall have stainless steel construction throughout, and PVC fill.

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

C. Provide side filtration and a basin cleaning system to remove solids from the basin and condenser water.

D. Provide automatic water make-up control with separate metering. Meter shall be of type that can provide data to the BAS.

E. Provide basin equalization piping on towers serving a common system.

F. Tower installation shall provide sufficient height for required condenser pump NPSH.

G. New cooling towers shall be of the induced draft cross flow design with TEFC (or TEAO) motors.

H. Design cooling towers according to ambient temperatures listed in UFC 4-510-01. Select towers for not more than a 10 degree approach temperature at design conditions.

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

2.2.5 Air Handlers

A. Drain pans in AHUs shall be stainless steel and constructed so there is no standing water in the pan. Slope pans in two dimensions to the drain connection. Furnish drain pans under cooling coils, heating coils and humidifier dispersion tubes.

B. Cooling coils (chilled water) shall be ARI listed for performance. Coils shall have no more than 12 fins per inch and serrated fins are not acceptable. The minimum design entering water temperature shall be 2 degrees F above system chilled water supply temperature as documented in latest official project plans with a water temperature differential across the coil of 12 degrees F. Provide stainless steel coil casings and intermittent supports. Aluminum coil fins shall be of 0.0075” minimum thickness. Copper coil tubing shall be of minimum tube wall thickness of .020” and 5/8” diameter. A single chilled water coil shall be no more than 8 rows. Where coil capacity requirements dictate more than 8 rows, the coil shall be split into two separate coils with minimum of 12 inches between them. Maximum cooling coil face velocity shall be no higher than 500 FPM at the AHU design capacity.

C. Heating coils (hot water or steam) shall be ARI listed for performance. Coils shall have no more than 12 fins per inch and serrated fins are not acceptable Aluminum coil fins shall be of 0.0075” minimum thickness. Copper coil tubing shall be of minimum tube wall thickness of .020” and 5/8” diameter.

D. Provide 200,000 hour (L10) rated bearings on shafts and motors. Provide TEFC (Totally Enclosed, Fan Cooled and NEMA premium efficiency) motors for fans.

E. Provide laser alignment and belt tensioning of supply and return fans upon installation. Laser alignment and belt tensioning tool, as well as user training, shall be provided to local FM staff upon completion of project.
F. Air Handlers shall have access doors in all modules except coil modules. Doors must be hinged at one side and with latches on one side that take no tool to operate. Doors shall provide full swing or have pin and sleeve hinge for removal. Each module shall have a vision panel and interior lighting with switching at exterior of AHU.

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

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

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

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

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

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

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

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

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

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

2.2.6 Variable Air Volume Terminals

A. All Variable Air Volume (VAV) terminal boxes shall be pressure independent type.
B. Heating water coils in VAV terminals serving exterior zones shall be two rows.

C. VAV terminals shall be double wall with insulation between panels so not to be exposed to airstream. Provide terminals with double-walled insulated manufacturer’s access panel at an easily accessible area for all interior components. Install VAV boxes to provide unhindered access to the access panel and controls.

D. Flex connector from medium pressure ductwork to VAV box inlet shall not exceed six (6) inches in length.

2.2.7 Piping Systems, Duct Systems and Miscellaneous General Requirements

A. All motors controlled by Variable Frequency Drives shall be of the design that reduces or eliminates inducted transient rotor voltage. This can be either motors fitted with grounding rotor brushes, ceramic bearings or other AFMSA approved technology.

B. Stencil or label all finished pipe surfaces to clearly label content and normal flow direction in agreement with ANSI/ASME A13.1. Provide identification each twenty feet at minimum.

C. All roof top equipment must be installed per the equipment manufactures' recommendation. The curb, base anchoring point and/or manufacturer equipment stand shall be securely anchored to the underlying structural members and meet the requirements for wind loading and uplift for the geographical area. Curbs should be installed per NRCA recommendations unless otherwise designed by a professional structural engineer as needed to meet special unique requirements specific to the site or region. Treated wooden skids, timbers and similar materials used for curbs and mounting platforms shall be coated, covered and flashed as necessary to eliminate exposure to UV and the elements; and shall present a seamless matching appearance consistent with the roof system. Minimize the use of roof mounted equipment.

D. When using existing concrete housekeeping pad for any mechanical equipment, contractor must verify the pad size. Contractor must completely remove the old pad down to solid foundation and construct a new house keeping pad if the existing pad is deteriorated or not sized to fit new equipment. Pad extensions are not acceptable.

E. Isolation valves, flow measuring ports and balance valves shall be installed on all coils and all components requiring TAB. Strainers required ahead of all control valves and pumps.

F. Above ceiling spaces shall not be used as return air plenum (See AFMSA ETL 2010-01 in Attachment 2).

G. Where ducts must be located outside the building, provide dimpled metal jacketing with an anodized finish in the color selected to best harmonize architecturally with the building.

H. Provide all stainless steel duct construction, with seamless welded joints; (to include all accessories) downstream from trim humidifiers or high efficiency final filters serving surgical procedure spaces. Provide drain nipple with plug in SS duct (i.e., Operating Rooms, Dental Surgery, Labor & Delivery, etc.). See UFC 4-510-01 Section 7-11.5.1 for additional details.

I. Flex duct connecting terminal boxes to supply air devices shall not exceed five (5) feet in length. Do not use flex duct for return or exhaust duct systems. Where the facility is undergoing a renovation involving complete replacement of ceilings and ceiling mounted air devices throughout a large contiguous space, the contractor shall replace the all old / existing flex duct with new.

J. Ductwork design shall use long radius elbows.

K. Supply, return and outdoor air ductwork shall be sealed with water based mastic at all joints and externally insulated. Insulation shall be 2” thick mineral fiber blanket with foil vapor barrier. Test all new ductwork per SMACNA standard.
L. All branch ducts shall have manual balancing dampers. This includes branch ducts on various floor levels connected to a vertical riser.

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

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

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

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

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

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

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

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

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

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

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

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

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

Z. Include water meter with pulse counter contactor on make-up water line, and connect to BAS.

AA. For condenser water systems, provide a high quality controller for controlling bleed, inhibitor feed and biocide feed. The controller is to have multiple modes for configuring the timer for the scale and corrosion inhibitor but its default mode is to control chemical feed proportional to make-up water.
AB. Include two (2) biocide timers with the capability to lock-out the bleed following a biocide addition. Use a pre-bleed timer in conjunction with the bleed lock-out.

AC. Install corrosion test coupon assembly.

