

## APPENDIX 04

### HAFB Base Facility Design Standard

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## 1. INTRODUCTION

This Facility Design Standard is intended to alert designers, design-build contractors, facility users, and others of the facility design requirements that are peculiar to Hill Air Force Base including remote sites under the base jurisdiction. This standard supplements or emphasizes established design criteria in government and industry publications including standards, codes, regulations, policies, directives, etc. This standard is being continuously revised and updated as regulations and policies change. Caution must be taken to ensure the latest edition is used. Many governmental jurisdictions have adopted statutes, administrative rules, and/or ordinances that set standards regulating professional practices within their jurisdictions. In addition to the standards set forth herein, said professionals shall also conduct their services in accordance with applicable jurisdictional requirements and standards of practice. Where level of effort differs between the standards set forth herein and any such jurisdictional requirements and/or standards of practice occur, the more stringent requirement(s) shall apply. However, if there are conflicting requirements the government standard will govern.

## 2. SPECIAL CONSIDERATIONS:

### 2.1 Base Location:

Hill Air Force Base is located near Ogden Utah approximately 30 miles north of Salt Lake City at an elevation of 4700 Ft above sea level.

### 2.2 Facility Requirements

Facility design including right-sizing shall comply with AFMAN 32-1084. In addition, administration facilities shall comply UFC 4-610-01.

### 2.2 Construction Season Limitations:

Earthwork can normally only be accomplished from 15 March to 15 November. Paving is normally accomplished from 15 May through 1 October. Structural work may generally be accomplished on a year round basis, but it must be protected from temperature extremes. Built-up roof construction is generally limited to the period from 15 May through 15 October.

### 2.3 Soil and Foundation Considerations:

Typical soils range from sand to silty sand with thin discontinuous layers of silty clay and clayey silt being common. Potable wells have a static water level of approximately 500 feet below the surface. However, the perched water may be encountered at more shallow depths. The average soil pH is approximately 7.8. The soil resistivity ranges from 2,000 to 15,000 ohms/cm. Spread footings are the typical structural foundation. All footings shall be at least 3 feet below grade.

### 2.4 Surveying:

2.4.1 Purpose: These standards are written to provide the Hill Air Force Base Contractors a guideline for producing adequate and accurate topographic and record drawings. These standards do not generally apply to architectural, mechanical, or electrical detail data inside of a building or structure. Definitions used in these requirements refer first to Definitions of Surveying and Associated Terms as published by the American Congress on Surveying and Mapping and second to Black's Law Dictionary. It is the intent of these requirements to:

2.4.1.1 Assist in the implementation of Hill Air Force Base's Geographic Information System through the inclusion of new base transportation systems (roads, railroads, airfields, canals); utility systems (water supply, sanitary sewer, fuel, communication, electrical, mechanical); residential, commercial, recreational and industrial structures and facilities; and other similar base improvements.

2.4.1.2 To provide data that meets accuracy standards required for new improvements consistent with Hill Air Force Base's Geodetic Control Network and Geographic Information System.

2.4.1.3 To provide information necessary to maintain current building and infrastructure data for end users (airmen, base employees, contractors, planners, designers, constructors, emergency personnel, ext.).

2.4.1.4 To provide a means of schematic verification that the intent of the approved engineering design has been met, thereby substantiating that the health, safety and welfare aspects of the engineering design have been adequately provided for by the construction of the project.

2.4.2 Geodetic Control / Monuments: Hill Air Force Base will make available all unrestricted Geodetic Control information to be used for survey purposes. All coordinate values for survey points shall be reported in either:

Universal Transverse Mercator coordinates (UTM), Zone 12 North. The horizontal datum shall be the North American Datum 1983 reference frame, GRS 80 ellipsoid, 2011 realization, otherwise known as NAD 83 (2011). The basis for all elevations shall be the North American Vertical Datum of 1988 (NAVD 88). GPS derived orthometric heights shall be calculated using the Geoid 09 model. The EPOCH shall be defined by the user at time of survey. The basis for all units of measure shall be meters.

Or, include a narrative detailing the coordinate system, format, projection, datum and units used on a project. Submission of survey digital data, maps or reports using a local coordinate system must be accompanied by information allowing transformation to Universal Transvers Mercator.

For more documentation, including station descriptions, of Hill Air Force Base's Geodetic Control Network, contact the base Installation Geospatial Information & Services (IGI&S) (GeoBase) office.

All base geodetic control monuments disturbed by construction shall be replaced by the contractor. Furthermore, one additional geodetic control monument shall be set for every 20000 square meters of construction area or land area otherwise disturbed for construction. The contractor will set all required geodetic control monuments under the direction and supervision of the Base IGI&S (GeoBase) office. All observation data sheets or other similar solution reports shall be submitted by the contractor.

2.4.3 Positional Tolerance: The following relative positional accuracies are provided as a guide for Hill Air Force Base record drawings. Positional accuracy shall be stated at the 95 percent confidence level. The preparer shall select the equipment and procedures necessary to obtain the horizontal and vertical positional accuracy required.

HPT= Horizontal Positional Tolerance; VPT= Vertical Positional Tolerance

*Buildings or Structures: HPT 0.10', VPT 0.05'*

*Airfield Pavements: HPT 0.10', VPT 0.05'*

*Hard Surface Roads, Drainage, Curbs, Gutters ext...: HPT 0.10', VPT 0.05'*

*Unfinished Surface (Ground) Elevations: HPT 1.00', VPT 0.20'*

*All sewer invert locations: HPT 0.50', VPT 0.05'*

*Other Surface/Subsurface Utilities: HPT 0.50', VPT 0.20'*

*Recreational Sites, Athletic Fields, Golf Courses, ext. HPT 1.00', VPT 0.30'*

*Training Sites and Ranges: HPT 1.00', VPT 0.30'*

2.4.4 Data Formats: The following submittal requirements shall be required for all topographic or final record plats, plans and drawings:

2.4.4.1. One full size set of bond copies printed at a legible scale to illustrate all required information.

2.4.4.2. One set of plats, plans and as-built drawings submitted in PDF form on CD-ROM.



2.4.4.3. In addition to the final plats, plans and as-built drawings submitted in hard copy and PDF form, a digital data file shall be provided to Hill Air Force base in one of the following formats:

DWG (AutoCAD drawing file) – contact the base IGI&S (GeoBase) office for version required

SHP (ESRI shape file)

DXF (AutoCAD drawing exchange file)

2.4.4.4 ASCII point file on CD-ROM containing all survey points. Include a narrative detailing the format, projection, datum and units used on the project.

2.4.4.5 Contractor shall accomplish the following options unless specifically noted as not required. Contractor shall request confirmation during design and installation to validate requirement:

Building Information Model (BIM), Digital elevation model (DEM), Digital terrain model (DTM) or other comparable file.

Survey raw data file and a report containing a narrative of the equipment and the procedures used to meet the specified requirements.

All digital files must be mapped to scale and submitted to the Hill Air Force Base IGI&S (GeoBase) office on CD-ROM. Each CD must have an external label indicating the format, density, company /organization name and creation date. All pertinent information used in constructing and managing said topographic and record drawings and database shall be included.

2.4.5 Layering, CAD and GIS Standards: In order to evaluate the accuracy and promote the efficient use of the data in Hill Air Force Base's GIS, digital file layering has been standardized. The digital data shall use the Hill Air Force Base CAD standard file layering and was developed in accordance with the A/E/C CADD Standard and the current Air Force Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE). The CADD A/E/C standards are available at: <https://cadbimcenter.erdcdren.mil>. To access the SDSFIE data models and tools, you need to register an account and be granted permission at: <https://www.sdsfieonline.org/>. USAF SDSFIE Data Models and Guidance are at: <https://www.sdsfieonline.org/Componants/USAF>.

2.4.6 Required Information: The survey shall be performed on the ground to obtain the information required in this standard and any additional information requested by the contracting officer. The surveyor or engineer preparing the plans shall "tie" the improvements into at least two of the above mentioned survey control network monuments. The following items are required to be shown on said topographic or record drawings:

2.4.6.1 The Basis of Bearing for the plans.

2.4.6.2 Location and elevation of all control network monuments used to prepare the plans.

2.4.6.3 Spot elevations covering the entire survey limits showing high points, low points, grade changes, and at sufficient intervals to represent the general character of the terrain.

2.4.6.4 Dimensions of curb, sidewalk, and gutter lines or ditch lines and all streets, alleys or roads indicating the type of paving surface and condition.

2.4.6.5 Electric Utilities – Location of power poles, guy wires, anchors, vaults, junctions, switches, transformers, meters, pedestals, generators, above/below grade lines, ext. Include elevations of the top and bottom of manholes.

2.4.6.6 Storm and/or Sanitary Sewers – the location of all manholes and other structures such as culverts, headwalls, catch basins, inlets, drains, cleanouts, flow controls, separators, tanks, ejectors, traps, ext.

Include elevations of the top and bottom of manholes, inlets and catch basins. Show type, size, and direction of flow and invert elevations of all pipes and/or culverts.

2.4.6.7 Water – Show type, size and location of any water valves, manholes, vaults, standpipes, regulators, fire hydrants, tanks, and ext. Include rim elevations of all vaults, valves, manholes and top of pipe elevations where applicable. Show type, size and location of all lines including all horizontal and vertical changes in alignment.

2.4.6.8 Gas- Show type, size and location of all valves, meters, and gas line markers. Show type, size and location of all lines including all horizontal and vertical changes in alignment. Show elevation on top of any valves.

2.4.6.9 Industrial wastewater – show type, size and location of all junctions, manholes, boxes, cleanouts, valves, meters, inlets, separators, pumps, ext. Show type, size and locations of all lines including all horizontal and vertical changes in alignment. Include elevations of the top and bottom of manholes. Show type, size, and direction of flow and invert elevations of all pipes.

2.4.6.10 Fuel – show type, size and location of all junctions, manholes, valves, vents, regulators, tanks, ext. Show type, size and location of all lines including all horizontal and vertical changes in alignment. Include elevations of the top and bottom of manholes. Show type, size, and direction of flow and invert elevations of all pipes.

2.4.6.11 Telephone – the location of all poles, manholes, boxes, ext.... Show type, size and location of all lines. Include elevations of the top and bottom of manholes.

2.4.6.12 Street lighting – the location of all lamp poles, boxes, ext...

2.4.6.13 Heating – the location and elevation of all steam manholes, vaults and lines.

2.4.6.14 Location, description, dimensions, and main floor elevations of all buildings and structures.

2.4.6.15 Define location and measured elevation of the highest point on all structures and buildings.

2.4.6.16 Location and dimensions of any existing tanks, fences, miscellaneous structures, driveways and other improvements.

2.4.6.17 Location and description of any building or structures within 50 feet outside the limits of the proposed or as-built construction. Provide main floor elevations of buildings and slab elevations of garages.

2.4.6.18 Location and top elevation of soil borings and monitoring wells.

2.4.6.19 Airfield Items – Location and description of all airfield paving, striping, lighting, navigation aids, ext... Include spot elevations of all pavements at not less than one inch (1") map intervals based at the final map scale.

2.4.6.20 A narrative detailing the format, projection, datum and units used on the project together with a statement certifying that all survey points and geospatial data complies with the aforesaid criteria.

2.4.6.21 Digital or wet signature and current contact information of the individual responsible for the plan preparation.

2.4.6.22 Contractor shall accomplish the following options unless specifically noted as not required. Contractor shall request confirmation during design and installation to validate requirement:

Contours at defined intervals.

Location of all drainage ditches and swales.

Location, elevation and volume of all ponds, detention areas, ext.

Location, diameter and species of all trees over a \_\_\_\_\_ inch breast height diameter.

Perimeter outline only of thickly wooded areas unless otherwise directed.

Location and elevation of the 100 year floodplain.

Location and elevation of swamps or wetland limits.

Location of visible rock formations.

2.4.7 Topographic and Record Drawing Plan Review: Within twenty business days upon completion of substantial exterior construction, the contractor shall submit (through the contracting officer), a preliminary topographic or record drawing to be reviewed by the base IGI&S office. The purpose of the review is to ensure all required topographic and site improvement information is correctly displayed and that the positional tolerances have been met as outlined in Section 2.4.3. The base IGI&S (GeoBase) office shall have fifteen business days to review the preliminary topographic or record drawing. If the base IGI&S office finds that the regulations of this section are not in full compliance, the base IGI&S office shall detail for the contractor the reasons for this determination and describe the type of additional information that may be necessary to demonstrate compliance. The base IGI&S office through the contracting officer shall direct the contractor on the procedure for continuing with the review, and shall decide, based on the nature of the outstanding comments and concerns, whether or not the contractor shall be required to provide a revised topographic or record drawing set. Upon acceptance by the base IGI&S (GeoBase) office of a compliant, complete and accurate topographic or record drawing, the contractor shall submit to the contracting officer the final topographic or record documentation to include all drawings, documents and files as required under Section 2.4.4.

2.4.8 Adjustments to these requirements: The Hill Air Force Base IGI&S (GeoBase) office may waive or adjust requirements specified herein upon a finding that the strict adherence to the requirements does not apply or is contrary to the long-term interest of Hill Air Force Base or the maintenance of the Geographic Information System. This standard is intended to be updated and enhanced as appropriate over time. Recommended additions and suggested changes are to be directed in writing to the Hill Air Force Base IGI&S (GeoBase) office.

## 2.5 General Security Requirements:

2.5.1 Design and construction contractors must coordinate with the Contracting Officer concerning obtaining the paperwork for identification badges (AFMC Form 496).

2.5.1.1 In order to gain access to restricted area contractors must submit the necessary paper work for a security clearance, through prescribed channels. If additional information is necessary contact your contracting officer for further guidance.

2.5.1.2 In order to gain access to controlled area contractors must undergo a local files check as a minimum. Some areas will require more stringent checks. Request for access should be submitted through the contracting officer or Air Force Project manager who will forward it on to 75 SFS/S5.

2.5.2 All privately owned vehicles entering the installation must comply with State of Utah emission standards, and insurance requirements.

2.5.3 Any proposed work affecting communication lines or security systems, must be reviewed and approved by 75<sup>th</sup> CES Electric/Electronic Shop, Base Civil Engineering, 777-0075 and 75 SFS/S4E, Security Forces, 777-5532.

2.5.4 All renovations and new construction of must be designed to adhere to current standards set forth for resource protection, antiterrorism, information security and industrial security requirements in:

- a. AFI 31-101, Integrated Defense, (OPR: 75 SFS/S5)
- b. DoDI O-2000.16 Vol 1, DOD Antiterrorism (AT) Program Implementation: DoD AT Standards, (OPR: 75 ABW/AT)
- c. AFI 16-1404, Air Force Information Security Program, (OPR: 75 ABW/IPI)
- d. AFI 16-1406, Air Force Industrial Security Program, (OPR: 75 ABW/IPD)
- e. Military Handbook 1013/1A, Design Guidelines for Physical Security of Fixed Land-Based Facilities or the Civil Engineering Facility Manuals (OPR: 75 Security Forces and Civil Engineering)
- f. Department of Defense Manual 5205.07v3/Air Force Manual 16-703V3, Special Access Program (SAP) Security Manual: Physical Security
- g. IC Tech Spec-For ICD/ICS 705, Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities

2.5.5 Any buildings, which will house assets, which are classified, contain funds, Arms, Ammunition or Explosives or controlled substances must have an initial and follow-up security standard inspection by the applicable government office prior to operation. (Resource Protection: 75 SFS/S5SR, 777-6155; Physical Security: 75 CEG/CEPM, 777-0584 or 777-4235; Information Security: 75 ABW/IPI, 777-7811; Industrial Security: 75 ABW/IPD, 777-6617)

2.5.6 If the project will be inside of or on the boundary of a restricted or controlled area, a free zone may be necessary. Contact with the 75 SFS Resource Protection Office during the initial design phase is critical to ensure proper design, execution, and approval of the free zone. Free zones will be established and approved IAW AFI 31-101 as supplemented and a copy of the free zone security procedures provided to the contractor prior to beginning work.

2.5.7 Any special security requirements needed for the contractor should be coordinated through 75 SFS/S5, 777-6155.

2.5.8 Foreign Nationals employed by the contractor must obtain clearance through the Foreign Disclosure Office, ext. 7-6858 before being allowed access to the installation. Foreign Nationals are not allowed to work in Controlled or Restricted areas.