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

2.3 HVAC Controls

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

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

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

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

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

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

- Floor plans with room numbers, temperature sensors, terminal boxes and AHU’s accurately located.
- VAV boxes with CFM (feedback), damper position (percentage), space temperature (feedback), space temperature set point, discharge air temperature (feedback) and reheat valve position (percentage).
- AHU depicting fan operation (feedback), fan speeds, duct static pressure (feedback), preheat mode, cooling modes, control valve status (percentage), CHW and HW coil leaving air temperatures (feedback), return and mix air temperatures (feedback), damper positions (percentage), total supply air CFM (feedback), outside air temperature (feedback), outside air CFM (feedback), chilled and hot water leaving temperatures (feedback), filter pressure drop (feedback).
- Where the BAS is going to be installed in a foreign location, maintained and operated by local foreign nationals, the BAS shall be so equipped to easily toggle the graphical interface and text to be displayed in both the local native language and modern English; and the system measurements can be toggled between SAE and metric units.
- Chilled water/condenser water/heating water systems: On the graphic of each system show all temperatures, fan speeds, pump speed, valve positions, percent equipment load, firing rate, along with all set points.
F. The installer/contractor shall train maintenance personnel in the use of the building control system to the level where they can independently control room set points, adjust operating schedules, recognize abnormal performance, acknowledge alarms, utilize the event log and generate trend logs. Operators must demonstrate their proficiency in these skills at final commissioning and before acceptance of the system.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

W. Provide open protocol BACnet access to the chiller and boiler local controls. Written site specific exemptions for LonTalk may be requested from AFMSA/SG8FE.
X. Chilled water control valves at air handling units shall be two-way, modulating, type that will vary the water flow properly through each coil to meet the building load. Valves are to have shut off pressure rating adequate to close off against pump maximum discharge pressure.

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

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

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

AB. For spaces where humidity requirements are not specifically prescribed under UFC 4-510-01 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 30% during periods of occupancy. In this case, it is acceptable to provide a humidifier at the outside air make up unit (if available) or in the AHU's to improve general indoor RH condition.

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

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

3.0 Testing Adjusting and Balancing of Air and Water Systems

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

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

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

3.2 TAB Definitions

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

3.3 TAB Requirements

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

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

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

3.5 TAB Preplanning Requirements
A. For projects that include renovation or modification of an existing HVAC (air and/or hydronic) system, the TAB agent MUST obtain engineering performance and design data for the current existing system BEFORE the proposed/current project modifications. The system operating design values must be obtained by the TAB agent.
B. The DoR and AFMSA/SG8FE representative will review the TAB Agent’s preplanning documentation and project preparation before field work is started.

3.6 TAB Reporting Requirements
A. The TAB agent shall communicate with the contractor and DOR on progress toward work complete and report and address problems as encountered on the project. The TAB agent shall communicate the system deficiencies to the contractor in written form and may provide recommendations for resolving such items.
B. The final TAB report with summaries, explanations, and notes, with the AABC or NEBB professional’s stamp and signature shall be submitted to the contractor and DoR for review and approval. Upon that review and approval, the report shall be submitted to the AFMSA/SG8FE representative for review. The signatures of the TAB agent, Contractor, and DOR shall be on the report before it is submitted to the AFMSA/SG8FE representative.

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

4.1 Functional Performance Testing Prerequisites
The contractor shall have the following documents and items on the project site when the CxA (Commissioning Agent) arrives on site. If the completion of a task or availability of any document or component is questionable, the Cx should not be scheduled. The CxA will spend the first day on site reviewing this documentation in detail BEFORE any system testing is started:
A. The FINAL Test and Balance (TAB) report with design engineer’s written review and approval (including seal).
B. The final construction documents. This includes the final drawings, specifications, SOW, and “Best and Final” accepted proposal.
C. The written controls sequence of operation. The document must be clear and include the sequence of operation for each and every system component including: fan speeds, duct pressure, valve modulation, damper modulation, alarms, special cycles, lead/lag, air temperature, overrides, occupied/unoccupied, and all other sequences.

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

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

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

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

H. Operation and Maintenance manuals.

I. Final As-Built drawings.

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

4.2 Other Requirements of Functional Testing

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

B. If the manipulation of the digital control system will be on a laptop, an external monitor of at least 22” must be provided during the Cx process for group viewing of the system commissioning.

4.3 Functional Testing On-Site Review Steps

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

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

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

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

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

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

5.0 Plumbing Systems Including Medical Gas and Fire Protection

5.1 Waste and Supply Piping

5.1.1 General

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

B. Sanitary sewer piping handling high temperature effluent shall be cast iron.

C. Supply piping shall be Type L Copper.

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

E. Domestic hot water systems shall include a recirculation piping and pump system to continuously circulate hot water in the system. The time taken for the Domestic hot water to reach a minimum 5°F temperature rise at any fixture outlet shall be no more than 10 seconds.

F. Design shall eliminate domestic hot water storage, tube and shell heat exchangers, steam to water converters as much as possible. Multiple parallel, condensing, high efficiency, rapid recovery water heaters shall be the basis of design.

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

H. Natural gas piping shall be schedule 40 steel.

I. All new water and gas meters shall communicate with energy monitoring system and are subject to AFMSA/SG8FE approval.
J. Connect domestic water heaters and pumps to the BAS. Provide firing rate for heaters, supply water temperature, return water temperature, status of recirculating pump, and control of auto isolation valves.

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

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

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

5.1.2 Fixtures
A. Waterless urinals are NOT allowed.
B. Auto sensor operated flush valves and hand wash faucets shall be used in public restroom areas.

5.2 Medical Gas Systems
5.2.1 General
B. Provide zone valve boxes with a minimum of one spare space for future gas pipe and valve.
C. Provide area alarm panels with a minimum of one spare space for future gas alarm.
D. Main piping shall be sized one pipe size larger than calculated requirement.
E. Basis of design for medical air compressors shall be assemblies with multiple oil less scroll compressors. No reciprocating or oil sump air compressors are allowed.
F. Basis of design for medical vacuum pumps shall be rotary oil-less type.
G. Connect medical gas source equipment to the BAS to show status of equipment, motors, compressors, as well as supply pressure of the system at the source equipment.

5.3 Fire Protection Systems
5.3.1 General
A. Fire protection systems shall conform to all NFPA and UFC standards.
B. Wet pipe sprinkler piping shall be schedule 40 steel for all threaded pipe and schedule 10 steel for all grooved pipe. No plastic pipe is allowed. Flexible stainless steel braided pipe may be used for connection to the heads. The flexible pipe cannot be kinked.
C. Install new or modified sprinkler system heads in the center of ceiling tiles.
D. The sprinkler piping shall not be installed directly on top of the ceiling and shall be coordinated with the general contractor, mechanical contractor, and the project engineer before any pipe is installed.

6.0 Electrical Infrastructure Systems
6.1 General Requirements
A. Pursuant the HQ Air Force Civil Engineer ETL 10-2: Light-Emitting Diode (LED) Fixture Design and Installation Criteria for Interior and Exterior Lighting Applications, dated 18 Mar 2010, LEDs are not permitted for use as
luminaires inside Air Force facilities (which include AFMS facilities). The only exception is for exterior lighting, task lighting, lighting in display cases and bulletin boards. Refer to AFEC ETL 10-2 and UFC 3-530-01 for additional information.

B. Interior Electrical Distribution (600 volts or less). Interior lighting and power loads shall be served at the highest voltage available.

C. Light Fixture Type - Fluorescent lighting shall be T-5 or T-8, (T-8 lamps shall be limited to 28 watt) electronic ballast and supplied with 277/480 volt system. Exemption: Electronic ballast with RFI filters shall be used in operating rooms, delivery rooms, laboratories, special procedure rooms, MRI areas, medical equipment repair and test areas.

D. T-5 High Output (HO) fluorescent lighting will be used in high ceiling areas (over 20') and mechanical machine rooms and warehouse areas in lieu of HID.

E. Dry type transformers shall be utilized to provide 120/208 volt power for 120 volt lighting, receptacle and small equipment loads. All dry type transformers shall be copper wound, NEMA TP-1 compliant; K-rated based on non-linear load content and shall be wired and grounded as a separately derived system.

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

G. Medical hospital switchgear shall be configured incorporating a Main/Tie/Main configuration. Breakers shall be electrically operated, of draw out design, with solid state overcurrent, short time instantaneous and ground fault (if required) adjustable trip devices.

H. All branch circuit distribution panel boards shall be of the bolt-on circuit breaker type and equipped with a main breaker for multi-story buildings only.

I. Ground fault protection shall be coordinated for selective overload, short-circuit and ground fault protection.

J. Bus-in switchboards, panel boards and transformer windings shall be copper. Aluminum bus or aluminum transformer windings are not allowed (Exception – Aluminum windings are allowable on large pad mounted liquid filled power transformers greater than 1500 kVA.)

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

6.2 Location and Space Requirements

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

6.3 Conduit, Cable Tray and Wire.

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

B. Conduit fittings for Electrical Metallic Tubing (EMT) shall be compression steel type.
C. Conduits 1-1/4” trade size and larger shall have grounding bushings. All others shall have plastic or fiber bushings.
D. All conduits and other wall penetrations shall be sleeved and fire stopped.
E. All conduits terminating at vibrating equipment shall utilize water-tight flexible metal conduit, the flexible metal water-tight conduit shall not exceed 36”.

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

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

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

6.7 Hospital Grade Receptacles
A. Hospital grade receptacles shall be provided in the following areas and annotated as “HG” receptacles on the final as-built drawings:
   • General care patient bed locations.
   • Critical care patient bed locations.
   • Any location where a patient bed or patient care service console is located.
   • Anesthetizing locations, operating rooms, delivery rooms, oral surgery, cystoscopy, cardiac catheterization lab, angiography, CT scanning room, MRI scanning room, medical maintenance, intensive care, emergency trauma rooms, fluoroscopy rooms, endoscopy rooms, pulmonary/respiratory therapy, and nuclear medicine.

6.8 Ground Fault Circuit Interrupters (GFCI)
A. Hospital grade Class A GFCI receptacle protection shall be provided at locations required by NFPA 70 and “WET” locations. GFCI are NOT to be installed on circuits serving critical life support equipment.

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

6.10 Operating Room and Delivery Room Receptacles & Power Requirements

NOTE: Operating and Delivery Rooms shall be considered as “wet procedure locations” and require the utilization of Isolation Panels unless a complete risk assessment is completed in accordance with NFPA 99.

A. Surgery, Operating and Delivery rooms shall be provided with at least thirty-six (36) each simplex or duplex receptacle. Twelve (12) shall be located in each service column and six on each wall mounted 3 feet above the floor. These receptacles shall be 20-ampere, 125-volt, 2-pole, 3-wire, straight blade, grounded type.

B. Each Surgery, Operating and Delivery room shall also be provided with at least one (1) each 60-ampere, 250-volt, 2-pole, 3-wire, twist lock, ground-type flush mounted receptacle for mobile fluoroscopy unit or laser photo coagulator.

C. Each Surgery, Operating and Delivery room shall be provided with two (2) each three phase panel-boards located within the respective room. These panels shall be fed from a separate critical branch subpanel and whenever practical from separate critical branch automatic transfer switches. Panel phases shall be connected in the same phase arrangement.

D. Patient Care Area Grounding. General care areas and critical care areas including all anesthetizing locations shall be provided with a grounding system as required by, NFPA 70 and NFPA 99. Grounding system design and initial testing shall be included in the contract documents.

6.11 Medium Voltage Apparatus (Above 600 Volts)

A. All exterior medium voltage switchgear, transformers, cable junction pedestals and vacuum switches shall match and meet the published requirements, including color, manufacturer and construction type of the local base.

B. All medium voltage switchgear enclosures shall have site glasses installed that provide visibility switch contact positions and operable connections. Switchgear enclosures shall also be equipped with removable panels and inspection ports that provide an easy and safe view and infrared thermal inspection of critical connection points.

C. Switchgear, transformers and other similar apparatus that is to be positioned outside on grade, shall be provided a permanent foundation with substantial footing on compacted soil to support the apparatus. Pre-formed concrete pads are not acceptable.

D. Transformers shall be:
   - Fused protected on the primary (H) side of the coils
   - Equipped with a load break on/off switch
   - Non-PCB, mineral oil or silicone oil filled
   - Loop feed-through load-break elbow connected with parking stands and arresters.
   - Equipped with no-load tap changers with two +2.5% taps and two -2.5% taps.
   - Newly installed cable junction pedestals and/or "sectionalizers" shall match any published standards for the existing base. The cable pedestals shall contain sections for both 600 amp and 200 amp connections. Cable junction pedestals shall not be placed on a pre-formed concrete pad.

E. Medium voltage electrical cable shall be 133% insulation, Type MV-105, EPR, ribbon shielded unless otherwise directed by base requirements.
F. Medium voltage underground conduit shall be schedule 40 PVC, except for 90 degree elbows, which shall be long radius rigid conduit. Four (4) inch trade size minimum and shall comply with any local base standards.

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

H. All conduits emerging from grade shall be corrosion wrapped or PVC coated rigid metal conduit (RMC).

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

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

6.12 Hospital Electrical Utility Main Service Entrances

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

6.12.1 Hospital low voltage main service entrance switchgear

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

6.12.2 “Best Source Select” Controls

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

6.12.3 Status Display

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

B. All circuit breakers shall be electrically operated, draw out type with digital or electronic trip modules.
6.13 **Main Utility Room, Generator and EES Room Lighting.**

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

6.14 **Essential Electrical Systems for Healthcare Occupancies**

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

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

6.14.1 **Diesel Engine Generator Sets.**

Generator sets and auxiliaries shall be sized and approved in accordance with ETL 13-4, C1, dated 15 May 2014 and located as close as possible to the hospital to minimize line losses and prevent excessive cable runs. Service entrance transformers and other equipment not supporting the essential emergency system shall not be installed in the same room as the engine generator sets. When configured as a pair (2 generators), each generator sets shall be individually sized N+1 and capable for 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 carry120% of the Life Safety, Critical Care and Essential Equipment loads continuously for 72 hours. The alternators shall be brushless, 60 Hertz, 277/480 volts, except in overseas areas where local conditions will dictate different system voltages and frequencies.
A. Prime mover emissions shall meet the minimum requirements of Tier II requirements unless local published standards are more stringent.