2.5.9 Locks and Hasps:

Padlocks: Key Actuated

Low Security: MIL SPEC P-17802

Medium Security: MIL SPEC 43951

High Security: MILSPEC MIL-P-43607

Hasp: High Security Hasp, MILSPEC MIL-H-29181

Built In Combination Locks, Authorized Group 1R:

Mas-Hamilton, Electronic Lock

For interior doors in an environmentally controlled area: CDX-10

For safes: X-10)

*NOTE: Built in combination locks and mechanical/digital cipher locks shall not be installed on any doors.*

2.5.10 Intrusion Detection & Access Control Systems: See section 14.12 and 14.13 for further guidance.

## 2.6 Construction Permits:

2.6.1 No excavation shall be done prior to receiving a Base Civil Engineering Excavation Permit. If excavation is started without obtaining a permit, the Contractor shall be held liable for repairs to any broken utility lines and for other damage resulting from the broken lines. The Contractor shall request a permit 14 calendar days prior to scheduled start of digging. Hand digging shall be required to locate utilities shown on the contract drawings, Excavation Permit or 3 feet (1 meter) on either side of locations identified by Base Maintenance Shops.

2.6.2 Designers shall complete the Water Quality Compliance Planning Checklist for all projects involving exterior construction. This shall occur during the design phase of design-build or design-bid-build projects. The checklist is available from the Base Civil Engineer office. Contractors must obtain a Utah Pollutant Discharge Elimination System (UPDES) storm water permit or waiver if the project disturbs more than 1 acre of soil surface area. To obtain the permit a contractor must prepare a Storm water Pollution Prevention Plan (SWPPP) and then submit a Notice of Intent (NOI), and the required fee to the State of Utah, Department of Environmental Quality (DEQ), and Division of Water Quality (DWQ). Contractor shall submit and receive approval of the UPDES permit before starting construction. State approval memorandum shall be provided to the 75 CEG Project Manager

2.6.2.1 Projects disturbing a soil surface area greater than one acre will require the submission of a sediment and erosion control plan to the 75 CEG project manager for subsequent review and approval by the Environmental Compliance Office 75 CEG/CEIE. The contractor must receive approval of the plan and implement Hill AFB approved Best Management Practices (BNP) before starting construction.

2.6.2.2 Projects disturbing more than one acre of soil surface area will also submit a plan for permanent stabilization (erosion control) of disturbed area to the project manager for subsequent review and approval by the Environmental Compliance Office 75 CEG/CEIE. The contractor shall receive approval of the plan and implement approved best management practices before contract closeout. Examples of best management practices are available at the following web sites:

[http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con\\_site.cfm](http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm)  
<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm>

2.6.2.3 Projects with a footprint greater than 5,000 square feet must maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology (historical flows) of the property with regard to the temperature, rate, volume, and duration of storm flow. Use of LID techniques in accordance with EISA Section 438 Guidance shall be implemented. Ensure compliance with UFC 3-210-10.

2.6.2.4 Storm water prohibited discharges (UPDES Section 1.3) shall be adhered to unless a waiver is granted through the Base Environmental Compliance Office, 75 CEG/CEIE. Expiration of approved SWPPP/UPDES permits shall be resolved within a 60-day period unless otherwise specified by 75 CEG/CEIE. Updates to the SWPPP must be addressed during construction as required. Any changes to the SWPPP are to be distributed to all Base stakeholders and prime/subcontractors.

2.6.2.5 Vehicle Washout/Wash-down Areas (UPDES Section 2.3.4c) are to be posted and area use designated.

### 2.7 Borrow and Disposal:

Unless otherwise designated, all borrow shall be obtained off base at the contractor's expense. All non-recyclable, non-hazardous solid waste shall be sent to off-base permitted disposal facilities. Recyclable material can be re-used with permission only. The contractor is required to develop a comprehensive Solid Waste Management Plan detailing how the amount of waste diversion will be achieved to meet Federal regulations.

### 2.8 Utility Line Identification:

2.8.1 Contractor shall provide and install a tracer wire of 10 gage insulated copper within one foot of all new utilities (except metallic or electrical lines) placed underground at Hill Air Force Base. Utility shall be defined as, but not limited to: electric systems; storm, sanitary and subsurface drainage systems including French drains, rain gutter collection and distribution systems, and other water collection systems; potable and non-potable water systems; natural gas systems; industrial waste systems; fuel systems; communication systems; street lighting systems; heating and cooling systems; airfield associated systems; environmental systems; other objects designed for future use such as buried conduits and pipes; and other comparable items, objects or systems. The determination and definition of a utility requiring tracer wire shall be at the sole discretion of the United States Air Force. The contractor may be required to place tracer wire on other utility items and systems at the request of the US Air Force.

2.8.2 If length of new utility is 500 feet or less contractor shall install one terminal box of 2" diameter pipe at each end of the wire marking the utility location.

2.8.3 If length of new utility is greater than 500 feet, contractor shall place terminal boxes at 500 feet intervals.

2.8.4 Terminal boxes shall have a metal screw-on type lid mounted flush with pavement or raised above the existing ground elevation, as determined by the project manager. (Handley Industries or approved equal).

2.8.5 Contractor shall provide a 21-day notice to the Civil Engineering project manager of all utility line installations to allow the Air Force to survey and map all new utility lines. Contractor shall not backfill utility trenches until the lines have been surveyed and approval given.

### 2.9 Construction Identifications signs:

Construction signs are required for all Military Construction (MILCON) Projects. Construction signage shall comply with UFC 3-120-01 except as specified below. All construction identification signs, including those on the Corps of Engineers (COE) projects, shall have "Dakota Brown" lettering on an adobe "Greystone" background. For COE jobs, a red castle on the sign is acceptable.

### 2.10 Explosive Site Plan Compliance:

For projects within the Quantity Distance (QD) zone and in other hazardous areas, an Explosive Site Plan (ESP) is developed to ensure that the proposed project is compatible with the other operations within the



area. The design of the project must comply with the required separations shown on the ESP and other criteria determined by the Weapons Safety Office (SEW). Any changes to the criteria set forth on the approved ESP must be resolved by the Base Master Planner, (CEAO, Mr. Chris Rose) and the Weapons Safety Office prior to completion of the design.

### **2.11 Asbestos and Lead-Based Paint (LBP):**

An asbestos containing material (ACM) and lead-based paint (LBP) surveys will be required for any project that requires renovation or demolition. Any ACM or LBP removal will be coordinated with Civil Engineering's Abatement Operations Officer who will in turn coordinate with Bioenvironmental Engineering and Environmental Management ACM and LBP Program Managers as necessary. Removal shall be done by qualified Civil Engineering personnel, the IDIQ contract (75 CES/CEOHA contractors) or through the base ACM and LBP qualified contractors. A list of approved contractors may be obtained from base abatement shop.

Division of Air Quality rule R307-801-9: The asbestos project operator shall ensure that the structure or facility to be demolished or renovated is inspected for ACM by an inspector certified under the provisions of R307-801-6. An asbestos survey report shall be generated according to the provisions of R307-801-10. The asbestos project operator shall make the asbestos survey report available on site to all persons who have access to the site for the duration of the renovation or demolition activities. If no asbestos inspection is conducted, the operator shall ensure that all resulting demolition debris is disposed of as asbestos waste. "Asbestos project operator" means any asbestos contractor, any person responsible for the persons performing an asbestos project in an area to which the general public has unrestrained access. Project managers will perform responsibilities of the asbestos project operator listed above.

### **2.12 Testing:**

Design specifications shall require the contractor to engage an independent testing for all testing that is required including soils, asphalt, concrete, welding, etc. unless such testing is required by regulation to be performed by the government.

### **2.13 Bird Aircraft Strike Hazard (BASH):**

Design shall eliminate and not contribute to BASH conditions in accordance with AFPAM 91-212 and the Hill AFB BASH Plan 91-212. For seeding recommendations see paragraph 3.9.

### **2.14 Missile Maintenance and Storage Facilities:**

Facilities built or converted for maintenance or storage of intercontinental ballistic missile components. Any new building, modification, or major renovation must be reviewed for compliance with weapon system interface control standards. Hill Air Force Base Point of Contact is AFNWC/NIES, Patricia Rose. (801) 775-2858.

### **3. CIVIL ENGINEERING CONSIDERATIONS:**

**3.0 Applicable Standards:** All utilities shall comply with applicable DoD and Base Standards and American Public Works Association (APWA) Manual of Standard Plan and Specifications. If these standards conflict then the government standards will take precedence. However, water and sanitary sewer segments/appurtenances which will become ownership of the system owner, American Water, shall comply with their design guide, specifications and details for Hill AFB available at their web site <https://amwater.com/corp/products-services/military-services/hill-air-force-base>. These specifications generally take precedence over other standards. It is recommended that prime contractor contract with American Water to construct water and sewer lines that will be owned by them. If not constructed by American Water then the contractor shall pay American Water for compliance inspections and connection fees for the applicable water and sewer lines during construction.

Utility line placement in new roads shall comply with the Base standard utility corridor detail currently on file. All abandoned utility lines shall be removed unless otherwise approved by the 75 CEG Director.

#### **3.1 Airfields:**

3.1.1. General: Airfield pavements shall be designed in conformance with current Air Force Instructions and directives. Airfield pavements shall be designed for Air Force medium aircraft loading unless specific circumstances dictate.

3.1.2. Design Parameters:

3.1.2.1 Air Field Type: Air Force Medium

3.1.2.2 Sub grade soil group: F2 (CBR 8-15).

3.1.2.3 Frost Depth Design: Comply with UFC 3-301-01 Structural Engineering.

3.1.2.4 Freezing index: 595 degree days.

3.1.2.5 Portland cement concrete pavement flexural strength: 650 psi at 90 days.

3.1.2.6 Portland Cement concrete slab size 15 feet X 15 feet minimum, 20 feet X 20 feet maximum except where matching existing structures.

3.1.2.7 Asphalt cement ductility: 50 at 32.9 degrees F.

3.1.2.8 Fuel proofing- Rubberized coal tar shall be placed over all bituminous concrete where fuel spills are anticipated.

3.1.2.9 Slurry seals- Slurry seals shall not be used on asphalt pavement runways (ETL 11-26).

3.1.2.10 Shoulder areas- Follow Air Force criteria per UFC 3-260-02.

3.1.2.11 Miscellaneous- All airfield design and construction must comply with Unified Facilities Criteria (UFC) 3-260-01 *Airfield and Heliport Planning and Design*, UFC 3-260-02, *Pavement Design for Airfields*, AFI 32-1042, *Standards for Marking Airfields*, and Engineering Technical Letter (ETL) 04-2 (Change 1): *Standard Airfield Pavement Marking Schemes*.



3.1.3 Recycling: Demolished bituminous concrete pavement shall be recycled. Demolished Portland cement concrete pavement shall be recycled. All recycled materials shall be reported to project Manager.

### **3.2 Pavement Repair:**

#### **3.2.1 Typical Maintenance Work:**

3.2.1.1 Crack Filling: Rubberized asphalt crack sealing will normally be accomplished by in house forces.

3.2.1.2 Cold planning: Cold planning shall be used to correct surface irregularities and to match curb and gutter elevations prior to overlaying.

3.2.1.3 Heat scarifications: Heat scarification will be used to insure bonding of bituminous overlays where considered necessary by the Pavements Engineer, especially for thin overlays.

3.2.1.4 Slurry seals: Slurry seals will be used as one option to seal low volume surface roads after sealing all cracks.

3.2.1.5 Open graded plant mix seal coat: This seal coat will be used as one option to seal all roads and parking lots.

3.2.1.6 Coal tar treatment: Coal tar seals will be used to seal bituminous concrete in fuel spillage areas.

3.2.1.7 Overlays: Bituminous overlays will be used to rehabilitate bituminous concrete. It will normally be placed a minimum of 1 inch thick. It will be the option of the Government's pavement Engineer as to whether any existing bituminous concrete will be removed prior to placing the overlay.

3.2.1.8 Traffic control in construction areas: The contractor shall provide and maintain all construction traffic control devices. These devices and their layout shall conform to Part VI of the Manual of Uniform Traffic Control Devices or the Utah State Department of Transportation equivalent. The traffic control plan shall be submitted to the Base Traffic Engineer prior to implementation.

### **3.3 Potable Water:**

3.3.1 Well drilling: All future wells shall be drilled by using the reverse rotary drilling method.

3.3.2 Pipe: Water pipe 4-inch through 16-inch diameter shall be PVC AWWA C 900, HDPE or ductile iron. All pipe larger than 16-inch in diameter shall be ductile iron. Tracer wire and warning tape shall accompany any new water pipe installed.

3.3.3 Pipe depth: Water piping shall be installed a minimum of 4 feet below grade. Fire protection lines shall be installed a minimum of 5 feet below grade.

3.3.4 Pressure gages: Pressure gages shall be placed at the outlet of all well pumps; at the inlet and outlet of all pressure reducing valves, pressure sustaining valves and altitude valves; and at any other location where knowledge of pressure would be beneficial.

3.3.5 Valves: Valves shall be placed at all locations where it would be desirable to isolate the system for maintenance and repair. The number of valves shall not be kept to a minimum as a cost cutting measure. Valves will be placed in conjunction with fire hydrants. Air release valves shall be used at high points to allow the discharge of air in the water distribution system.

3.3.6 Standards: All new water lines and appurtenances shall comply with the standards set forward in the Utah Safe Drinking Water Regulations.

3.3.7 Connections: To avoid pipe shaving residue in building and water distribution systems all connections to existing lines shall be accomplished with a standard tee fitting. Hot tap connections are prohibited unless special permission is granted by the Civil Engineering water shop.

### 3.4 Non-Potable Water:

3.4.1 General: The Base has the right to utilize 139 acre-feet of non-potable irrigation water every year. This water is available for use from 15 April to 15 October each year. It is piped part way across the south boundary of the Base, entering at the southeast corner of the Base. A booster pump has been provided.

3.4.2 Available pressure: The available pressure ranges from 40 to 50 psi without the booster pump and between 60 to 80 psi with the booster pump operating. Approximately 400 gpm must be flowing before the booster pump can be operated to prevent cycling.

3.4.3 Place of use: This non-potable irrigation water shall be used wherever possible along the south border of the Base, especially in large areas that can be irrigated with high flowing heads, such as athletic field and parks. Housing area lawns and the Child Care Facility shall not be irrigated with this water because of the possibility that children will ingest the water.

3.4.4 Irrigation systems: Design and construction of irrigation systems shall comply with the 75th Civil Engineer Squadron OI 99-2 entitled Sprinkler System Installation, Operation and Maintenance.

### 3.6 Industrial Waste Treatment:

The industrial waste treatment plant decontaminates waste from the aircraft maintenance areas of the Base. The contaminants include toxic metals, complexing agents, and organic compounds. The entire system is approved by the Environmental Protection Agency. No new toxicants can enter the system and the system cannot be enlarged or expanded without notification and approval. All structural load assumptions shall be noted on the first sheet of the structural drawings. Drawings are seldom lost or destroyed but calculations often are misplaced.

### 3.7 Structural:

3.7.1. Soil Bearing Capacity: Structures at Hill Air Force Base, Little Mountain Test Facility, or the Utah Test and Training Range shall have specific geotechnical studies performed. For minor inhabited structures at Hill AFB the design engineer may use the recommended allowable soil bearing pressure of adjacent facilities.

3.7.2. Stair Tread Minimum Live Loads: The minimum live loads shall be 100 psf and a 300 lb concentrated load at the location of maximum stress (not simultaneous with the uniform live load.) The minimum concrete depth shall be 2 inches if filled pans are used. Design of metal stairs shall conform to the Metal Stair Manual published by the National Association of Architectural Metal Manufacturers.

3.7.3. Design Frost Penetration: Comply with UFC 3-301-01 Structural Engineering.

3.7.4. Concrete compressive strength: A minimum concrete compressive strength of 3000 psi at 28 days shall be for all applications except exterior slabs, which shall have a minimum compressive strength of 4000 psi at 28 days.

3.7.5. Reinforcing Steel Strength: A minimum yield strength (Fy) of 60,000 psi shall be used for reinforcing steel.

3.7.6. Floor slab joints: Joints for slabs on grade shall be located so that the area between joints is square. If a square area between contraction joints is not possible, the length of the rectangular area shall not exceed one and one fourth (1  $\frac{1}{4}$ ) times the width. The saw depth for the contraction joints shall be as recommended by ACI standards but in no case less than one-fourth (1/4) of the slab thickness. For reinforced slabs the reinforcement bars shall be discontinued through slab joints and not used for load transfer. Load transfer shall be accomplished with dowel bars, keyed joints, thickened edge, or a combination thereof.