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

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

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

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

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

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

6.14.2 Generator Paralleling Switchgear

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

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

C. PLC Alarm and Event History/Log - The PLC will have a non-volatile memory and user friendly report generator that can display and generate an alarm, systems operations, fault/failure, test and event chronological log/record/report. The PLC memory shall be capable of storing at least 20,000 critical events that cannot be purged or erased from memory, and 100 gigabytes worth of memory for non-critical data where the oldest non-critical events can be downloaded and/or erased when no longer required.

D. Priority Load Management – Healthcare essential electrical loads are divided into three categories: Life Safety, Critical Care, and Essential Equipment Loads. In some locations, a fourth (4th) priority is established for critical “mission” loads such as the Medical Command Center and communications. All other loads are considered “non-essential” must be sacrificed (shed) to salvage the higher priority loads should the system become overloaded. Sensing shall be accomplished through the use of a watt-transducer and as the system approaches capacity (80% of the available generator rating), load management will be initiated and shedding of lesser priority loads shall commence until at or below 70% of the available generator capacity, or added generators are brought on-line to accept and/or reduce bus load. The order for shedding loads is in reverse order of
importance. The first load to be shed is all non-essential loads, followed by the essential equipment load (with the exception of the Fire Pump and Fire Pump Controls), then the critical care load. The Life Safety load is never shed and the EES will run to failure to protect this vital load.

6.14.3 Automatic Transfer Switches (ATS)

A. All ATS shall be double-throw, 4 poles with draw-out design/construction and grounded as a separately derived system. All ATS shall be listed as an assembly and shall be factory assembled (to include the ATS enclosure). All ATSs shall have indicator lights to identify Normal Power (green in color) and Emergency Power (red in color). Where multiple ATSs are employed, the physical arrangement, lights and indicators shall be arranged alike as to not confuse the operator when visually scanning all systems.

B. All Life Safety and Critical Care loads shall have ATS equipped with 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.

C. Load by-pass must be achieved with no load interruption.

D. ATSs feeding high efficiency motors rated 25 horsepower or larger shall be provided with an in-phase monitor to prevent an out of phase transfer. The in-phase transfer shall be achieved without control of the frequency of either power source to prevent excessive motor in-rush current. Closed transition switches shall not be utilized. By-pass isolation switch for the ATS serving non-essential loads are optional.

E. Each ATS shall be equipped with a manual “TEST” switch. Each “TEST” switch shall simulate a normal power source failure and automatically cause the engine generator set to start, attain rated frequency and voltage, and transfer associated electrical system loads from the normal source to the emergency source.

F. Depending upon the number of ATSs a group of switches may be installed at a centralized location in order for the operator to conduct the test at a single point. These switches shall be wired in series with its corresponding ATS.


A. A remote alarm annunciation panel that is storage battery powered shall be provided in a location readily observed by facility management personnel at a regular work station. The annunciation panel shall indicate alarm conditions of the alternate power source and shall include as a minimum the following:

- Battery and battery charger malfunction.
- Engine generator runs status.
- Engine generator alarms.
- Fuel levels, less than 4 hours supply in the day tank and less than 96 hours supply in the main storage tank. A separate audible and visual derangement signal shall be provided within the hospital at a location that is continuously monitored such as a nurse station. The derangement signal shall be appropriately labeled but need not display individual alarm conditions.

6.14.5 General Emergency Electrical Systems Requirements

A. When converting 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 ETL 13-4, C1 dated 15 May 2014.

B. When the facility renovation (typically Level II and Level III) drives the replacement or redistribution of building electrical power distribution systems in the building an opportunity for the removal of the Emergency Power generator will be leveraged. When removing the generator and redistributing generator power the following features shall be provided:

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

D. 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.

E. An electrical distribution panel board properly sized to serve mission critical refrigeration equipment power outlets that are required in the following sections, no other loads are authorized.

- Pharmacy refrigeration equipment.
- Laboratory (mission critical) refrigeration equipment.
- Immunizations clinic refrigeration equipment.
- Logistic (war reserve material) refrigeration equipment.

Where possible, these loads will all be served by a centrally located panel board which is to be connected to the load side of the manual portable generator transfer switch.

6.15 Energy Conservation and Sustainable Requirements.

A. Do not exceed 80 percent of the lighting power densities for exterior areas and 50 percent for building facades and landscape features as defined by ASHRAE/IESNA Standard 90.1-2010. Lighting controls shall be utilized to reduce energy consumption.

B. Lighting controls systems shall be provided to turnoff lights automatically when the space is not in use. Provide duel technology occupancy sensors in non-occupied spaces (corridors, class rooms, conference rooms and break rooms etc.) and other common areas (building entrances, lobby areas, waiting areas and cafeteria etc.). Provide daylight controls to automatically turn off certain lights while day light is sufficient. Lighting in office areas and outpatient clinic spaces shall be scheduled off during off hours or controlled by motion sensors. Consider using day lighting technology in design, such as light shelves, to bring light further inside of the building and reduce glare. Provide task lighting where appropriate. In patient rooms, for an example, task lighting facilitates exams and can be turned off so patients rest in lower ambient light level.
C. Motor Efficiency. Motors shall be high-energy efficient type. Minimum motor efficiencies shall be either Energy Star or in accordance with DOE Buying Energy Efficient Products Recommendations (reference to www.eren.doe.gov/femp/procurement for recommended efficiencies).

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

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

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

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

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

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

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

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

6.17 Conduits
A. Prior to reutilizing any existing fire alarm conduits, conduits must be inspected for damage, loose connections and loose straps

B. All existing wires and cables must be removed.

C. Any additional conduits attached to the existing conduit run must conform to this design guide section 4.3 Conduit, Cable Tray and Wire.

D. Mass Notification system shall be installed in conjunction with a new fire alarms system as outlined in UFC 4-021-01 and NFPA 72.
7.0 Building Envelope/ Roofing Systems

General Requirements

A. The contractor shall protect interior of facility from asphalt, smoke, chemicals, adhesive odors, paints, dust, debris, water damage and/or any other construction activity that would cause damage to the facility, its contents, building structure, building components or its occupants.

B. 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, 3rd 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.

C. Set up work site to minimize damage to the buildings and grounds. Protect sidewalks, grass, and all other building and site components. Restore the site to preconstruction conditions, unless specified for enhancement in the contract. Damaged materials and equipment must be replaced and repaired by professional skilled trade-persons of that field/discipline (electrical, mechanical, plumbing, concrete and framing, etc.). Final inspection and acceptance shall be accomplished by the contracting officer’s technical representative.

D. Repair all components and associated defects in direct connection with areas to be repaired or replaced.

E. Provide for the safety of all construction workers, building occupants and passersby. Suitable protection and security must be provided during all phases of construction process, both during and after normal duty (business) periods.

F. Complete daily cleanup of site to include all construction debris.

G. 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.

H. The design engineer shall conduct a vapor drive analysis for all building envelope systems scheduled to be replaced or renovated.

I. 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.

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

K. 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).

L. 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.

M. No new products or systems shall be installed over decayed, rotten, unsound, corroded or wet building materials.
N. 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, USAEC and Facility Management at all times.

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

P. All repairs/replacements of building envelope system shall match the surrounding structure and building envelope components from an aesthetics standpoint. Contractor shall make their best effort to blend the repair area's appearance to match surroundings.

Q. 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.

R. 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.

S. 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.

T. All cleaning practices and product used shall be in accordance with cleaning products manufacturer's printed instructions.

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

V. 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 Structural Decks

A. 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 5% of the square footage of the deck surface for all deck systems (excluding structural concrete) for a replacement allowance in the base price unless a different amount is specified in the proposed work scope.

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

C. All decks must be clean and dry before the application and installation of new materials. If it is necessary to protect building and begin work prior to drying, additional venting must be provided and protection sheets added as needed.
D. Replacement of damaged or deteriorated decking shall be of like type, material, thickness and profile. Deck attachment shall meet all applicable structural load requirements including live load, dead load and current uplift requirements. Document repairs to decks with photos. Plywood shall not be used to patch or cover holes in non-wood structural decks.

7.1.1 Concrete Decks
A. Concrete deck damage is considered but not limited to: thermal cracks, settling cracks, spalling, corrosion cracking, swelling, d-cracking, crazing, and deflection. All repairs shall be made to ensure proper adhesion, application and drainage of roof system.

B. 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.

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

7.1.2 Metal Decks
A. Metal deck damage is considered but not limited to; scaled, corroded, blistered and un-adhered paints and finishes, unattached metal panels, bent or buckled metal panels, excessive deflection, and areas that would prevent proper attachment and drainage of the roof system.

B. Rust repair shall include wire brushing, sanding, 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.

C. Insure all metal decks are fastened securely to building structure. Visually inspect all welds and fasteners for weaknesses, rust, corrosion and cracks. Replace deteriorated deck fasteners and clips with new.

7.1.3 Lightweight Concrete/Poured Gypsum Decks
A. Lightweight concrete and Gypsum decks shall be completely removed and replaced in areas found to be saturated (moisture levels over 25% by weight) or deteriorated to a point where fastener pullout values do not meet minimum requirements. Moisture survey results must be provided at 35% design submittals.

B. Lightweight concrete and Gypsum decks must be vented per roofing system manufacturer’s specifications for a medical facility.

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

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

7.2 Vapor Barrier
A. Moisture movement through the building envelope systems shall be controlled by a continuous vapor barrier when needed. The location of the vapor barrier shall be determined by the vapor drive analysis as described in the general requirements.
B. Obtain vapor barrier components from a single manufacturer.
C. Provide products which comply with all state and local regulations controlling the use of volatile organic compounds (VOC's).

7.3 Wood Nailers/Blocking
A. Wood nailers must be at least 3-1/2 inches (89 mm) wide or 1 inch (25 mm) wider than adjacent metal flange. Thickness must equal that of insulation but not less than 3/4 inch (18 mm) thickness.
B. Contractor shall utilize Borate treated wood for wood blocking and nailers that are encapsulated within the building envelope system (not exposed to the exterior).

7.4 Roof Insulation & Cover Boards
A. 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.
B. Uneven decks and obstructions must be removed and or repaired prior to installing base insulation.
C. For insulation system designs, ensure against fastening methods that will provide a thermal bridge through the roofing system.
D. Insure all subsequent layers are properly bonded before proceeding to the next layer.
E. Rigid insulation board shall be installed in multiple layers, if thickness is greater than two (2) inches, with joints staggered in both directions. Joints shall be staggered minimum of twelve (12) inches. When installing with
hot asphalt, 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. Roof insulation “R” values shall be a minimum of R-30. Any deviations from this requirement must be approved by AFMSA/SG8FE.

K. 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.

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

M. 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’ 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.

7.4.1 Types of Insulation and Cover Board

A. Polyisocyanurate
   - Rigid board with fiber reinforced facers on both sides, meeting or exceeding the requirements of ASTM C 1289
   - Compressive Strength (Polyisocyanurate): minimum 25 psi (172 kPa)
   - Polyisocyanurate insulation with a smoke index greater than 50 shall not be utilized in AFMS facilities.

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

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

D. Perlite
   - The use of perlite insulation within insulated assemblies is not permitted, with the exception of perlite cant strips.

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

F. Gypsum-based Roof Cover Boards
- Meeting mold-resistance standard ASTM D3273
- Class A fire rating in accordance with UL 790
Prime as necessary according to manufacturer’s requirements and testing assembly certs

7.5 Low-sloped Membrane Assemblies - General

A. All membrane flashing heights shall be a minimum of eight (8) inches in height as measured from the bottom of the right angle, to the top of flashing membrane
B. Membrane flashing material shall be applied tight to the wall and be totally free from wrinkles, air pockets and blisters.
C. Membrane sheets are to be installed wrinkle free and with no “eyebrows,” “fish mouths,” blisters, voids, or lifted edges at corners.
D. 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.
E. 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.
F. Install all penetrations, nailers and curbs prior to installing membrane roofing materials.
G. All membrane wall flashings shall be sealed and membrane applied in three course fashion. Sealant, membrane, sealant.
H. Low sloped roofs shall require plies be installed so that the flow of water runoff will not be against (or in the direction of) the laps. “Strapping” maybe used on slopes of higher pitch or incline with AFMSA/SG8FE approval.

7.5.1 Modified Bitumen

A. 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.
B. 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.
C. Proper bitumen temperature (per written manufacturer’s recommendations) shall be maintained to insure thorough, uniform and consistent lamination of all plies. Minimum temperature differential between Equiviscous Temperature (EVT) and flash point shall be a minimum 75 degrees F.
D. 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.
E. All base, inter-ply and cap sheets shall be broomed or rolled into place immediately following application of asphalt and sheet goods to ensure full adhesion.
F. 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).

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

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

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

J. 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.

7.5.2 BUR, with Gravel Surfacing

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

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

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

D. 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.

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

7.5.3 Thermoplastic Membrane

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

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

7.5.4 Thermoset Membranes

- EPDM
- Approved Membrane Attachment: Fully adhered.
- Membrane Thickness: 90 mil nominal. Minimum.
- Tape splicing is the only acceptable membrane splice method.
7.6 Steep Slope Roofing

7.6.1 Metal Roofing

A. 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, they are considered to have failed, or damaged and must be replaced as required before acceptance (or as a warranty repair) if already accepted.

B. Erect metal roofing straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than .64 cm in 12.2 m 1/4 inch in 40 feet.