3.7.7. Procedure for attaching equipment and other objects to existing roof trusses, joints, beams, and other members of the roof structure: Use clamps instead of drilling or welding. The Base Structural Engineer prior to installation of these loads will give approval for attachment of equipment or other object from the existing roof structures.

3.7.8. Compaction: For cohesive soil under structures, building slabs, steps and paved areas, compact to a minimum of 95% of maximum density determined in accordance with Method 106 of MIL-STD-621 using CE55 compaction effort. For cohesion less soil, compact to a minimum of 100% of maximum density.

3.7.9. Steel Fabrication and Erection: Drill or punch all holes in steel members. Never allow holes to be burned with a torch.

3.7.10. Structural design loads for buildings and other structures shall be developed using Unified Facilities Criteria (UFC) 1-200-01 General Building Requirements, which references compliance with the International Building Code (IBC) Chapter 16 as modified by UFC 3-301-01, Structural Engineering. Use IBC Chapter 16 and UFC 3-310-04 for seismic design.

### **3.8 Traffic Engineering:**

3.8.1 Speed Limit: The Base Speed limit is set at 25 mph on the main arteries unless otherwise noted.

3.8.2 Lane Widths: All traveled lanes will be 12 feet minimum in width. Where curb and gutter is not provided, a 3 foot wide paved shoulder will be provided. Storm drain grates will be selected to avoid presenting a hazard to narrow tires. Car pool and bus stop drop off lanes will be included were needed.

3.8.3 Parking: Parking stalls will be 9 feet wide minimum measured normal to the vehicle and 13 feet wide for a handicapped stall. Minimum geometrical configuration shall comply with SDDCTEA Pamphlet 55-17 Better Military Traffic Engineering, Chapter 17. All new parking lots shall have curb and gutter placed around the perimeter. Curbed islands and landscape planters will not be used if they make snow removal too difficult.

3.8.4 Traffic signs and striping: All traffic signs and striping shall conform to the standards contained in the Manual of Uniform Traffic Control Devices. Striping will be included in all new projects and included when restriping is required. Signposts will be constructed of a 2-inch by 2-inch Dakota Brown steel tube section. The tubing will be mated with steel tube section that is driven into the ground. This will allow for the rapid repair of damaged signposts. The backside of all signs shall be Dakota Brown.

### **3.9 Building Demolition:**

Demolition of buildings shall include all elements of the superstructure and substructure including footings and foundations. Utility lines shall also be removed. Only the 75 CEG Director may waive this requirement.

#### 4. ARCHITECTURAL:

##### 4.1 Architectural Compatibility:

4.1.1 General: The Hill Air Force Base Architectural Compatibility Standards Brochure shall be followed as a guide.

4.1.2 Colors: All exterior building finish colors shall conform to the above standard. The colors are taken from the Federal Standard 595B, Colors Used In Government Procurement. All exteriors shall be Federal Paint number 30099, Dakota Brown; or 23617, Greystone. No building shall have more than one color trim unless allowed by the Architectural Compatibility Officer. Factory pre-finished siding and roofing can match the manufacturer's standard, available color selection as long as the color matches the above colors as closely as possible. All selections are subject to the approval of the Base Architectural Compatibility Officer.

4.1.3 Facades: The majority of the permanent facilities at Hill AFB are brick. This standard should be maintained. Any other materials used shall complement the brick in making an aesthetically pleasing, traditional statement. Choices should conform to the Base Architectural Compatibility Standards. All new and remodeled facades shall blend with and complement the permanent construction of the installation.

##### 4.2 Interior Design:

4.2.1 Carpets: Comply with AF ETL 07-4. Carpets will contain a definite pattern and shall be suitable to the function area. All carpeting will meet the flame spread rating required in the Life Safety Code.

4.2.2 Sound Attenuation: Any building design requiring reduction of exterior generated noises shall be done in accordance with the Uniform Building Code, Chapter 35. Also consult the Hill Air Force Base Air Installation Compatible Use Zone Report, amended April 1982, for further sound attenuation guidance. Any penetrations through an STC rated wall shall utilize flexible couplings within 12" of each side of the wall.

4.2.3 Noncombustible material: The installation of exterior finish material shall comply with the requirement that at least 75 percent of the total interior wall surface of any one room must be of non-combustible material, Class B. This material must have a flame spread of 75 or less. Wood paneling will not be used. Wall carpeting will have a smoke development rating of 25 or less.

4.2.4 Concealment: All wiring, piping, and ductwork will be concealed whenever possible.

4.2.5 Interior Graphics Systems: An interior graphics system will be used where appropriate to control message size and complexity, to establish a specific lettering style, establish a color scheme, and enhance the overall interior environment.

4.2.6 Systems Furniture: Systems furniture should be considered for installation in large open areas to condense personnel and optimize space utilization. It should not be used to cover window spaces or exterior fin tube heating. For Right-Sizing requirements comply with AFM 32-1084. The cubicles should be appropriately for the use intended but under no circumstances should be less than 48 square feet. The electrical designer, the architect, and the interior designer must coordinate during the design process. Systems furniture is typically specified and ordered when construction is nearing completion; therefore, if proper coordination has not occurred earlier in the design process, field interface problems will occur. Specify an 8-wire harness consisting of 4 circuit conductors, 1 oversized neutral conductor, 1 full sized neutral

conductor and 2 separate equipment grounding conductors. Provide oversized neutrals to match the harness configuration and balance loads between circuits and phases. A single circuit must not serve more than 4 cubicles under any circumstances.

4.2.7 All suspended acoustical ceilings shall have a recessed-grid with drop (tegular) edge tile. Tile shall be a 2 by 2 grid or 2x4 grid scored in the center so the 2x4 appears like a 2x2 grid."

4.2.8 All paper towel and toilet paper dispensers shall comply with the Custodial Contractor requirements. Use Georgia-Pacific model numbers 52109 or 58201 for paper towel dispensers and model numbers 56783 or 56784 for toilet paper dispensers.

### 4.3 Accessibility design:

ABA Accessibility Standard for Department of Defense Facilities. Any new building, addition or major renovation shall comply with this new Standard. Hill Air Force Base Point of Contact is Richard Nehring. (801) 775-3369.

### 4.4 Keying and Hardware:

#### 4.4.1 Padlocks: Key Actuated

Low Security: MIL SPEC P-17802

Medium Security: MIL SPEC 43951

High Security: MILSPEC MIL-P-43607

Hasp: High Security Hasp, MILSPEC MIL-H-29181

Built In Combination Locks, Authorized Group 1R:

Mas-Hamilton, Electronic Lock

For interior doors in an environmentally controlled area: CDX-10

For safes: X-10)

NOTE: *Built In Combination Locks shall not be installed on exterior doors.*

#### 4.4.2 Card Access: See Section 14.13.

4.4.3 Keying: Master keying shall be ASSA model # V80600IC-626 SUB 595-95 Yale with 1210 core. All locks shall be furnished with removable core cylinders. The cylinder will be capable of being removed through the face of the knob by means of a control key. All cores and keys will be purchased by the contractor but must be shipped either through Clark Security Products Inc or directly to HAFB Lock Shop. A key schedule and plan is required. The purchasing contractor must allow 6 weeks for shipment. All cores will be pinned by the Base Lock Shop. All locks will be grand master keyed into the base system and shall be sub-mastered by the BCE locksmith.

4.4.4 Hardware: Locksets and latches shall comply with (ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade (1) (2) (and) (ANSI/BHMA A156.2, Series 4000, Grade 1). Latches shall be Yale lever arm, Model 5407-LN, 626 finish, with 2 ¾ backset, and Augusta handles that accept ASSA removable core #V-80600. Provide trim of wrought construction and of commercial plain design. STC 45 and STC 50 doors shall have cam hinges.

4.4.5 Exit Control Hardware: Exit Control Locks (DETEX) ECL-230X (Dead Bolt) shall be attack resistant design for maximum holding force, dead bolt lock -1" throw with just over 3/4" engagement with the frame. Provide saw resistant dead bolt, corrosion resistant alloy lock body, 100 decibel alarm,

powered by 9-volt battery (included), surface/flush reversible strike, panic device with photo luminescent sign providing maximum security and a 100 decibel alarm for secondary exists.

#### 4.5 Sign Policy:

All signs shall be in accordance with UFC 3-120-01 *Air Force Sign Standard* and the base Architectural Compatibility Standards. All parking and traffic signs must be installed on a 2 by 2 quick punch type signpost installed in sleeves. All sign posts must be finished Dakota Brown. The back of all signs must be painted or covered Dakota Brown.

#### 4.6 Insulation:

Steel-Frame Walls and Roofs shall be constructed in a manner compliant with ASHRAE Standard 90.1 Tables A2.3 or A3.3. U-values used for energy analysis shall be as shown and will require continuous insulation, (uninterrupted by framing) as required by those tables. Minimum steel frame wall construction is a 3.5 inch stud depth, 16 inches on center with R-11 in the stud cavity and an additional R-10 continuous insulation for a total adjusted wall assembly of R-17 (U-value .057)

4.6.1 As required under ASHRAE 90.1 2004, Insulation shall not be installed resting upon removable suspended ceilings. Nor shall it be installed in a manner which can contaminate clean rooms.

#### 4.7 Painting:

All large exterior equipment shall be painted unless a screen is provided for the equipment. Heat-generating electrical equipment such as transformers or switches shall be painted Federal Paint Number 23617, Greystone. The color of other mechanical and miscellaneous equipment shall be on a case by case basis and be painted either Federal Paint Number 23617, Greystone or 30099; Dakota Brown,. This includes, but is not limited to HVAC units, including exterior conduit systems. All architectural coatings must comply with the VOC limits established by the EPA in the Architectural Coatings Rule published under the authority of the Clean Air Act.

4.7.1 General: Painting for new surfaces will consist of a prime coat and two topcoats. Semi-gloss paint will be used in high traffic, interior areas. Treat any waste associated with removal of lead paint will be treated as a hazardous material. Removal of red lead on structures shall comply with the procedures detailed in local, state and federal regulations and procedures. If repainting is required, the surface will be spot primed and one finish coat will be applied. Spray painting is limited to water tanks; fuel tanks; interiors of unoccupied buildings; the underside of docks; overhangs of 800 series buildings or any other job where the massiveness and intricacy precludes brush or roller application. Any spray painting will be done with an airless spray gun. Do not specify spray-painting if over-spray will damage aircraft, vehicles, equipment or other facilities. Post indicator valves, bollards, etc., shall be painted Dakota Brown. Fire hydrants that are supplied with potable water will have their barrels and caps painted Dakota brown and bonnets painted IAW proper flow test data, National Fire Protection Association (NFPA) Standard 291. Additionally, fire hydrants supplied within a high pressure loop or supplied by a fire pump will have their barrels and caps painted red and bonnets painted IAW proper flow test data, NFPA Standard 291. All fire hydrants barrels will have factory finish reflective-type paint to ensure rapid identification during night operations. All hydrants will be classified and have bonnets painted a specific color based on their rated capacities (at 20 psi residual pressure) as follows:

Class AA — Rated capacity of greater than 1500 gpm — Light Blue



Class A — Rated capacity of 1000–1499 gpm — Green

Class B — Rated capacity of 500–999 gpm — Orange

Class C — Rated capacity of less than 500 gpm — Red

4.7.2 Concrete Exterior Surfaces: These surfaces shall not be painted except to prevent water penetration, unless specifically approved by the Base Civil Engineer.

4.7.3 Floor Coating:

### 4.8 Canopies:

Canopy designs shall be approved for Architectural Compatibility.

### 4.9 Doors:

4.91 Personnel Doors: All metal doors shall be 16 Gauge minimum. Door and frame shall be powder coated.

4.9.2 Overhead Coiling Doors: Curtains shall be galvanized, 18/22 gauge minimum steel. Doors shall be insulated with a full perimeter seal. Doors shall have a 2-wire electric safety reversing edge, electrically operated motor and emergency disconnect and auxiliary chain hoist. Powder coat both sides of door, hood, trim and tracks. Exterior color shall be Dakota Brown. Install vertical EPDM weather stripping and header brush seal above the door to make the opening weather tight. Provide all necessary equipment including life safety devices to meet all applicable codes. Close button must be continually pushed to close the door.

### 4.10 Windows:

4.10.1 General: Because unique conditions at Hill Air Force Base all new windows must meet the Antiterrorism Force Protection explosion protection requirements provided in UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings. In addition the following applies:

4.10.1.5 All window air leakage shall not exceed 1.0 cfm/SqFt and shall be determined in accordance with the National Fenestration Rating Council and shall be so labeled and certified by the manufacturer.

4.10.2 Windows in administrative areas: Other than facilities with Historic Preservation concerns, all windows will be “projected in” tilt sash style with bronze glass and a bronze anodized finish.

4.10.3 Dormitory windows: Provide single hung, non-tilt windows with bronze tinted glass and bronze anodized finish.

4.10.4 Housing Areas: These windows will be sliders, single hung style or projected in windows with clear glass and a white anodized or white vinyl finish.

4.10.5 Window thermal performance shall meet or exceed minimum energy standards for federal buildings. Spectrally selective coatings must be chosen for performance in the particular application and be factory applied. Low-e coatings and solar reflective coatings perform distinctly different functions and are not interchangeable. Selective coatings must be properly placed on the correct glazing surface in order to perform properly.

### 4.11 Dormitories and Billeting Facilities:

The design of these facilities shall follow the guidance provided by AFMC, Guidelines for Facilities Excellence, 1996.



### 4.11 Roof Drainage:

Provide gables at all entrances unless it is specifically unfeasible or has a canopy. Metal roofs shall be equipped with a snow management system. Use rain gutters only when gutters are the only feasible method available to channel runoff to the storm drain system or for safety considerations. Provide heat tape system with rain gutters.

### 4.12 1200 Zone Rest rooms:

Alterations of 1200 Zone buildings will standardize the location of the rest rooms in the center of the buildings.

### 4.13 Roofs:

4.14.1 General: Roofing shall utilize the methods described below.

4.13.1.1 All projects when utilizing conventional membrane roofing materials for new projects or complete reroofing shall meet the following criteria. Roofing system at HAFB shall be designed and installed to be a true SBS (ASTM D6162, D6163 and D6164) polymer modified bituminous system (MB), no VOC, highly recycled, high tensile and tear strengths and include the roofing manufacturer's detailed inspection with reporting documentation of compliance with the UFC 3-110-03 "Roofing" and UFC 3-330-02A Commentary on Roofing Systems".

4.13.1.2 Conventional BUR systems per the UFC 3-110-03 will be acceptable for repairs of existing BUR roofs.

4.13.1.3 Refer to UFC 3-110-03 "Roofing" and UFC 3-330-02A "Commentary on Roofing Systems" for all other roof systems that may be repaired such as Asphalt shingles and standing seam metal roofs. Other roofing systems will be entertained on a case-by-case basis prior to award of any contract unless the SOW specifically delineates a system.

4.13.2 Drainage: Sloped roofs shall be used in lieu of flat roofs when possible. To avoid snow sliding into door entryways roof gables will be used to the maximum extent possible. Hill AFB is located in a cold region, and because of past experience with ice and snow damage, the use of external gutters shall be limited to entryways where a roof gable is not possible. Drainage will be provided with a roof designed to slope away from personnel activity. The use of roof overhangs that extend over sidewalks is encouraged. Metal roofs shall not have internal guttering. Horizontal roof drains in unheated attic spaces shall be kept to a minimum to prevent freeze-ups.

4.13.3 Corrugated Cement Asbestos Roofs: These type roofs exist on a considerable number of roofs in the West area of Hill AFB. When it necessary to repair this type roof consideration should be given to replace the entire roof; however, it may be overlaid with plywood and asphalt shingles. The majority of the asbestos roofs have been encapsulated. If the contractor needs to mount new equipment or disturb the roof, great care should be taken to not disturb the asbestos.

4.13.4 Heat Tape: Heat tape is to be avoided whenever possible. It creates a maintenance problem and most often does not receive routine maintenance due to the lack of funds and maintenance personnel. When heat tape is absolutely necessary the use of an EMCS monitored system shall be used that includes an on/off moisture sensor to detect snow and ice, a thermostat which disables operation were ambient temperature will allow melt to occur and an analog amp sensor to verify the heat is working. Together, these devices limit energy use to only what is needed.