C. 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.

D. 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.

E. Metal panels with scratches in excess of 24” in length and penetrate the protective coating shall be replaced.

F. 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.

G. Metal roof system shall incorporate “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 of eave, not in the field of the roof.

H. Metal roofs shall not be installed on less than a 4:12 pitch roof without prior approval in advance of AFMSA/SG8FE.

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

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

K. 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.

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

M. Insure that all openings are of sufficient size to allow for movement around all pipes, fixtures and penetrations.

N. 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).

O. 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.

P. Snow retention systems must be of rail type. Minimum of two complete rails with a clamp installed at every seam.
7.6.2 Shingle Roofing
A. 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.
B. 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.
C. All shingles shall have a minimum of six fasteners per shingle.
D. All fasteners shall be installed by hand with hammers, no pneumatic nail guns are allowed.

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

7.7 Elastomeric Coatings
A. 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.
B. 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. Coating systems shall incorporate integrated reinforcement mesh at all flashings, penetrations and areas that experience expansion and contraction.
C. Designated walkways shall be a contrasting color to the field of the roof.
D. New coating shall meet at minimum reflective value of .81 and a solar index of 98.

7.8 Sheet Metal Flashing and Trim
A. 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.
B. 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 change in roof slope or direction. The sheet metal shall be corrosion resistant with a minimum thickness of 22-gaage for galvanized painted steel, 24-gaage stainless steel, 050-aluminum or copper at 1 Lb. per square foot. Cleats shall be 18-gaage for steel, .063 for aluminum and 22-gaage for stainless steel, but no less than thickness determined by design loads.
C. Counter flashings shall be fabricated and installed to extend and minimum of three (3) inches below the lowest fastener or top edge of base flashing material.

D. 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.

E. Coping and metal roof edge flashing shall be installed with a concealed cleat.

F. 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).

G. Expansion joints in the roof system shall be metal and conform to NRCA and SMACNA standard details and guidelines.

H. 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.

7.9 Drainage

A. 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.

B. 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.

7.9.1 Roof Drains

A. Drains must remain functional throughout the construction process or provide alternative method of draining water in the event of rain.

B. Protect all drains from construction debris and clogging. Cover all drains prior to beginning tear off. Verify all drains are open, functioning and free of debris before work commences. Contractor will be responsible for all plugged and inoperable drains at the completion and testing of drains for final commissioning.

C. Replace all drain bolts regardless of condition and install new drain bolts in anti-seizing compound.

D. Replace all broken drain bolts by drilling out broken bolt, re-tapping and replacing with a stainless steel bolt.

E. Replace all damaged rings: damaged rings noted as cracked, broken, and heavily rusted to prevent water tight seal. Repaint all rings prior to reinstalling. Replace all damaged and missing drain bowl covers. Repaint the remainder of drain covers with two coats of rust inhibitive industrial enamel paint.

7.9.2 Gutters and Downspouts

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

7.9.3 Scuppers

A. All collector heads shall have overflow capabilities.
7.10 Roof Accessories/Features

A. Do not install condensate lines or gutter discharges within one foot of roof flashing details. Where existing lines and penetrations are too close to the flashing, relocate the line as necessary to meet the twelve (12) inch separation requirement.

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

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

D. All roof top equipment must be installed per the equipment manufacturer’s recommendation. The curb, base anchoring point and/or manufacturer equipment stand shall be securely anchored to the underlying structural members and meet the requirements for wind loading and uplift for the geographical area. Curbs should be installed per NRCA recommendations unless otherwise designed by a professional structural engineer as needed to meet special unique requirements specific to the site or region. Treated wooden skids, timbers and similar materials used for curbs and mounting platforms shall be coated, covered and flashed as necessary to eliminate exposure to UV and the elements, and shall present a seamless matching appearance consistent with the roof system.

E. 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.

7.10.1 Skylights

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

7.10.2 Lightning Protection

A. See Electrical Section 6.

7.10.3 Walk-pads/Walkways

A. For all membrane systems, pre-manufactured walkpads shall be used to establish protective walkways on the roof.

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

7.10.4 Ladders

A. Consult with AFMSA/SG8FE on location for new fixed ladders on existing facilities.

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

C. Ladders will have walk-through section at top with fixed handrails 42” above landing.

D. Ladders with heights ranging from 20’ – 30’ shall be caged ladder construction.

E. All fixed ladder construction shall have a minimum load rating of 300 lbs.

F. Attachment points and underlying structure shall be evaluated by a structural engineer licensed in state or country for capability to meet load requirements.
7.10.5 Solar Panels
A. Solar panels shall not be installed or reinstalled on roof systems unless written approval has been received from AFMSA/SG8FE.

7.11 Exterior Wall Systems and Components
General
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.

7.11.1 Structural Framing and Sheathing
A. 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.
B. 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.

7.11.2 Wall Insulation
A. For future use

7.11.3 Through-wall Flashing
A. Clean surface of substrate from projections, which might puncture membrane flashing material.
B. Lap membrane flashing a minimum of 6 inches at end laps (150mm).
C. 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.
D. 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.

7.11.4 Masonry Walls
A. Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.
B. Lay masonry with fully buttered (mortar) head and bed joints.
C. 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.
D. Where fresh mortar joins partially set mortar, remove loose masonry and mortar, and lightly wet exposed surface of set masonry.
E. When adjustment is necessary to be made after mortar begins to harden, remove hardened mortar and replace with fresh mortar.
F. Joint Profile: Tool mortar joints to a concave appearance. Unless otherwise specified in the PWS or Base Architectural Design Guide.
G. Tool exposed joints when "thumb-print" hard.
H. Keep the drainage cavity free from mortar. Install mortar netting at the through-wall flashing to prevent the blockage of drainage within the wall cavity.
I. Flush cut all joints that are not tooled.

7.11.4.1 Mortar
A. Masonry Cement: Complying with ASTM C91: Type S.
B. Portland Cement: Complying with ASTM C150: Type I.
C. Mortar Aggregate: Complying with ASTM C144, standard masonry type. For joints narrower than ¼ inch (6mm), use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent with the No. 16 sieve.
D. Do not use anti-freeze compounds to lower freezing point of mortar.
E. Mix mortar ingredients in accordance with ASTM C270. Mix only in quantities needed for immediate use.

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

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

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

7.11.4.5 Water-repellant Coatings
A. The applicator shall be approved by the manufacturer to install the product.
B. Do not install new products over decayed, rotten, unsound, degraded, damaged or wet building materials.
C. Existing substrates shall be pre-tested to determine the current absorption rates in random areas, in which minimum application rates will be established for the project. A minimum of three (3) tests or one (1) per 1000 sf of surface type, whichever is greater.