This system will notify occupants via EMCS that the system is working and when the system has failed or in need of repair.

4.13.5 Plywood Decking: Fire retardant treated plywood (FTR) is banned on all new and re-roofing projects. This type of plywood deteriorates when used as roof decking. Untreated exterior glued plywood will be used for decking.

4.13.6 Roof Penetrations: All roof penetrations will be kept to a minimum. The Base roofing engineer will be consulted prior to calling for penetrations in new and existing roofs. This coordination will answer questions on existing roof warranties and recommended penetration details for both new and existing roofs.

4.13.7 Fall Protection: Where feasible permanent anchor points for horizontal lifelines for entire roof coverage shall be provided for future building maintenance, etc. Anchorage to which personal fall arrest equipment is attached shall be capable of supporting at least 5,000 pounds per employee attached, or shall be designed, installed, and used as part of a complete personal fall arrest system which maintains a safety factor of at least two, under the supervision of a qualified person. The designer shall *provide* calculations which certify that the building can structurally support the loads imposed by all fall protection systems to be installed. The kind of personal fall arrest system selected should match the particular work situation, and any possible free fall distance should be kept to a minimum. Fall protection systems shall comply with applicable AFI, OSHA, and ANSI rules and regulations. Applicable standards include, but are not limited to; AFI 91-203, OSHA 29 CFR 1910, ANSI Z359.1-2007 and ANSI Z359.2-2007.

#### 4.14 Landscaping:

4.14.1 General: All new construction and major renovation projects, (facility construction, site design, and landscape construction) will follow best management practices and the following requirements.

4.14.2 Xeriscape Landscapes. Xeriscape landscaping will be the primary comprehensive approach to landscaping for water conservation and pollution prevention for all installation landscape projects. Xeriscape uses native, naturally occurring plant material in the landscape design to convey a sense of regional context while embracing sustainable landscape design and preservation of native and endangered species. Native plants are more acclimated to the climate and require less irrigation. The xeriscape methodology is relevant to planning and design, soil analysis, selection of suitable plants, practical turf areas, efficient irrigation, use of mulches, and appropriate maintenance choices. An emphasis will be given to a desert motif using water resistant plantings. Landscaping will emphasize the architectural lines and features of adjacent buildings and areas, and will be designed to require little or no pruning. Landscaping will be designed with year-around consideration for human comfort. Passive solar cooling methods will be considered such as deciduous tree shading on the east, south and west exposures.

4.14.3 The intent is to limit or eliminate the use of potable water for landscape irrigation. Irrigation typically uses potable water, although lower quality water is equally effective for irrigating landscapes. Sources of non-potable water include: captured rainwater from roof and parking lot runoff; gray water from building systems; and municipal recycled water supply systems.

4.14.4 Water efficiency design strategies will be applied to landscape irrigation by the use of cycle irrigation methods to improve penetration and reduce runoff. For optimal growth, cycle irrigation provides the right amount of water at the right time and place. Designs/retrofits will include the use of low-precipitation-rate sprinklers (better distribution uniformity), bubbler/soaker systems, or drip irrigation systems. For technical information related to irrigation, see UFC 3-420-01, Plumbing Systems; UFGS 32 84 23, Underground Sprinkler Systems; and UFGS 32 84 24, Irrigation Sprinkler Systems.

4.14.5 Shrubs and Trees: Shrubs and trees will be the most drought resistant varieties, and where possible will be placed without irrigation sprinklers. Large trees will be planted with enough space to facilitate growth and trimming, which will normally dictate that they be planted at least 20-feet apart. Tree removal or replacement shall be coordinated with the Natural Resources Manager in 75 CEG/CEV. An evaluation of the proposed action will be analyzed, and a determination made as to the need for removal or replacement and the mitigation requirements for live, dead or dying trees.

4.14.6 Slopes: All slopes shall be no steeper than 3 to 1. Provide slope protection using recent technology for all slopes.

4.14.7 Where lawn grass is used, it shall be provided with irrigation sprinklers, and will be sodded not begun from seed, except for dry land seeding applications. Irrigated lawns shall consider incorporation of a river-run rock or lava rock perimeter to preclude water over spray of sidewalks and pavements.

4.14.8 Restoration of Native Ground Cover: All native ground cover that is disturbed by construction and not scheduled for landscaping shall be re-seeded with drought resistant grasses and legumes. Mixtures of dry land alfalfa, fairway crested wheat grass and Indian rice grass will be used in good sandy, loam soils. Use sand drop seed with fairway crested wheat grass in gravelly soil. Machine drilling on generally level to mildly sloping ground is preferable. Hydro seeding should only be used on 3 to 1 slopes. This native ground cover seeding should take place in April, May, September and the first half of October only. For MAMS and airfield areas the following seed mixture and application rates shall be used to prevent BASH conditions. For soil preparation an application procedures see 75 CEG/CEIE memorandum dated 25 February 2014.

Common Name	Variety	Rate (lbs./acre)
<b>Western Wheatgrass</b>	<b>Rosana</b>	2.5
<b>Intermediate Wheatgrass</b>	<b>Oahe</b>	2.0
<b>Streambank Wheatgrass</b>	<b>Sodar</b>	4.0
<b>Crested Wheatgrass</b>	<b>Hycrest, Roadcrest, or Ephraim</b>	2.0
<b>Sand Drop Seed</b>		0.12
<b>Bluebunch Wheatgrass</b>		2.5
<b>Sheep Fescue</b>		2.0
<b>Total</b>		15.12

## 5. SUSTAINABLE DESIGN AND DEVELOPMENT.

### 5.1 Policy:

Provide certification using the DoD version of Guiding Principles (GPs) Compliance certification of either the 1) US Green Building Council (USGBC)/ Green Business Certification Inc. (GBCI), or 2) Green Building Initiative (GBI) rating systems, for all applicable projects. All projects will register for Guiding Principles Compliance certification using the DoD version of either USGBC/GBCI or the GBI rating systems, and shall achieve verification of meeting the Federal requirements as detailed in UFC 1-200-02.

### 5.2 Sustainable Design.

5.2.1 The facility design process can take one of several paths towards construction; however, meeting sustainable development objectives shall always be a primary concern regardless. Concept design is typically developed through an intensive, cross-disciplinary session called a "charrette." This is led by the design agent and A-E contractor and attended by the full Air Force team (AFCEE PM, MAJCOM representative, installation PM, architects, engineers, landscape architects, interior designers, planners, facility managers, and energy managers) and all other design consultants. It is the responsibility of the design agent, working with the Air Force PM, to determine the source organization for ensuring the project Sustainable goals.

Current public laws and executive orders require all new Federal facilities to meet a comprehensive set of requirements commonly referred to as the Federal High Performance and Sustainable Building (HPSB) GPs. These requirements have been consolidated into UFC 1-200-02, *High Performance and Sustainable Building Requirements*. This UFC is organized around the HPSB Guiding Principles. Per DOD *Sustainable Buildings Policy*, when a building meets the requirements of this UFC, it is considered compliant with the HPSB Guiding Principles. Additionally, the memo requires DOD Components to "... establish an auditable process to ensure applicable new buildings and major renovations meet requirements as defined in the UFC. The auditable process shall include green-building certification ...." To reduce confusion about project sustainability goals, advance compliance with the Federal requirements, streamline HPSB GP compliance and tracking requirements, and identify a third-party certification that can be used for all new construction and major renovation projects, the AF adopted newly developed USGBC/GBCI and GBI Guiding Principles Compliance rating systems as indicators of HPSB GP compliance.

Guidance documents and the AF Sustainability Requirements Scoresheet can be found at:

[http://www.wbdg.org/ccb/browse\\_cat.php?c=265](http://www.wbdg.org/ccb/browse_cat.php?c=265).

### 5.3 Sustainable Applicability.

The third-party certification requirements contained herein apply to AF construction activity as follows:

- All new buildings larger than 5,000 SF, with construction costs greater than \$3M
- All renovations to an existing building larger than 5,000 SF with construction costs greater than \$3M and 50% estimated re- placement costs
- To the extent practical for:
  - a. Buildings not on AF installations in the United States and its territories
  - b. Building supporting contingency operations

- c. Non-permanent buildings
- d. Projects marked as “austere” on the DD Form 1391

## 5.4 US EPA Recovery Materials Advisory Notice.

New buildings and major renovations to existing buildings which exceed 25% of the replacement value, shall be designed specified and constructed in accordance with US EPA Recovery Materials Advisory Notice (REMAN) for Comprehensive Procurement Guideline (CPG) 9/2007, Federal Green Construction Guide Sec 04-20-00, DoD Green Procurement Program Strategy GPPS, and the partial list of current applicable Federal Regulations below:

- Executive Order 13834, Efficient Federal Operations  
<https://www.denix.osd.mil/sustainability/eo-13834>
- RCRA 6002
- C.F.R. 247.1-247.17
- FAR 23.4

Hill AFB is an active participant in the recycling of post-consumer waste derived from facility and production operations. The recycling of post-consumer waste program requires that products produced by the process be manufactured utilizing a minimum of 10% of these qualified recycle component materials and the products to meet all applicable current product specifications. Many products meeting these guidelines are readily available at comparable cost and therefore shall be incorporated to the maximum extent of product availability. Products manufactured from facility and production waste available for construction purposes include but are not limited to concrete masonry units and cultured marble bath panels & fixtures.

## 5.5 Construction and Demolition Waste Diversion.

The Contractor is required to develop a comprehensive Solid Waste Management Plan detailing how the contractor will achieve 54% (by weight) waste diversion for each project as implemented by the Office of the Under Secretary of Defense memorandum dated 1 Feb 2008 in reference to EO 13423. For required non-hazardous solid waste management, a project adapted Construction and Demolition Waste Management Plan similar to UFGS 01 74 19 will be used. In order to track C&D waste diversion, accountability and documentation must be initiated prior to actual work in the field. The Contractor's Non-hazardous Solid Waste Diversion Report must be submitted on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted and each quarter thereafter until the end of the project. The report must indicate the type and amount of waste generated, type and amount of waste diverted, type and amount of waste sent to waste-to-energy facility and alternative daily cover, destinations of all diverted materials, in tons, and the percent that was diverted.

## 6. ENERGY AND WATER CONSERVATION REQUIREMENTS.

### 6.1 Facility Energy Policy:

6.1.1 New buildings (excluding single family and low rise multi-family residential buildings), new building additions, and major renovations to existing buildings which exceed 25% of the replacement value, shall be designed and constructed in accordance with latest Federal Energy Regulations or Air Force and DoD policy whichever is more stringent. A partial list of current applicable Federal Energy Regulations are:

1. Energy Policy Act 2005 as codified in 10 CFR Parts 433, 434 and 435. (EPACT 2005)
2. Energy Independence and Security Act of 2007. (EISA 2007)
3. Current sustainability EO 13834, Efficient Federal Operations

A partial list of Dept. of Defense and Air Force energy regulations are:

1. UFC 3-400-01 Energy Conservation
2. UFC 1-200-02 High Performance and Sustainable Building Requirements.

Specifically, new buildings, building additions, and major renovations exceeding 25% of replacement value, shall be designed and constructed in compliance with ANSI/ASHRAE/IESNA Standard 90.1 - 2004 Energy Standard for Buildings except Low Rise Residential Buildings.

New construction, building additions, and major renovations, of single family housing and low rise (3 stories or less) multifamily residential buildings shall be designed and constructed in compliance with the International Energy Conservation Code. ICC

In addition to compliance, design and construction shall achieve an energy consumption level that is at least 30 percent better than the level achieved through compliance under ASHRAE 90.1 or ICC as applicable. If the 30 percent energy consumption savings cannot be achieved in a life cycle cost effective manner, the maximum savings level that is cost effective shall be achieved. Energy consumption levels for both the baseline building and the proposed building shall be determined by using the Performance Rating Method in ASHRAE 90.1 Appendix G with the following correction to paragraph G1.2

*Percent improvement = 100 x (Baseline building consumption - Proposed building consumption) / (Baseline building consumption - receptacle and process loads.)*

6.1.2 All energy consuming products shall be either ENERGY STAR qualified or FEMP-recommended. These products are in the upper 25 percent of energy efficiency in their class.

6.1.3 Both recovered and renewable energy shall be used in each design to the maximum extent that is life cycle cost effective. Solar hot water shall be used in each design to furnish a minimum of 30 percent of the hot water demand if life cycle cost effective.

6.1.3 For buildings less than 20,000 SqFt. the designer may choose to meet or exceed the minimum requirements listed in the prescriptive table below in lieu of the extensive computer modeling required by the Performance Rating Method in ASHRAE 90.1 Appendix G.

6.1.3.1. This table is based upon: Advanced Energy Design Guide for Small Office Buildings for climate zone 5B. However, modifications have been made to comply with additional Federal Energy Policy Act requirements.

# BASE FACILITY DESIGN STANDARD

## HILL AIR FORCE BASE

2 Apr  
2020

Item	Component	Minimum Requirement
Roof	Insulation entirely above deck	R-20 Continuous Insulation
	Metal Building	R-13 + R-19
	Attic and other	R-38
	Single Rafter	R-38 + R-5 Continuous Insulation
	Surface Reflectance/Emittance	See Notes Below
Walls	Mass	R-13 Continuous Insulation.
	Metal Building	R-13 + R-13
	Steel Frame	R-13 + R-10.0 Continuous insulation
	Wood Frame and Other	R-19 + R-3.8 Continuous Insulation
	Below Grade	R-7.5 Continuous Insulation
Floors	Mass	R-10.4 Continuous Insulation
	Steel Frame	R-30
	Wood Frame and Other	R-30
Slabs	Unheated	No Recommendation
	Heated	R-10 for 36 inches
Doors	Swinging	U .70
	Non-Swinging	U .50
Vertical Glazing	Window to Wall ratio	20% to 40% Maximum
	Thermal Resistance	U .42
	Solar Heat Gain Coefficient	.46



# BASE FACILITY DESIGN STANDARD

## HILL AIR FORCE BASE

2 Apr  
2020

	Window Orientation	$(A_n \cdot SHGC_n + A_s \cdot SHGC_s) > (A_e \cdot SHGC_e + A_w \cdot SHGC_w)$
	Exterior Sun Control (S, E, W only)	Projection factor .5
Skylights	Maximum percent of roof area	3%
	Thermal Resistance	U .69
	Solar Heat Gain Coefficient	.39
Interior Lighting	Lighting Power Density	0.9 Watts/SqFt
	Light Source	90 Mean Lumens/Watt
	Ballast	Electronic Ballast
	Dimming Controls for daylight	Dim fixtures within 12 Ft of N/S window or 8 ft of skylight edge
	Occupancy controls	Auto-off all unoccupied rooms
	Interior room surface reflectance	80% + on Ceilings, 70% + on walls and partitions
HVAC	Air conditioners (0-65,000 Btuh)	Energy Star Rated
	Air conditioner (66,000 – 135,000 Btuh)	Energy Star Rated
	Air conditioner (136,000 – 240,000 Btuh)	Energy Star Rated
	Air conditioner ( > 241,000 Btuh)	Energy Star Rated
	Gas furnace ( 0 – 225,000 Btuh - SP)	Energy Star Rated
	Gas furnace( 0-225,000 Btuh – Split)	Energy Star Rated
	Gas furnace( > 225,000 Btuh )	Energy Star Rated
	Heat pump (0 – 65,000 Btuh)	Energy Star Rated
	Heat pump (0 – 65,000 Btuh)	Energy Star Rated
	Heat pump ( 65,000 – 135,000 Btuh)	Energy Star Rated
	Heat pump ( > 135,000 Btuh)	Energy Star Rated



Economizer	Air conditioners & heat pumps –SP	
Ventilation	Outdoor Air dampers	Dedicated Outdoor Air with Motorized control
	Demand Control	CO2 Sensors
Ducts	Maximum Friction loss Rate	.08 in W.C./100 feet
	Sealing	Seal Class B
	Location	Interior only
	Insulation Level	R-6
Service Water	Gas Storage	90% Et
	Gas Instantaneous	Energy Star Rated
	Electric Storage 12 KW	EF>.99 - .0012 x Volume
	Pipe Insulation d < 1.5 inch	1 inch
	Pipe Insulation d < 1.5 inch	1.5 Inch

Metal Building: A pre-fabricated structure with metal panels attached directly to purlins.

Mass: Concrete or masonry wall or floor providing the main structural support (not veneers) and having a heat capacity greater than 7 Btu/SqFt.

Steel Frame: Walls, roofs, and floors with metal framing members similar to traditional wood framing.

Heated Slab: Slab floors with heating elements either within or below the slab.

Et: Thermal Efficiency.

EF: Energy Factor.

Roof Flectance Shall meet or exceed “Cool Roof Rating Council” Solar Reflectance Index (RFI) of  $\geq 78$  for low-slope roofs (Pitch 2:12 or less) and  $\geq 29$  for high-slope roofs (Pitch greater than 2:12).

6.1.3 Energy Compliance Analysis and Life Cycle Cost Analysis Calculation Methods. All calculations shall be based on expected conditions including anticipated occupancies, scheduled hours of operation and weather history. Calculations shall be performed using professionally recognized and proven energy analysis programs capable of simulating the features, systems and loads used in the proposed design. Programs shall perform full 8760 hourly calculations using TMY2 or TMY3 weather data for Salt Lake City, Ogden, or Hill Air Force Base. Preferred modeling program is Energy Plus available free from Dept. of Energy. Other acceptable programs are DOE2.1E, BLAST and E Quest.

6.1.4 Utility incentives and rebates for work done on Hill AFB shall only be coordinated through the Energy Management Office. Contractor shall provide invoices and other information needed to obtain rebates upon the request of the Energy Office.

NOTE. COMcheck and REScheck are acceptable for demonstrating minimum compliance but are not acceptable alone for demonstrating compliance with requirements to exceed the minimum standard by 30% as required under Federal Energy Policy Act (EPACT 2005).

### 6.2 Energy Code Compliance Documentation:

6.2.1 The Lead Project Architect, Lead Project Mechanical Engineer, and the Lead Project Electrical Engineer, shall each prepare separate narratives listing the energy conservation measures considered, the impact of each measure on the total energy consumption, and a listing of each energy conservation measure adopted.

6.2.2 Signed Energy Compliance Analysis forms and all other compliance documentation listed in Appendix G of ASHRAE 90.1 shall be provided to the Government for Approval (unless the design follows exactly, the prescriptive approach listed above). Spreadsheet and pdf versions of the Energy Compliance Analysis forms are available from Hill AFB engineering office. Alternate forms may not be used.

### 6.3 Energy Requirements for Building Renovations:

6.3.1 Where renovation costs are equal to or greater than 25% of the replacement cost of the building, the entire building shall brought up to compliance with the requirements for new construction listed above as required by UFC 3-400-01 Energy Conservation.

6.3.2 Where renovation costs are less than 25% of the replacement value the entire building shall be brought into compliance with requirements for new construction to the maximum extent practical. All new work shall comply with requirements for new construction.

6.3.3 In accordance with UFC 3-400-01, sustainable design shall be an integral part of every project. This requires an integrated and coordinated approach to the planning, design and construction of facilities and extensive use of environmentally preferable products, recovery and recycling of materials and waste reduction as well as an emphasis on the long-term quality and productivity of the built environment. Energy and water conservation are primary goals of sustainable design and development. Comply with EO 13834, Efficient Federal Operations <https://www.denix.osd.mil/sustainability/eo-13834/>. Appliances, HVAC equipment and other energy consuming equipment shall have an energy efficiency rating in the upper 25 percent of that available as long as these efficiency requirements are nonproprietary and life cycle cost effective. In general, the Department of Energy and Federal Energy Management Program recommendations from the Buying Energy Efficient Products Guide and the Environmental Protection Agency Energy Star products program meet these requirements. The DOE recommendations are available on the web at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).

6.3.4 Interpretation of terms used in ASHRAE Standard 90.1 is as follows:

Adopting Authority: The US Air Force.

Authority Having Jurisdiction (AHJ): US Air Force - HQ AFCEA/CES. US Army - HQ USACE/CECW-CE as appropriate.

Building Official: The Contracting Officer's Representative.

Owner: Hill AFB.

Permit Holder: The Contractor.

Residential Spaces Not Excluded from this Standard: Dwelling units, hotel/motel guest rooms, dormitories, temporary lodging facilities, hospitals, prisons, and fire stations.

Residential Spaces Excluded from this Standard and therefore covered under the ICC Energy Code: Single-family houses, multi-family houses of three stories or less, mobile homes, and modular houses.

### 6.4 Economic Analysis:

6.4.1 Designers may choose one of four methods listed in 10 CFR 436 to demonstrate life-cycle cost effectiveness. These methods include lower life-cycle costs, positive net savings, savings-to-investment ratio that is estimated to be greater than one, and adjusted internal rate of return that is estimated to be greater than the discount rate as listed by OMB Circular Number A-94 Guide to Discount Rates for Benefit-Cost Analysis of Federal Programs. Additional information is available at [http://www.access.gpo.gov/nara/cfr/waisidx\\_o4/10cfr436\\_04.html](http://www.access.gpo.gov/nara/cfr/waisidx_o4/10cfr436_04.html)

6.3.3 The Life Cycle Costing in Design (LCCID) program is in full compliance with these regulations and is periodically updated to include the latest differential escalation rates, energy cost projections and similar economic factors. LCCID is available from the Building Systems Laboratory at the University of Illinois, <http://www.bso.uiuc.edu>, and from the Construction Criteria Base distributed by the National Institute of Building Science. Another life cycle costing program in full compliance with the Federal Regulation and updated with the latest economic factors is the Building Life Cycle Costing (BLCC) program available from the National Institute of Standards and Technology. The Department of Energy's building energy tools web site has a link to BLCC (under Energy Economics) and it can also be found at <http://www.eren.doe.gov/femp/techassist/softwaretools/softwaretools.html>. The appropriate cost and savings associated with the utilization of recovered energy, solar heat, solar photovoltaic energy and other renewable or waste heat applications shall be included.

### 6.5 Meters:

6.5.1 All new construction and all major renovations or additions to existing buildings shall include utility meters for each utility serving the building. Design and installation of all meters shall be capable of communicating with the Energy Management Control System (EMCS).

6.5.2 All utility meters shall comply with the EPACT 2005 requirements for advanced metering, be capable of 15 minute interval measurements, 30 days of internal parameter storage, and be 100% compatible with existing systems for remote collection of data. Recorded values for Electricity (kWh consumption, kW demand, kVAR reactive power, PF power factor), Natural Gas (cubic feet), Steam (klbs), Water (kgal). Memory for recording interval readings shall be ANSI C12.19 compliant. Meter shall provide time-stamped readings for every measured parameter.

6.5.3 The data shall be transmitted to the EMCS system in Building 593. All communication connections will be made by the Contractor to include all wiring, conduit, radios, and/or antennae required to support transmission of data to the EMCS server interface.

6.5.4 The EMCS integration shall include complete installation of all hardware, connection to system, and verification of pulse weight or meter multiplier. Each meter point shall record all relevant parameters with time-date stamp.

6.5.5 The Contractor must be required to perform a complete point-to-point test of the completed meter Installation. The test shall be conducted by validating the readings measured at the meter and those transmitted to and received by the EMCS server.

6.5.6 Questions regarding Automatic Meter Reading System (AMRS) installation should be directed to the Base Utility Manager (Mr. Nickolas King). He can be reached at (801) 777-5944.

6.5.7 Steam distribution and condensate lines shall be located above ground when possible. When the lines must be placed in an underground system, they should be installed in a utility trench.

6.5.8 Automatic Meter Reading (AMR) compatible gas meters and pressure regulators shall be installed for all new and renovated facilities or when gas service to existing facilities is installed, replaced, or upgraded and connected to the EMCS system. Meters shall be Dresser Roots rotary style meter or equivalent and meet the requirements of UFGS 33 51 13.00 30, Natural Gas Metering. To facilitate maintainability, all new meter set piping must have a meter bypass loop with a plug valve and plug valves on each side of the meter. All new meter set piping shall also include two test tees, one on each side of the pressure regulator, and a wye strainer with 100 count mesh stainless steel screen prior to the meter and pressure regulating device as described in Chapter 10.

6.5.9 AMR compatible watt hour meters shall be installed on all facilities requiring new electric service or modifications to existing service and facility power requirements and connected to the EMCS system. Meter shall be a Shark 200 v2 or equivalent and meet the requirements of UFGS 26 27 13.10 30, Electric Meters.

6.5.10 AMR compatible potable water meters shall be Neptune Technology Group T-10. Provide a raceway for communication connectivity to the communications room closet. Meters shall be provided for potable water entry/service points and base water well facilities.

## 6.6 Water Conservation.

6.6.1 All new construction and major renovation projects, (facility construction, site design, and landscape construction) will follow best management practices and the following requirements.

6.6.1.1 Xeriscape Landscapes: Xeriscape landscaping will be the primary comprehensive approach to landscaping for water conservation and pollution prevention for all installation landscape projects. Xeriscape uses native, naturally occurring plant material in the landscape design to convey a sense of regional context while embracing sustainable landscape design and preservation of native and endangered species. Native plants are more acclimated to the climate and require less irrigation. The xeriscape methodology is relevant to planning and design, soil analysis, selection of suitable plants, practical turf areas, efficient irrigation, use of mulches, and appropriate maintenance choices. Certain LEED credits are linked to proper application of xeriscape concepts.

6.6.1.2 Landscape Irrigation Systems: The LEED rating system does include credits for water-efficient landscaping practices. The intent is to limit or eliminate the use of potable water for landscape irrigation. Irrigation typically uses potable water, although lower quality water is equally effective for irrigating landscapes. Sources of non-potable water include: captured rainwater from roof and parking lot runoff; graywater from building systems; and municipal recycled water supply systems.

6.6.1.3 Water efficiency design strategies will be applied to landscape irrigation by the use of cycle irrigation methods to improve penetration and reduce runoff. For optimal growth, cycle irrigation provides the right amount of water at the right time and place. Designs/retrofits will include the use of low-precipitation-rate sprinklers (better distribution uniformity), bubbler/soaker systems, or drip irrigation systems. For technical information related to irrigation, see UFC 3-420-01, Plumbing

Systems; UFGS 32 84 23, Underground Sprinkler Systems; and UFGS 32 84 24, Irrigation Sprinkler Systems.

## 7. MECHANICAL SYSTEMS DESIGN REQUIREMENTS.

### 7.1 Purpose and Scope:

The purpose of this part of the standard is to provide technical guidance and outline technical requirements for the more typical aspects of the mechanical engineering design on Hill Air Force Base. The information provided shall be utilized by mechanical designers in the development of the plans, specifications and calculations, and shall serve as the minimum mechanical design requirements. Project conditions may at times dictate the need for designs that exceed these minimum requirements.

7.1.1 Refrigerant Management. When any work is conducted on a refrigerant containing appliance, whether moving, repairing, replacing, or installing new, the designer will include the following Refrigerant Management practices as part of the contract requirements:

7.1.1.1 Technicians performing any work must be EPA certified.

7.1.1.2 All refrigerants remain property of the Air Force and must be recovered.

7.1.1.3 Prior to removing or relocating existing equipment the remaining refrigerant must be evacuated from the equipment and all associated piping by a certified recovery or recycling machine. Reclaimed refrigerant will be returned to the government in containers supplied by the Air Force for that purpose.

7.1.1.4 Designers will list, on the project drawings and in the specifications, the type of refrigerant and the working charge of the equipment specified.

7.1.1.5 The plans and specifications shall require the installing contractor to update these drawings to show the actual size and type of equipment installed and the final total installed refrigerant charge.

7.1.1.6 The plans must state that the contractor is not permitted to purchase any refrigerant on behalf of the government. If additional refrigerant required beyond the pre-charge will be provided by the government.

### 7.2 Energy Supply

**7.2.1 Fuel Source and HVAC System Selection. The use of electric resistance heating is not permitted without prior approval from base civil engineering office. Solar hot water shall be used in each design to furnish a minimum of 30 percent of the hot water demand if life cycle cost effective.**

7.2.1.1 New facilities and facilities undergoing major and minor renovation as defined in UFC 3-400-01, *Energy Conservation*, are required to be analyzed to determine the most cost effective and practical fuel source(s) and heating and cooling system types. Both recovered and renewable energy shall be used in each design to the maximum extent that is life cycle cost effective. Provide energy analysis in accordance with UFC 3-400-01.

7.2.2 All new facilities and major renovations where the HVAC system is to be upgraded will consider the use of Ground Source Heat Pumps (GSHP) as the first choice. Provide mechanical system based on lowest life cycle cost. Provide completed compliance forms provided in ASHRAE 90.1 User's Manual, any additional documentation to support compliance with this Standard, and applicable state government required forms.

7.2.3. Facility Energy Conservation. The Energy Policy Act of 2005 (EPACT05) and The Energy and Independence and Security Act of 2007 (EISA 2007) have increased the energy conservation requirements. New facilities shall be designed to achieve energy conservation levels that are at least 30%

below the levels established by ASHRAE Standard 90.1-2004 or the International Energy Code (for residential buildings).

**7.2.4 ENERGY STAR:** All HVAC equipment, appliances, related electrical equipment, and water saving fixtures shall meet or exceed the minimum efficiencies listed by Energy Star and Federal Energy Management Program (FEMP). The FEMP website lists all Energy Star and FEMP rated products and provides recommended efficiencies and life cycle data. The FEMP website is at <http://www.eren.doe.gov/femp/>. For product groups where Energy Star labels are not yet available, select products that are in the upper 25% of energy efficiency as designated by FEMP.

**7.2.5 Sustainable Design.** Integrate sustainable development principles into the mechanical system selection and design. Utilize the U.S. Green Building Council's LEED Green building Rating System as a tool to apply sustainable development principles and as a metric to measure the sustainability achieved through the planning, design, and construction processes.

**7.2.6 Indoor Environmental Quality and Mold.** Provide outside air ventilation as prescribed by the latest edition of ASHRAE Standard 62. Consider the factors of "Multiple Spaces", "Ventilation Effectiveness", and "Intermittent or Variable Occupancy" as specified in ASHRAE Standard 62. The building and mechanical system must be designed and constructed to prevent the growth of mold. Comply with UFC 3-101-01.

**7.2.7 Economizer Cycles.** Economizer cycles should be considered even when not specifically required under ASHRAE 90.1. Air side economizers shall not be utilized in areas requiring humidification without being specifically designed for humidified spaces. Such systems will require special design approval. Other energy saving measures may be used in their stead. Contact the Government Project Manager for direction.

**7.2.8 Building Pressurization.** Maintain the building under positive pressure in order to negate infiltration.

### 7.3 Heat Generating Systems:

**7.3.1 Boilers.** Install boiler(s) and associated hot water pumps in a mechanical room inside the facility unless otherwise noted in the Project Program. Passageways around all sides of boilers shall have an unobstructed width of 1 meter (3 feet), or the clearances recommended by the boiler manufacturer, whichever is greater. Fuel Fired Hot Water Heaters and Hot Water Boilers require ultra-low NO<sub>x</sub> as the Best Available Control Technology (BACT). Hot water heaters are also subject to ultra-low NO<sub>x</sub>, specifically Utah State Construction and Fire Codes Act, Subsection 15A-6-102 Nitrogen Oxide emission limits for natural gas-fired water heaters

**7.3.1.1 Multiple Boilers.** In multiple boiler installations, the lead boiler should operate up to full capacity prior to starting the next boiler. During heating season, multiple boilers should be kept warm and ready should the lead boiler fail to operate.

**7.3.1.2 Boiler Procurement.** All boilers will be ASME certified as required by Dept. of Defense.

**7.3.1.3 Boiler Emissions.** Boilers must comply with regulatory requirements under the Clean Air Act regarding Title V and New Source Review permits programs as well as requirements under New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutants (NESHAP). Contact the local or regional Public Works Department or Base Civil Engineering Branch for specific requirements.



7.3.1.4 Draft Hoods. Provide for each gas-fired piece of equipment, except power vented and condensing type equipment.

7.3.1.5 Barometric Dampers. Provide barometric dampers for all boilers requiring negative draft.

7.3.1.6 Steam Boilers. On boiler start-up, the condensate in a gravity system may not return quick enough to maintain the boiler water level. Contact the boiler manufacturer for boiler feed system tank size and location.