7.11.5 Stucco
A. Three-coat stucco systems shall be used over sheathed construction, masonry and concrete substrates: (1) scratch coat, (2) brown coat, (3) finish coat.
B. Self-furring metal lath shall be used for the attachment of the base coat to the moisture barrier and substrate.
C. Aluminum or non-corrosive metal trim and accessories shall be incorporated into the system, as acceptable to the manufacturer.
D. The total thickness of the base coat (scratch and brown) shall be 3/8 inch to 7/8 inch thick. The base coat mix shall contain ½ inch long, alkali resistant fibers to improve cohesiveness and provide crack and impact-resistant qualities to the system.
E. The first (scratch) coat shall be moist cured for a minimum of 48 hours before application of the second (brown) coat. Assure that the scratch coat is still moist (not saturated) just prior to the application of the brown coat. Trowel float the brown coat surface uniformly.

F. Allow entire base coat to cure for a minimum of seven (7) days prior to starting finish coat application.

G. Tolerances for levelness of the stucco plaster shall be ¼ inch in 10 feet for flat surfaces.

H. The finish coat shall be 1/8 inch thick and applied to a moist base coat. Textured and colored finishes shall be as selected by the Government.

7.11.6 EIFS

A. All new or replacement EIFS designs shall incorporate water managing and drainage capabilities within the system.

B. 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 ½ inch. Use fire-rated material when applicable. Sheathing shall be installed with stainless steel screws. Stagger board joints; fit ends and edges tightly together.

C. 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.

D. A polymer modified (PM) drainable system is required for all EIFS systems. The intent is to provide a highly durable system relying on mechanically fastened base layers of insulation in lieu of thin-coat, adhesively attached PB systems.

E. XPS (extruded polystyrene) insulation used in the PM 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.

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

G. PVC trim and accessories shall be incorporated into the system, as acceptable to the manufacturer.

H. 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.

7.11.7 Metal Wall Panels

A. Metal panel systems shall be divided as wet-joint and dry-joint systems.

B. Commonly used materials for metal wall is aluminum which is lightweight, corrosion resistant, easily formable into 3-dimensional shapes, can contain various textures, colors and a range of reflectance value.

C. Metal panel systems are also available from steel, stainless steel, copper, or composite materials. In high-end applications, stainless steel and copper are often applied. Steel panel system requires protective coatings for resistance to corrosion.

D. Suggested Types of Metal Wall System:
   - The Lap-Seam panels shall be manufactured from minimum 0.05-inch (18 guage) sheet metal.
• Composite wall panel systems shall be used where the panel system contributes to thermal insulation of the building envelope. The composite panels consist of two sheets of metal adhered to a core material which is typically the insulation. The sheet metal thickness shall be minimum 0.05 inch (18 gauge). The core material thickness varies depending on the type and density of insulation. The composite panel systems shall be selected by one of following system; (a) Foamed-Insulation Core; (b) Laminated-Insulation Core; (c) Honeycomb Core.

• Flat Plate Metal Panel Wall system shall be used where high impact resistance and durability are required. The system shall be fabricated from minimum 1/8 inch (10 gauge) thick metal plates.

• Metal-Faced composite Panels consist of a thin -0.05-inch (18 gauge) face metal adhered to thermoplastic core. The panel’s overall thickness is minimum 1/4-inch.

7.11.8 Glass Curtain Walls
A. Glass Curtain Systems or Curtain Glazing systems consists of aluminum framed (With or without structural steel reinforcement) wall with horizontal and vertical mullions and in-fill panels of glass, metal, thin stone, or composite materials.
B. Curtain-wall glazing systems are designed to be either interior or exterior glazed system.
C. Design consultant with expertise in custom curtain wall systems should be hired for projects that incorporate these systems.
D. When designed for exterior, the Glass curtain wall system shall be designed for waterproofing performance testing.
E. Curtain wall glazing system shall be designed to transfer their dead-load and live loads back to structure or intermediate framing.
F. 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.

7.12 Joints Sealants
A. Thoroughly clean all surfaces of the joint. Joints must be sound, clean, dry, and free from oils and all loose aggregates. Ensure compatibility of sealant with the proposed application considering size of joint, building movement and designed expansion and contraction. Joint preparation is paramount in successful application and shall be photographed. Prime substrate when necessary.
B. 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.
C. Avoid air entrapment in sealants by using proven industry standards of application.
D. Joint size shall allow maximum expansion and contraction. Proper joint design of: 2:1 width to depth ratio.
E. 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.
F. Use high quality structural caulking between dissimilar materials (water based acrylic is not acceptable).
G. For joints larger than 1” in width, gun-grade sealant is not permitted. Designs shall incorporate pre-molded materials.
H. All items within this section shall be applicable to sealant joints around wall fenestrations.
7.13 Fenestrations

7.13.1 General

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

B. A blast engineer or consultant must do a report based upon the threat level and determine the blast loads that will be imposed upon the components of the building.

7.13.2 Windows

A. All new window and glazing shall meet AT/FP standard and below is the minimum glazing performance requirement:

- The double-pane laminated glass
- SHGC = min. 0.27
- U = min. 0.35
- Low e-coating on number 2 surface in the glass pane. Low e-coating shall be exposed to the air space between glazings.

B. 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.

7.13.3 Doors

A. For future use

7.13.4 Louvers /Vents

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

7.14 Warranties

A. Roof warranties are to be for full replacement and to have a 20 year No Dollar Limit (NDL) from date of final inspection/acceptance by the Government. No proration (NDL) warranties permitted.

B. The installing roofing contractor shall warranty the roof application for a period of five (5) years to be leak free. This coverage shall include flashing details which leak, and blistering. With regard to blistering, an area is to be considered as failed where there are more than two blisters per 100 sq. ft. contiguous surface. Also, any blisters that surface area exceeds 1 sq. ft. are required to be repaired.

C. All roofs must be inspected by a factory trained person who is familiar not only with the manufacturer’s product, but familiar with the engineered design of the roof system being installed, and possess certification or endorsement by the roof designer as qualified to verify quality work and adherence to the system design. This quality assurance representative (QAR) shall perform inspections and tests throughout the installation process. The QAR shall certify that the roof system was installed pursuant the manufacturer’s design requirements and approved installation practices; and that the system is warrantable.
D. Warranty repair coverage to include replacement of all wet substrate materials. The contractor shall cut back into at least six (6) inches of dry substrate in all directions on the repair perimeter to ensure that the transition of the new substrate is affixed to an acceptably dry existing substrate.

E. No disclaimer for ponding water is acceptable. All systems must be designed for positive drainage.

F. Installing contractor shall provide written manufacturer’s warranties on all building envelope components including roofing, coatings, water proofing, sealants, paints, and masonry sealants. Installing contractor shall warranty the installation of all materials for minimum of five years.

7.15 Building Envelope Commissioning

A. 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.

B. Provide all project support documentation (warranties, warranty service contact numbers, as-built, red lines drawings and O&M manuals etc.) are provided to the Facility Manager.

C. Performance testing of drains shall be required on all new and repaired drains at final commissioning. The test method shall be to plug the drains with air expandable test ball and flood roof areas around drains, visually inspect the underside of the drains, and then observe the flow and evacuation of the water when the plug is removed. Any leaks experienced around the drain, may require the total replacement of the drain assembly.