7.3.1.7 Condensing Boiler Systems. Provide hydronic systems with condensing gas-fired boilers with a water volume equal to five (5) minutes of water flow through the system pump (minimum), or as required by the boiler manufacturer. This insures there is sufficient water volume to prevent short cycling of the burner. If there is insufficient water volume, an inertia tank must be installed to attain the minimum system volume required. Non-condensing boilers do not require this minimum.

7.3.2 Combustion Air. Provide combustion air for gas and oil-fired equipment in accordance with International Mechanical Code (IMC) and NFPA requirements.

7.3.3 Steam Heating. Steam heat should not be used except on rehabilitation projects where budget constraints preclude conversion of an existing steam heating system to hot water.

7.3.4 Infra-Red Gas Radiant Heaters. Infra-Red heating system designs shall be reviewed and approved by the equipment manufacturer and submitted designs shall include a letter so certifying. When using non-condensing gas infrared heaters, the length of the exhaust flue should be minimized. To minimize condensation, run the flue horizontally with a slight pitch down from the heater to a sidewall exit. Heaters should be properly braced where excessive movement, such as by wind through an open hangar bay door, may cause separation of radiant pipe sections and rupture of gas connections. Consider condensing type IR heaters for larger applications. Provide sufficient overhead ventilation for condensing type IR heaters to carry water vapor out of the building.

#### **7.4 Cooling Generating Systems:**

7.4.1 Condensing Temperatures. The design condensing temperature for air-cooled condensers, chillers, etc. must be ambient design temperature plus 2.8 degrees C (5 degrees F) dry bulb.

7.4.2 Chilled Water Systems. Chiller manufacturers recommend minimum system volumes to prevent short-cycling of the chiller(s) to promote long chiller life and good chilled water temperature control, especially in smaller chilled water systems. In small systems it may be necessary to install an inertia tank in the chilled water loop to achieve the required minimum system volume. Check the requirements of the chiller manufacturer and provide an insulated, inertia tank of sufficient volume when required. Install the chilled water storage tank downstream of the chiller and upstream of the cooling coils. Provide calculations to demonstrate compliance with this requirement. Volumes for components may be estimated where manufacturer's data is not available.

7.4.3 Chillers. When multiple chillers serve a common central chilled water system, install a flow control balancing valve on the leaving side of the chilled water and condenser water (where applicable) of each chiller. Flow orifices with butterfly valves should be provided for larger pipe sizes. On multiple chiller systems, design pumping and piping systems to prevent water flow through chillers that are not in operation. Avoid the use of reciprocating compressors when possible. Utilize roof mounted chillers only as a last resort. If located on the roof, mount the chiller on a steel skid with isolators supported from the structural roof framing.



7.4.4 Cooling Towers. Provide a butterfly or 3-way diverting valve in the by-pass line for all cooling towers that are specified to have a condenser water by-pass for regulating the condenser water supply temperature. Provide automatic isolation valves on inlet and outlet of each cell for multi-cell or multi-tower applications. Size condenser water flow to chiller for the design flow rate, not the oversized tower flow rate. Cooling tower piping shall by-pass to the cooling tower's sump.

7.4.5 Ground-Coupled Heat Pump (GCHP) System Design Guidance: The guidelines that follow are intended to complement the guidance and requirements of ASHRAE and recognized consortiums, such as the International Ground Source Heat Pump Association (IGSHPA). Nonresidential, commercial scale ground source heat pump systems require the utilization of computer design software. Such software should consider the interaction with adjacent loops and long-term buildup of rejected heat in the soil.

7.4.5.1 Provide a bypass line around the condenser of each heat pump unit to facilitate flushing and purging the condenser loop without subjecting the condenser coil to residual construction debris.

7.4.5.2 Provide isolation valves and valved tee connections for flushing and purging of the well field independently from the building condenser water system.

7.4.5.3 Do not provide automatic water makeup in residential GCHP systems. Reserve the added complexity and cost to larger, non-residential systems of 10 tons or larger. Utilize cupronickel refrigerant-to-water heat exchangers in open condenser loops only.

7.4.5.4 Provide test ports (sometimes referred to as "Pete's plugs") on the inlet and outlet to each heat pump unit, circulating pump and desuperheater, if incorporated.

7.4.5.5 Utilize reverse return headers in large well fields. For heat pumps with reduced flow requirements of 2 GPM/ton or less, consider series return in order to maintain fluid velocities necessary to foster good heat transfer. Base the decision to commit to reverse return on installed cost, pumping costs and the system flow requirements. Consult ASHRAE and IGSHPA Design documentation for additional information.

7.4.5.6 Regulatory requirements for vertical wells vary widely among States. Some regulations require partial or full grouting of the borehole. Confirm with the Government Project Manager and consult current state and federal regulations, as well as relevant building codes.

7.4.5.7 The thermal conductivity of grouting materials is typically low when compared to the conductivity of native soils. Grout acts as an insulator and will, thus, hinder heat transfer to the well field. When governing regulations permit, consider the following alternatives:

- a. Reduce the quantity of grout to an absolute minimum. Fine sand may be used as backfill where permitted, but caution must be exercised to ensure the interstitial space between pipe and borehole is filled to enhance conductivity.

- b. Utilize thermally enhanced grout. Consult ASHRAE, Commercial/Institutional Ground-Source Heat Pump Engineering Manual. Reduce the borehole diameter as much as possible to reduce the insulating effects of grout or backfill.

7.4.5.8 Antifreeze solution is required if condenser loop temperatures are expected to drop below 5 degrees C (41 degrees F). Avoid use of antifreeze, but if necessary, keep concentrations to a minimum. Utilize condenser water circulating pumps with high efficiency motors. Design them to operate near their peak of maximum efficiency.

7.4.6 Refrigerants. The use of Ozone Depleting Substances (ODS) as well as the qualifications and credentials of personnel servicing equipment that contains ODS is restricted. Refrigerant servicing

equipment must meet the appropriate certification from the manufacturer (e.g. Underwriter's Laboratory certification label attached to equipment).

7.4.7 Refrigerant Piping. Avoid refrigerant piping runs longer than 15 meters (50 feet) unless specifically allowed by the equipment manufacturer. Size refrigerant piping in accordance with the manufacturer's recommendations.

### 7.5 Distribution Systems:

#### 7.5.1 Air Distribution.

7.5.1.1 Locker Room HVAC Systems. Draw conditioned air into locker rooms from adjacent spaces, and provide additional supply air as required. This uses the outside air required for human occupancy in the adjacent spaces for secondary air conditioning of the locker space and maintains locker spaces at a negative pressure with respect to adjacent spaces. No air shall be returned from the locker space to the building HVAC system.

7.5.1.2 Outside Air Ducts. Size outside air ducts for velocities a minimum of 4.1 m/s (800 fpm) for accurate flow measurement. Provide a straight duct of suitable length to facilitate an airflow measurement traverse. Provide an airflow measuring station for VAV systems to verify proper outside air quantities. Equipment layout shall allow for the straight duct length requirements of the airflow measuring station in accordance with the manufacturer's recommendations. Provide an access door in airflow measuring stations to facilitate cleaning and repair.

7.5.1.3 Variable Speed Drives. Select system equipment following AFPAM 32-1192 Energy Efficient Motors and Adjustable Speed Drives. Select to deliver design flows so that maximum operational flexibility is maintained. Verify fan performance at minimum and maximum operating points.

7.5.1.4 Vibration and Noise Isolation. Where vibration and/or noise isolation is required, provide a vibration isolator schedule on the drawings indicating type of isolator, application, and deflection in mm (inches).

7.5.1.5 Access Panels. Provide access panels in floors, walls, and ceilings (except in lay-in tile applications) as required to access valves, smoke dampers, fire dampers, balancing dampers, balancing valves, air vents, drains, duct coils, filters, equipment, etc. Indicate location and size on drawings. Verify that the dimensions will yield reasonable accessibility.

7.5.1.6 Equipment Supports. Provide for vibration isolation where required and schedule the vibration isolation components on the drawings. Coordinate with and provide hardware required to meet Anti-terrorism requirements in **UFC 4-010-01** and seismic requirements in accordance with UFC 3-310-04, Seismic Design For Buildings. All equipment mounted on a roof must be fastened to the building as recommended by the structural engineer.

7.5.1.7 Space Noise Levels. Design and install systems to maintain noise levels below those recommended in the ASHRAE Handbooks.

7.5.1.8 Variable Air Volume (VAV) HVAC System Design Guidance The guidelines that follow are intended to complement the guidance and requirements of ASHRAE.

7.5.1.8.2 Utilize computerized load calculations based on the ASHRAE Transfer Function Method, the Heat Balance Method, or the Radiant Time Series method. Select all central air handling equipment and central plant equipment for "block" loads. Spread diversity through the supply ducts, taking full diversity at the air handling unit, and lessening diversity when moving away from the air handling unit toward the VAV terminal units, until no diversity is taken at the distant VAV terminal run outs.

7.5.1.8.3 Design for both peak and part load conditions (minimal wall transmission load, low occupancy, etc.). VAV Systems shall provide acceptable air circulation and proper outside air for all conditioned spaces regardless of the loading conditions.

7.5.1.8.4 Address the psychrometric performance of the cooling coils, with full consideration of the method of capacity control and its limitations, during part load conditions when the sensible heat ratio can be significantly reduced. Submit part load design calculations. Check the fan operating characteristics throughout the range from the minimum to the maximum flow conditions that will be experienced. Evaluate the off-peak turndown requirements for the main air handler VAV fan. Do not utilize discharge dampers or inlet vanes for air flow modulation. Provide variable frequency drives for air volume modulation.

7.5.1.8.5 Design a positive means of maintaining ventilation rates during part load conditions. Select the minimum primary air requirements of the VAV terminal units to maintain at least the minimum outside air ventilation requirements. The Direct Digital Control (DDC) system shall comply with the requirements of ASHRAE 62 for polling of boxes to maintain proper ventilation levels. Provide an air flow monitoring station in the outside air duct controlling the outside and return air dampers or a constant volume outside air fan to maintain the minimum outside air requirements. Constant volume outside air fans are the most reliable method of maintaining outside air rates and are preferred. When using airflow measuring stations (AFMS) for monitoring and maintaining constant outside air ventilation rates, avoid placement of the AFMS in the outside air duct unless a minimum of 12 duct diameters of straight duct downstream of the outside air louver can be provided. Turbulence generated by the outside air intake louver will generate high turbulence and a highly unstable control loop. For large systems using a constant air volume (CAV) fan use a pressure independent velocity controller in the outdoor air intake to keep outdoor airflow constant as the VAV air handler fan modulates. Provide a low velocity filter module upstream of the air injection fan to prevent dust/dirt build up that may clog the pitot tubes associated with the volume regulator. Provide a duct access door at the inlet to the CAV terminal box for periodic inspection and cleaning.

7.5.1.8.6 Utilize the static regain method in design of the supply ductwork. Design return ductwork using the equal friction method.

7.5.1.8.7 Provide control for a constant cooling supply air temperature. Resetting the supply air temperature upwards increases the coil sensible heat ratio and results in elevated space relative humidity.

7.5.1.8.8 Provide electronic controls; pneumatic controls present problems with repeatability and maintenance.

7.5.1.8.9 Locate the static pressure sensor for modulating fan capacity two-thirds to three-quarters the distance from the supply fan to the end of the main trunk duct. Locate in straight run of ductwork. Provide static pressure reset in accordance with ASHRAE Standard 90.1. Provide protection against over pressurization of the supply duct system. Utilize pressure independent (PI) terminal units. Do not use light troffer return units. Light troffers reduce room sensible loads with undesirable effects on room air changes and outdoor ventilation distribution. Control the cooling coil capacity, especially in the more humid climates. VAV is inherently one of the best of the chilled water systems for air conditioning in tropical climates.

7.5.1.8.10 Do not utilize DX VAV systems without prior approval of the Government Project Manager. Direct expansion equipment shall be specifically designed and manufactured for VAV applications. The same manufacturer shall provide central air handling units, VAV boxes/zone dampers and zone controls. Airflow through the evaporator coils shall not be modulated. Provide duct mounted zone control damper

units with integral control box, designed for use with DX VAV packaged systems. Self-modulating air diffusers will not be allowed.

7.5.1.8.11 Provide round or flat oval duct systems for primary air on all VAV supply systems. Utilize round ducts wherever space availability permits.

7.5.1.8.12 Proper VAV box primary air entry conditions are critical for achieving stable, accurate airflow delivery. Every effort must be made to avoid high turbulence in the proximity of the VAV terminal flow sensor. Design the primary air duct branches to the VAV terminals with a straight duct section of at least 6 to 8 duct diameters (more if required by specific manufacturers). Reducer and increaser duct fittings installed immediately upstream of the VAV terminal connection collars are prohibited. If the branch duct size is other than the VAV terminal connection collar size, install the reducer or increaser fitting upstream of the aforementioned straight duct section.

7.5.1.8.13 Primary air connections to VAV terminals should always be with a rigid duct. If a section of flexible duct, or a flexible connection, is required for vibration control, limit the length to no more than 305 mm (12 inches), and ensure that it is placed at least 6 to 8 duct diameters upstream of the VAV box collar connection/flow sensor.

7.5.1.8.14 VAV terminal boxes have minimum primary air velocity limitations imposed by the volume regulators utilized. Though many manufacturers claim their VAV boxes can deliver minimum primary air at flow rates resulting in inlet velocities of 189 L/s (400 fpm) and a velocity pressure of 2.48 Pa (0.01 inch w.g.), the lack of a certifying agency to test the manufacturer's claims support a more conservative approach. Minimum primary airflow rates shall be established to attain minimum velocity pressures of no less than 7.45 Pa (0.03-inch w.g.). Do not utilize system-powered (also called "pressure dependent") terminal units.

7.5.1.8.15 Special consideration must be given when fan-powered VAV boxes are specified and when it is necessary to specify a VAV box fan CFM in excess of the specified maximum primary air CFM. When used with a dropped ceiling return plenum, the excess VAV box CFM will introduce secondary air into the conditioned space. This has the effect of transferring return side coil cooling loads to room-side sensible loads. Always make sure the transferred sensible heat is taken into account in the calculated room-side sensible heat. Failure to do so may result in inadequate primary airflow rates to satisfy the room sensible heat loads.

7.5.1.8.16 Discharge dampers shall be installed on all series fan-powered VAV boxes (SFPVAV), regardless of the type of fan speed control utilized (3-speed fan switch or solid state speed control).

7.5.1.8.17 When it is necessary to install VAV terminals at high elevations above finished floors, service and maintenance accessibility must be carefully analyzed. Where mounting heights are in excess of 3.6 m (12 feet) above finished floors, special accommodations are necessary:

- a. Do not use fan-powered VAV boxes in such locations, since there are many serviceable components involved. Instead, consider using non fan-powered terminal boxes for use in high mounting height locations to eliminate the need for fan servicing and filter change access.

- b. When DDC controls are installed, specify the installation of the DDC digital controller to facilitate ease of access.

- c. If scaffolding, scissor lifts, ladders or other means is required to access VAV units, special considerations must be made. Be sure clear floor area is available below the VAV boxes to facilitate the means of access (i.e. scaffolding, etc.) and in an area that will be likely to remain clear of permanent or semi-permanent equipment or furnishings.

d. When DDC controls are provided for VAV boxes, specify the ability to monitor VAV box hot water control valve position (if provided with hot water coils), control damper position, primary airflow, flow sensor pressure differential, and box leaving supply air temperature. The means to monitor VAV box function will maximize the means to troubleshoot remotely, thus reducing the frequency for above ceiling access by maintenance personnel.

e. Utilize electronic controls for VAV boxes mounted in high areas.

f. Specify the integral mounting of communication ports for the VAV box digital controllers to the room zone temperature sensor. When occupied/unoccupied modes of control are required of the VAV system, specify remote momentary override switch mounted integral to the room zone temperature sensors to permit non-standard schedule operation during unoccupied modes.

7.5.1.8.18 Fan-powered VAV terminal boxes can be noisy. Perform an acoustic analysis to ensure designs are within acceptable NC criteria noise levels. Pay particular attention to noise attenuation in locations where the boxes are installed in spaces without dropped ceilings. Analyze potential for sound breakout from main supply air ducts. Provide attenuation as required. Do not provide acoustical duct liner for attenuation.

7.5.1.9 Duct Lining. Duct lining shall only be used for room to room transfer applications. Increase the duct dimensions as required. Acoustical duct lining shall not serve as thermal insulation for duct.

7.5.1.10 Fire Dampers. Provide fire dampers and access panels in ductwork penetrating fire rated walls and floors in accordance with NFPA 90A.

7.5.1.11 Flexible Connections. Provide flexible connections in ductwork at equipment. Support duct at flexible connections to ensure proper alignment.

7.5.1.12 Flexible Duct. Flexible duct lengths shall not exceed 1829 mm (6 feet) in length and shall not be used to make right angle bends.

7.5.1.13 Louvers. Provide rain or storm proof louvers at wall intakes and exhausts. Indicate dimensions, airflow rate, and air pressure drop. Consider the potential for carry-over of wind driven rain.

7.5.1.14 Screens. Provide insect or bird screens, as applicable, at all building intakes and exhausts.

7.5.1.15 Door Louvers. Size for minimal pressure drop.

### 7.5.2 Water Distribution.

7.5.2.1 Variable Speed Drives. Select system equipment to deliver design flows so that maximum operational flexibility is maintained. Verify pump performance at minimum and maximum operating points.

7.5.2.2 Chilled Water Pumps. Provide a dedicated primary pump and condenser water pump for each chiller. Provide piping and valve configuration that allows each chiller to operate with any primary pump and with any condenser water pump. Provide back-up or standby pumps so that the total system capacity is available with any one pump out of service.

7.5.2.3 Hot Water Pumps. Provide back-up or standby pumps so that the total system capacity is available with any one pump out of service.

7.5.2.4 Piping systems. When terminal equipment loads are relatively equal in percentage of total load, design closed system piping using reverse return method.

7.5.2.5 Pressure and Temperature Taps. Provide pressure and temperature taps ("Pete's Plugs") on the inlets and outlets of all coils, pumps, chillers, heat exchangers, and other equipment.



7.5.2.6 Expansion and Compression Tanks. Utilize diaphragm type expansion tanks. Size the expansion tank according to the latest edition of the ASHRAE Systems Handbook. Indicate the acceptance volume, nominal dimensions, configuration (i.e. horizontal or vertical) and pre-charge air pressure.

7.5.2.7 Expansion Loops and Devices. Provide expansion loops and/or devices as required for proper piping protection. Detail and dimension loops and schedule joints indicating minimum total traverse and installed expansion traverse. Indicate guide spacing. Avoid the use of expansion joints where possible due to the high resultant thrust. Instead utilize geometry and ball joints where possible.

7.5.2.8 Cold Water Make-up. Provide for make-up to each water system. Provide pressure gauges up and downstream of the PRV. Provide bypass line with a globe valve for each PRV. Provide hose bibs in the make-up water line to cooling towers and evaporator condensers for wash down of equipment.

7.5.2.9 Drain Lines. Provide drain lines from air handling units, fan coil units, etc. Provide a water seal on drains as required. Terminate condensate drain lines in accordance with the IMC.

7.5.2.10 Backflow Preventers. Backflow preventers are required at all connections to the potable water system. Design shall comply with AFI 32-1066, Backflow Prevention Program. Note this document requires compliance with the backflow prevention portions of the Uniform Plumbing Code, not the International Plumbing Code. The State of Utah also has regulations regarding backflow prevention. Where conflicts exist the more stringent shall apply.

7.5.2.11 Chemical Feeders. Fill openings should be no higher than 1.2 meters (4 feet) above the finish floor for ease of filling.

7.5.2.12 Air Vents. Provide in locations as required in the IMC. Provide manual type vents where possible. Use of automatic air vents is discouraged and should be minimized. Pipe the drains from automatic vents away from concealed areas for visual inspection and to prevent damage to ceilings, etc. Provide manual shut-off valves or stop-cocks for automatic air vents.

7.5.2.13 Drain Valves. Provide manual drain valves at all low points and at each strainer in piping systems. Ball valves and strainers shall be a combination type assembly. Plumb drain valves to floor drains where possible. Where not possible, provide hose connection with hose cap.

7.5.2.14 Check Valves. Provide check valves to prevent backflow and at the discharge of most pumps. When used in drain lines, verify sufficient head to open flap to regain flow. Provide non-slam type on high head applications. Provide damping type on air compressor discharges.

7.5.2.15 Strainers. Strainers will have shut off valves installed on either side of the strainer to facilitate cleaning and to minimize loss of water.

7.5.2.16 Freeze Protection. Design pipe temperature maintenance systems (i.e. heat trace) to the lowest recorded temperature in UFC 3-400-02, Engineering Weather Data.

7.5.2.17 Underground Piping Systems. Underground piping systems for steam, condensate and chilled and hot water must be factory-prefabricated, pre-insulated, and direct bury type. The Underground Heat Distribution System manufacturer is the company responsible for the design and manufacture of the pre-engineered system. The manufacturer directs the installation of their system, and provides a representative on the job site.

7.5.2.18 Legionella Disease. Design waterside systems to avoid potential exposure to Legionella Disease.

7.5.3 Building Exhaust System.

Provide exhaust system for removal of heat, fumes, dust, and vapors in various spaces in accordance with ASHRAE. If natural ventilation is proposed, provide calculations to support its use as a reliable means of ventilation.

**7.5.3.1 Equipment Room Ventilation.** Provide mechanical and electrical equipment rooms with 10 air changes per hour or an exhaust rate to limit room temperature rise to 5.6 degrees C (10 degrees F) above the outdoor summer design dry bulb, whichever is greater. Ventilate equipment rooms with a thermostatically controlled exhaust fan and a weather tight inlet air louver or hood. To ensure that equipment rooms containing combustion burners for boilers, water heaters, or furnaces do not operate as negative pressure areas, utilize supply fans rather than exhaust fans for ventilation. For design heating temperatures less than 4.4 degrees C (40 degrees F), provide motor operated, normally closed dampers at air inlet and exhaust openings. Equipment rooms containing refrigeration equipment shall be ventilated in accordance with IMC and ASHRAE Standard 15.

**7.5.3.2 Exhaust/Intake Locations.** Provide adequate separation between outside air intakes and exhaust outlets, waste vents and boiler stacks. Consider prevailing winds and force protection requirements. Outside air intakes must be 3.0 m (10 ft.) minimum above ground elevation to satisfy Anti-Terrorism (AT) requirements.

**7.5.3.3 Roof Fans.** Roof exhaust fans should be avoided due to maintenance access restrictions and roof leak potential. If provided and where feasible, utilize direct drive fan motors with speed controllers to reduce maintenance requirements.

#### **7.5.4 Fire Station Diesel Exhaust.**

Provide an engineered fire apparatus exhaust removal system. Refer to Interim Technical Guide (ITG) # FY00-06 for additional information. The system should include an overhead sliding track mechanism to permit a flexible exhaust hose to travel with the fire apparatus into and out of the apparatus bays. The fire apparatus exhaust hose shall automatically disconnect from the vehicle as it exits the bay.

#### **7.5.5 Maintenance Bay Vehicle Exhaust.**

Provide an engineered vehicle exhaust removal system. The system shall include an overhead or under floor system. Overhead ductwork system shall be provided with a retractable flexible exhaust hose to travel from the vehicle exhaust into and out of the ductwork. The exhaust fan for all systems shall be specifically designed and manufactured for vehicle exhaust.

### **7.6 Kitchen HVAC Systems:**

Check project documentation to determine if air conditioning of kitchens is allowed. No air shall be returned from the kitchen to the HVAC system. Design dining facilities in accordance with UFC 4-722-01 *Design: Dining Facilities*, and so that air flows from dining areas to kitchen areas to provide make-up air for kitchen exhausts. Maximize the use of dining area make-up air to the kitchen as this will provide secondary cooling for the kitchen staff. If additional make-up air is required for kitchen exhausts, provide push-pull kitchen hoods with built-in heated make-up air supply. Design kitchen hoods in accordance with UFC 4-722-01. Kitchen hoods with built-in make-up air shall be of the horizontal face discharge type. "Short circuit" hoods are prohibited. Provide control interlocks for supply and exhaust fans to ensure that the HVAC system balance is maintained and that the proper direction of airflow is maintained during normal operations. Utilize evaporative coolers on kitchen supply air where appropriate. Analyze application carefully to insure increased humidity of the ventilation air does not negate any cooling affect. Provide fire suppression system for hoods in accordance with UFC 3-600-01, *Fire Protection Engineering*.

### 7.7 Industrial Ventilation:

7.7.1 General. Design industrial ventilation systems in accordance with the latest edition of Industrial Ventilation, A Manual of Recommended Practice, published by American Conference of Government Industrial Hygienists (ACGIH). Air Force projects shall comply with UFC 3-410-04N, Industrial Ventilation, and AFMAN 48-155 Occupational and Environmental Health Exposure Controls.

7.7.2 Design Guidelines. Research the process or operation before design starts (i.e. find out contaminants, toxicity, process temperature, etc.).

7.7.3 Provide hoods designed for effective capture of contaminants while minimizing air flow for energy conservation. Do not specify or provide a canopy hood unless process is nontoxic.

7.7.4 Specify the appropriate fan for the application. When selecting a fan, consider noise generation, material handled through the fan (e.g., corrosives, flammables, etc.), and future expansion or flexibility of the system.

7.7.5 Provide tempered make-up air for all ventilation systems. Ensure that make-up air does not cause turbulence at the exhaust hood. Interlock make-up air fan to exhaust fan. Do not recirculate exhaust air.

7.7.6 Provide an offset discharge stack, with drain, for exhaust systems. Do not utilize a "conical cap" exhaust stack. Provide at least 7.5 m (25 feet) between exhaust outlets and outside air inlets to prevent circulating contaminated exhaust air back into the building.

7.7.7 Provide an air cleaning device when required by state and federal regulations. Obtain clear guidance and direction from the Government Project Manager. Select air cleaning devices that will maximize contaminant removal and ease of maintenance while minimizing cost.

7.7.8 Provide air flow and static pressure calculations with each design following the methods in the latest edition of the ACGIH Ventilation Manual.

### 7.8 Indoor Air Quality Standards:

7.8.1 Ventilation Air. Supply ventilation air to satisfy ASHRAE 62, *Ventilation for Acceptable Indoor Air Quality*, for the number of occupants, or as required to meet the continuous exhaust air requirement (excludes intermittent exhaust) plus 15 percent for pressurization, whichever is larger. Ventilation air must be 110 to 120 percent of exhaust air for all spaces with direct mechanical exhaust. Systems will be equipped to separately dehumidify and precondition ventilation air if the latent cooling load at the 1 percent humidity ratio and corresponding coincident mean dry bulb design weather condition causes a system reheat requirement to maintain space conditions. Systems must provide the capability to condition ventilation air and maintain space relative humidity less than 60 percent over the full range of cooling loads.

7.8.2 Design Analysis. The HVAC design analysis for new facilities or renovation of existing facilities must include a psychrometric analysis documenting that the system meets design criteria. The analysis must provide calculations of system cooling load, energy/mass transfer through conditioning equipment and fans, and a system schematic indicating state point dry bulb and wet bulb temperatures (or humidity ratios) of outside air, mixed air, supply air, and return air flow streams. The cooling load for this analysis must be based on the load conditions identified in section 6.13 Design conditions.

7.8.3 Dormitories and Visitors Quarters.



7.8.3.1 Ventilation. In addition to meeting the requirements above, new facilities must employ separate, dedicated, central ventilation air constant-volume supply systems that supply dehumidified and tempered 100 percent outside air to all occupied spaces. The design intent of these systems is not to provide total space heating and cooling; systems must continuously condition and deliver ventilation air to each occupied space. The ventilation air must be tempered to within room comfort conditions. Ventilation air room supply conditions must not be at or below room dew point. Humidification of ventilation air during periods of low ambient humidity is not required. Facility central ventilation air supply systems must not be subject to intermediate season (no-heat/no-cool) shutdown. (Individual room heating/cooling equipment must have occupant control, but may be subject to intermediate season heating/cooling curtailment as directed by local command.) Systems must be designed to minimize the transmission of sound between quarters. The designer will perform a psychometric analysis documenting that the system is designed to maintain space humidity with ambient condition of ventilation air at the 1 percent humidity ratio design weather condition. The system must provide the capability to condition ventilation air and maintain space relative humidity less than 60 percent over the full range of cooling loads. Use only metal ductwork for the central ventilation systems. Duct insulation must be external, and duct board or internal duct liner is not allowed.

7.8.3.2 Exhaust Systems. A central ducted bathroom exhaust system will be used instead of individual exhaust fans for each space. The exhaust system must run continuously and be interlocked with the building supply air system. The exhaust duct for each space must have a manual volume damper accessible from the space for proper balancing. Install an exhaust grille constructed of corrosion-resistant material just outside each shower stall and bathtub. Exhaust systems must be designed to minimize the transmission of sound between quarters. Exhaust from moisture-producing equipment (i.e., clothes dryers) must be vented to the exterior.

7.8.3.3 Heat Recovery. Use heat recovery from exhaust air to reduce the energy consumption necessary to condition ventilation air where savings from heat recovery results in a life cycle cost payback for the heat recovery equipment.

7.8.4 Filtering. Filter ventilation air before it enters an air handler, heat recovery equipment, or preconditioning equipment. Use extended media filters with a Minimum

Efficiency Reporting Value (MERV) of 7 or greater, in accordance with ASHRAE 52.2-1999, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*.

7.8.5 System Selection Criteria. Do not utilize room fan coil units or packaged terminal units, such as individual through-wall heat pumps, for facilities such as office buildings and Bachelor Quarters or for any facility larger than 465 square meters (5000 square feet), unless conditioned make-up air is provided to each space through a central, continuously operating, dedicated make-up air system. Conditioned make-up air shall be ducted to each room or to the return side of each fan coil or terminal unit.

## 7.9 Controls and Instrumentation:

7.9.1 General Control System Operations.

7.9.1.1 The authorized Hill AFB method for Building Automation System (BAS) controls is through Direct-Digital Control (DDC) methodology. Installers of DDC equipment shall use government-provided information technology (IT) systems to program all field devices intended for use within the CE Industrial Control System (ICS). All programming shall be performed from the EMCS central office. If any programming or configuration requires the use of files external to the local ICS Information Systems (IS) network, those file shall be transferred through the use of government-provided media, secured through

EMCS and virus-scanned through an air gap system before use on the VLAN. No other externally-sourced hardware or software shall be used in the configuration of EMCS ICS Field Devices.

7.9.1.1.1 Two EMCS GUI front ends are currently utilized at Hill AFB; AscentCompass by Alerton, and InfoScan by Dorsett Technologies, Inc. DDC installers incorporating control systems into the ICS shall use the existing Alerton or Dorsett front ends. Predominant controls shall be the rule for control systems expansion, e.g. any control systems expansion into a building shall use the predominant control system already extant within that building, etc.

7.9.1.2 DDC installers shall provide the equipment, software, and services necessary to complete all installation and commissioning tasks for full control system operation. Installers shall coordinate all computer and network system access with EMCS to ensure all security protocols are followed. Installers shall provide only that equipment which is necessary to completely install a functional control system.

7.9.1.2.1 System and network security is to be maintained at all times. Unauthorized users will be disallowed from using the systems, and unauthorized equipment connected to the network will be removed. No unauthorized hardware or software is to be placed on the network at any time. Failure to adhere to these conditions may result in disciplinary action taken against companies or people, up to and including permanent bans from accessing the ICS network. Any attempt to circumvent or damage the integrity of the ICS network, either by willful negligence or deliberate malicious action, will be met with the same disciplinary actions.

7.9.1.3 All DDC field devices shall be connected to the CE ICS VLAN. The current nature of EMCS's Authority To Operate (ATO) forbids the direct connection of any communications device to the VLAN itself. All equipment that is to be monitored or controlled through EMCS is to be connected with the EMCS field devices acting as an interposing agent between that equipment and the VLAN.

7.9.1.3.1 Vendor equipment intended for direct control and monitoring through EMCS shall have configuration software provided to the government for installation onto trades service laptops. These laptops are the only authorized interface equipment for configuration and factory startup of the units. Coordination between vendor representatives and the appropriate maintenance trades involved will be facilitated through EMCS.

7.9.1.4 All DDC installer personnel directly working with parts, pieces, and equipment shall hold company-level certifications for the work they are performing. In lieu of such certifications, company-official documents stating that their personnel are considered qualified for the purposes of performing labor related to the utilized equipment will be accepted.