D. Water test all problematic areas identified as suspect during the initial pre-construction site visit and building history, prior to submission for final acceptance by the government. The water testing shall follow AAMA 501.2, and AAMA 502 or ASTM E 1105 if necessary.

8.0 GENERAL REQUIREMENTS APPLICABLE TO ALL DISCIPLINES

A. Removal of Abandoned Infrastructure (Mechanical, Electrical and Structural) – The AFMS desires to leverage any opportunity to clean 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 Hander Room, Electrical Closet, etc.) that contractor shall include as a separate feature the removal and disposal of ALL abandoned equipment, piping, ductwork, electrical wiring and pneumatic lines or devices within the spaces where work takes place under the proposed contract. This is to include the removal and disposal of all abandoned infrastructure that is found within the spaces prior to the start of work. Typically, the conduit, race, tubing or wiring shall be removed back to either the first usable junction box or point where it enters the space.

B. Junction Boxes and Control Panel Boxes - Old large pneumatic control panels or large inappropriately sized junction boxes are to be removed and either not used as junction boxes or “right sized” to a smaller boxes more suited for the requirements going forward. Large EP control boxes that have been abandoned shall be removed and not used as a feed-through pull box for control wiring. Where wiring passes through such a panel, the panel is to be replaced with an appropriately sized electrical junction box, conduit extended to connect said junction box and the wiring re-pulled through the junction box.
C. **Electrical Infrastructure** - Old electrical raceways and bus work where the circuits are/were no longer required following your work and thus de-energized shall be removed back to the most upstream point. (discipline determine verbiage) At this point, the conductors shall be terminated in an approved method, the termination box shall be made safe and provide suitable protection and the terminated circuits shall be marked as de-energized both at the point of termination and at the service point (breaker, fused disconnect, or switch feeding the circuit). Wire ends shall be terminated as to present a neat and safe appearance without hanging strands or insulation.

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

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

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

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

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

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

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

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

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

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

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

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

**9.0 Infection Control**

**9.1 Interim Infection Control Measures (IICM)**

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

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

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

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

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

**F.** Contractors shall protect indoor air, absorbent materials, and mechanical systems from contamination in accordance with ASHRAE-62.1-2004, Chapter 7. Unfinished duct openings shall be covered by plastic sheeting during construction. AHU’s in construction areas shall not be used without a formal approval by the facility manager. Provide temporary filter media (aka “socks”) in construction area over return ductwork and MERV-8 filter in AHU’s during construction. Replace or clean media on a weekly basis.
G. After the completion of construction and prior to the beneficial occupancy, the contractor shall flush out the construction area with 100% outside air for a minimum of 72 consecutive hours. During the flush out period, temperature and humidity shall be controlled at 78°F/50%-60% RH for cooling and 60°F/40%-50% RH for heating, or as approved by the facility manager. The contractor shall remove all temporary media, and thoroughly clean the interior of the air handling unit and all associated equipment including filter racks, fan wheels, monitoring and controls probes and sensors, etc. All pre and final filters shall be changed after construction.

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

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

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

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

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

B. If situation is not corrected within eight (8) hours of receipt of warning or Non-conformance Notice, Contracting Officer will have cause to stop Work as provided in Task Order Documents.

C. Failure of Contractor to correct deficiencies may result in corrective action taken by Contracting Officer. All cost associated with Owner correction of Contractor deficiencies will be deducted from the Task Order Amount.

9.3 Infection Control Risk Assessment (ICRA):

A. An assessment of health risks related to construction, renovation or repair activities to determine which Interim Infection Control Measures need to be implemented.

B. Airborne contaminant producing activities include, but are not limited to:
   - Demolition and removal of walls, floors, ceilings, and other finish materials.
   - Demolition of plumbing, mechanical and electrical systems and equipment
   - Finish operations such as sanding, painting, and application of special surface coatings.
   - All other construction activity that may generate dust, smoke or fumes.
   - Site Work operations adjacent to occupied facilities.

9.4 Containment Areas

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

9.5 Protection Areas:

48
A. Interior occupied areas within facilities which are adjacent to Containment Area, either occupied or used for passage, as well as areas connected to construction area by mechanical system air intake, exhaust and ductwork.

9.6 Submittals.

A. The Contractor shall provide an IICM Draft Submittal at Design development stage and a Final Submittal at the Pre-final Design stage. Include the following information:

B. Drawings indicating Work areas and procedure for containment of airborne contaminants for Owner's review and approval. Indicate locations of necessary IICM, including temporary enclosures, barriers, isolation vestibules, negative air machines, exhaust fans, capped ductwork, etc.

C. Specific means and methods of achieving and maintaining control of airborne contaminants during construction for Contracting Officer's Representative (COR) review and approval.

D. Infection Control Construction Permit for each Work area for COR assessment and approval.

E. Submit Daily IICM Inspection Reports to COR.

10.0 Drawings and Project Documentation

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

B. Renovation projects must provide complete updated fire damper and smoke damper schedules.

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

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

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

F. The following are the pertinent blocks of the DD Form 1354 that need particular attention. Refer to Attachment 2 for clarification.

   Corp of Engineers Address
   Date prepared
   Project #

   for multiple items leave this section blank

   Civil Engineering Address if known
Installation Name
AFMSA contract #
Date Item was placed in service (for multiple items, date system was placed in service)
Number of the item(s)
Facility #
Identify the part, include part 3 if available
P=permanent , S=semi-permanent, T= temporary
Unit of measure
Quantity

11.0 Miscellaneous

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

11.2 Avoidance of Adverse Mission Impact.
A. Construction and work that requires complete shutdown of operations or mission shall be performed on weekends, facility training days, during night time facility off-hours or recognized holidays. Temporary entrance shall be provided to mission critical equipment, laboratories, pharmacy, critical refrigeration equipment, security/alarm system, and any other identified critical areas during all construction disruptions to maintain mission integrity. All day time construction features shall be performed around facility activities and not interfere with the daily operations of the facility personnel or infrastructure. The contractor shall strategize with AFMSA, medical group leadership, Facility Management staff and others as appropriate to minimize impact and coordinate construction activities throughout the project.
B. For Roofing Projects: When working on roofs or the building envelope, the contractor will install temporary closures, covers, etc. at the conclusion of each day’s work to ensure that water cannot penetrate to the interior of the building in the event of an overnight or evening rain or storm.
C. **Maintenance of Fire/Smoke Barriers during Construction:** Contractors working inside the building shall ensure that all penetrations of fire/smoke barriers are either sealed permanently with the appropriate fire stop, or a UL listed temporary fire stop if the penetration is to be reopened later during the execution of the construction.

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

Attachment 1 - Roof Insulation Zone Chart
Attachment 2 – Sample DD Form 1354
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Name</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Description</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Location</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Address</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Contact Person</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Phone Number</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Email</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Due Date</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Amount</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>