7.9.1.5 Generally speaking, EMCS prefers direct control of equipment over the use of packaged controllers.

7.9.1.5.1 The inconsistent manner in which communications interface hardware is constructed makes it difficult, if not impossible, for EMCS to control integrated packaged equipment units. While communications protocols such as BACNet, LONWorks, MODBUS, and others are well established, there are inconsistencies within the application of vendor communications hardware that creates time and cost burdens in order to make the various units function as desired.

7.9.1.5.2 Another issue that has been encountered in attempting to troubleshoot and maintain these units has been the unreliability of vendor support into these machines. Some vendors are unwilling to allow their programming and troubleshooting software to be utilized by untrained technicians, which can present a cost burden to maintenance entities, or they are unwilling to allow maintenance entities to perform the diagnostics themselves, requiring the use of approved vendor technicians which creates both

a time and a cost burden to the maintenance entities. These issues thus combined introduce critical security flaws into EMCS operations.

7.9.1.5.3 DDC Installer shall coordinate with EMCS and the Project Manager to ensure that the operability of the system can be maintained and/or alternatives prepared in the event of prolonged or permanent communications failure to these units, should they be provided as packaged control systems. The general contractor shall ensure that the communications interface provided by the mechanical equipment vendor can maintain fully compatible communications between the DDC field devices and equipment interface.

7.9.1.5.4 In the event that a packaged controller is used, it shall be used for monitor only. These interfaces shall not be used to control critical equipment.

7.9.1.5.4.1 All equipment with integral controllers shall be made to provide monitoring information through a standard communications interface. The approved communications protocols for these devices are MODBUS and BACNet.

7.9.1.5.4.2 Provide digital interfaces for these packaged controllers. Examples of devices where such digital interfaces may be available are chillers, variable frequency drives (VFDs), boilers, air compressors, and engineered distributed systems (variable refrigerant flow systems, water source heat pump terminal units, etc.).

7.9.1.5.4.3 After-market (non-factory) communications interfaces shall not be accepted.

7.9.1.5.4.4 Force Protection HVAC Shutdown is acceptable through interface unless there is any alternate hardware method for establishing this shutdown.

7.9.1.5.4.5 The use of gateways shall be coordinated prior to install. Unless otherwise approved, they shall not be used.

7.9.1.5.4.5.1 An example of approved gateway device hardware is the Mitsubishi M-Net to BACNet Gateway (BAC-HD150).

### 7.9.2 Control System Guided User Interface (GUI) Programs

7.9.2.1 BAS controls systems shall have the ability to represent the complete scope of the systems programming from within a single front-end GUI program, designed for the purpose of configuring the controls within that system. All data and functionality related to the control system, from informational displays to database population to control sequence programming, shall be performed from within this self-contained GUI.

7.9.2.1.1 Both control systems currently in operation on Hill AFB use database structures to run their systems. It shall be implied that any operations or maintenance on these systems directly accesses and manipulates these database structures as part of their normal operations.

7.9.2.1.2 No other software system may be used to program or alter the database outside of this single GUI, with the sole exception of advanced vendor tools meant to expedite and enhance the deployment or maintenance of systems for use by the government.

7.9.2.1.2.1 In the event such vendor tools are used to directly access the control system database, their functionality must be traceable through the GUI and subject to the same access guidelines as established by this document. If these vendor tools must be used in a manner that fails to access the control system database, but can affect other portions of the control system, namely, field device hardware, hosting machine, or other such equipment, the vendor shall provide training and accountability to the EMCS supervisor and other operators at the discretion of the supervisor. All such vendor tools are to be approved before actual use.

7.9.2.2 BAS Control Systems shall have the capability to represent the area of effect for their respective control influence. This capability shall include configurable information displays, report generation, and data tables of operational and maintenance information.

7.9.2.2.1 Informational displays shall include a labeled mechanical floor plan, complete with room numbers and equipment locations relative to the end user (e.g. VAV locations and the areas they service, air handling units mounted on the roof of multi-level buildings but servicing lower-level locations, cabinet and unit heaters, exhaust fans, etc.).

7.9.2.2.1.1 A cardinal direction indicator (compass rose, north arrow, etc.) shall be displayed on each floorplan display.

7.9.2.2.1.2 Informational displays shall be navigable through a drill-down approach method. Drill-down topology assumes a highest-level, minimum-volume representation of data for the building controls, with subsequent displays showing more involved and detailed information relevant to the equipment and areas shown. This assumes a tree-like structure where users will navigate from the highest-level, most general informational view possible, then navigating through the system until reaching the specific piece of information they wish to access. The first display, or main hub, shall be the general Hill AFB map, where link to different areas of the base shall be accessible following this approach.

7.9.2.2.1.3 Informational displays shall include links to all of the major equipment pieces, as well as attached display tables for similar-functioning or downstream-facing equipment, grouped together in a logically relevant manner. Links shall be provided to view the controls sequencing and programming embedded within each individual field device. Any in-house reporting and statistical information provided by the control system shall have a link dedicated to that information provided on the relevant informational display and shall be organized in a neat and tidy manner.

7.9.2.2.1.4 Links to the immediately preceding control display shall be provided on all informational displays, with links to a main “master” display provided relative to the information being displayed, e.g. links provided to main floorplan for individual equipment displays, links to main air handling unit for zone/space air discharge units.

7.9.2.2.1.5 Links to the sequence of operations text shall be included in any display tree relevant to the equipment being serviced. This text shall include the sequence of operations as well as the intended functionality of the equipment under controls. A copy of the sequence of operations in text form shall be provided to EMCS for future changes and adaptations.

7.9.2.3 BAS Control Systems shall have the capability to directly configure and manipulate the operation of all programming control sequences within field devices attached to the control system central controller.

7.9.2.3.1 Controls sequencing and programming shall be accomplished internally to the GUI. GUI shall have access to controls sequencing and programming hosted on the live devices. GUI shall be capable of manipulating and updating programs on live devices. No other external program or medium for configuration shall be allowed for use outside the control system GUI.

7.9.2.4 BAS Control Systems shall have the capability to directly alter and manipulate the data records of each unique control point residing on the control system central controller.

7.9.2.4.1 All control system components or points corresponding to real-world equipment shall be fully configurable from within the GUI. Any other system components internal to the operation of the control system for facilitation of BAS controls shall also be fully configurable from within the GUI.

7.9.2.5 Control Systems shall have the ability to generate reports and view live trending data from equipment.

7.9.2.5.1 All control system points corresponding to real-world equipment shall have data recorded into perpetuity. Data shall be time-stamped and recorded for retrieval at later dates. Data is to be set to record as deemed necessary by EMCS to fulfill mission objectives.

7.9.2.5.2 All control system points shall be capable of live trending data in order to optimize controls programs and sequencing. This shall be accomplished with any number of points necessary to the task of optimizing control programs and is to be done in a real-time or near-real-time manner.

7.9.2.5.3 All control system points shall have the ability to be included into relevant reports detailing point configuration, field device involvement, preventive maintenance needs, categorical filters, starts / stops / runtimes, and shall have the capability to allow user-defined reports as mission needs dictate.

7.9.2.6 BAS Control Systems shall have the ability to scale use and access to allow for differing needs of authorized personnel.

7.9.2.6.1 Access to the control system shall be accomplished solely for the purpose of one's duty. To that purpose, the following table shall be used to determine system access. Assume higher levels of access will include lower levels of access within the scope of their authority.

HILL AFB EMCS BAS CONTROL SYSTEM ACCESS LEVEL GUIDE					
<u>Access Level</u>	<u>Access Function</u>	<u>Intended User</u>	<u>Editable Properties</u>	<u>Viewable Properties</u>	<u>Modification Permissions</u>
1	System Administration	System Administrators and DDC Installers	User Accounts	User Accounts	All Configurable Control System Options
2	System Operations	System / EMCS Operators, Trained Advanced Programmers	Advanced Programming Features	System Alarm Control	All Configurable Equipment Entries
3	Basic Programming	Trained Programmers	Basic programming Features, Logs		All Programming Options
4	General Point Access	Trained Users	All Database Points, Schedules	System Alarm Access	All Non-programming options
5	Manual Equipment Control Access	Trained Technicians requiring elevated access to equipment controls		Direct Equipment Control Functionality	Direct Equipment Control Options
6	Advanced Setpoint Control	Technical Users who require limited access to user control points (e.g. Building Managers, Engineers, etc.)		Advanced Control Functions, Schedules	Indirect Equipment Control Options
7	Basic Setpoint Control	Non-Technical Users who need limited access to start and stop		Basic Control Functions	Indirect Equipment

		equipment and / or change basic setpoints (Painters, Occupants, HMI Operators, etc.)			Control Options
8	View-Only	All other authorized users		Database Point Details	

### 7.9.3 Control System Standard Practices

7.9.3.1 BAS Control Systems shall incorporate standardized equipment sets as part of their operation. All parts, pieces, equipment, programming, sequencing, and conventions shall be consistent and uniform in all areas of installation, commissioning, and formal acceptance.

7.9.3.1.1 Changes in convention shall be the sole responsibility of EMCS to adapt and implement in existing control systems. Future conventions will be discussed with DDC Installers at the time of implementation and should be implemented as quickly as possible within the scope of current projects.

7.9.3.1.1.1 For the purposes of accountability, all convention changes shall be directly applied only to those projects currently under construction. Formally accepted systems still under warranty shall be exempted from this requirement, as the acceptance at the time was directly granted using current standards.

7.9.3.2 BAS Control Systems shall contain standardized equipment for the purposes of mechanical equipment control and operation.

7.9.3.2.1 All field hardware devices shall have labels attached physically on or nearby their relative position within the control system panel. This label is to include a unique identifier matching that device with the corresponding entry within the control system database.

7.9.3.2.1.1 Included in this labeling requirement shall be the necessity to tag all field devices within the communications chain to include their uplink unit and their position in the chain.

7.9.3.2.1.2 Control Systems Panels shall be labeled such that their contents are clearly visible, the equipment serviced by the controls indicated, and panel location relative to the building itself affixed permanently to the panel.

7.9.3.2.2 All precision laboratories require the transmission of humidity, temperature, and dew point, where the output is a psychometric calculation output as an analog signal. The transmitter must have a digital display and be programmable. The probes attached to the transmitter must be accurate to <.8% rh and <.1 KOhm at 74°F.

7.9.3.2.3 All piping of 1.25" or greater in size requiring temperature measurement shall have thermowells installed to facilitate those measurements. Also include thermowells on tanks and pressure vessels to accomplish measurement tasks.

7.9.3.2.4 All variable air volume systems shall have duct pressure sensors for use in modulating the fan speed to control airflow.

7.9.3.2.5 All relief air systems shall have duct pressure sensors to monitor and control relief air movement.

7.9.3.3 BAS Control Systems shall contain standardized sequencing for the purposes of mechanical equipment control and operation.



7.9.3.3.1 Where multiple terminal units or zones are present, space temperature setpoints shall be linked to building setpoints to allow needed changes to take simultaneous effect.

7.9.3.3.2 All equipment designed for 100% backup shall be controlled with a lead/lag control scheme. Rotate lead devices on a regular schedule. Run times shall not be balanced.

7.9.3.3.3 All controlled equipment with feedback shall provide alarms when the feedback state fails to match the control state. Such alarms shall be triggered after a suitable time delay.

7.9.3.3.4 The use of occupancy sensors and/or demand-based ventilation shall be used where occupancy schedules are not sufficient and intermittent occupancy is expected to be common.

7.9.3.3.5 Load-based reset setpoints shall be provided for chilled-water and hot-water generating devices. Outdoor temperature resets are acceptable where no suitable broad indicator of load is available or non-monitored systems are also supplied from the same source.

7.9.3.3.6 Provide only such alarms as necessary to alert users to failures needing attention. Any condition which requires no user response should remain as a condition for the purposes of diagnostics and repair. No acknowledgement or action from the EMCS operator should be required.

7.9.3.3.6.1 All alarms are to be tested to ensure that conditions and notifications are properly configured. This requirement for testing shall be included in the BAS commissioning process.

7.9.3.4 BAS Control Systems shall contain standardized programming for the purposes of mechanical equipment control and operation.

7.9.3.4.1 A simple means for both temporary and permanent override of each controlled output shall be provided.

7.9.3.4.2 All refrigerant-based, comfort-cooling systems shall be incorporated into the EMCS load-shedding program to reduce summer electrical peak loads.

7.9.3.5 BAS Control Systems shall contain standardized naming conventions to facilitate ease of maintenance for the software resources of the system.

7.9.3.5.1 Each database point shall follow a naming convention that clearly conveys the function of the equipment to which it is attached.

7.9.3.5.2 Each database point shall leave space for unique identifiers that will tag the equipment to match tracking numbers with the various maintenance authorities on Hill AFB.

7.9.3.5.2.1 Software tagging shall include identifiers on the main field device references that include general location of equipment. Regardless of the tagging information included, clear descriptions of locations and instructions for access to these devices shall be placed on the equipment screen for which these field devices act as communications uplink devices.

7.9.3.6 BAS Control Systems shall contain standardized historical data storage to facilitate ease of maintenance by providing equipment operation trends.

7.9.3.6.1 Log all I/O points and provide reporting tools to view and export data.

7.9.3.6.2 All binary state transitions shall be logged where possible. Log all other states at 5-minute intervals.

7.9.3.6.3 All analog points shall be logged using Change of Value (COV) limits set according to the equipment being monitored. These values should catch real-time operating data in a manner that is indicative of the equipment under observation. Capture all meaningful sensor data or log at 5-minute intervals if no sufficient change is detected.

7.9.3.6.4 On a case-by-case basis as determined by EMCS and the end-user, controlled motor data shall be included. Calculate and log total starts, stops, and run-times, all in daily, monthly, and yearly data intervals.

7.9.3.6.4.1 To this reporting requirement, add a performance requirement that an adjustable, user-enabled reset alarm for 'maintenance due' that shall be triggered on run-time. An adjustable alarm for current run-time shall also be provided.

7.9.3.6.5 On a case-by-case basis as determined by EMCS and the end-user, flow sensors shall have calculated total flow by hour, daily, and monthly intervals in addition to maximum, minimum, and average values.

7.9.3.6.6 On a case-by-case basis as determined by EMCS and the end-user, space temperatures shall have calculated values by hour, daily, and monthly intervals in addition to maximum, minimum, and average values.

### 7.9.4 Control System Standard Construction

7.9.4.1 BAS Control Systems shall incorporate uniform 'looks and feels' to match similar construction throughout Hill AFB. Where possible, new control system panels are to be constructed and installed, labeled as belonging to the BAS, and secured from unauthorized access.

7.9.4.1.1 In situation where a new control systems panel may not be feasible, existing control panels may be used, provided the contractor can provide the following:

7.9.4.1.1.1 100% compatibility must be maintained. Ingoing BAS systems shall match exactly, with no intermediary devices between field hardware and the BAS field device. The same is also true of the ICS network; no intermediary devices may rest between field devices and the ICS network hardware.

7.9.4.2 BAS Control Systems shall incorporate uniformity within their own construction. All parts and pieces of the BAS shall match, with wiring conventions and construction principles remaining consistent throughout the scope of construction and execution.

7.9.4.2.1 The contractor shall provide control field devices and sensors rated for their environment.

7.9.4.2.2 Use bullet-type or contact sensors when monitoring small pipes up to 1.25". Insulate these devices to provide unimpeded temperature readings.

7.9.4.2.2.1 Do not provide pipe temperature sensors on small, non-critical loads such as VAV reheat water lines, fan coils, and unit heaters.

7.9.4.2.3 Use modulating damper actuators where applicable. On/Off damper actuators are acceptable for constant volume applications only.

7.9.4.2.4 Use DP/Pitot array or impeller-type (i.e. low-cost, reasonable accuracy) flow sensors.

7.9.4.2.4.1 For critical flow sensing, or where turbulence is likely, use high accuracy (+/-1% or better) ultrasonic or thermal dispersion array type sensors.

7.9.4.3 BAS Control Systems shall incorporate sound judgement and practical common sense within the staging and installation of these systems. All Hill AFB safety regulations must be followed at all times, and all installers are to be regularly trained on appropriate conduct while on Hill AFB.

7.9.4.3.1 Whenever possible, keep control components outside of hazardous-rated areas.

7.9.4.3.2 Building-monitored outdoor air temperature sensors are preferred to averaging points. Where such devices are unable to be installed on a north-facing side of the building, due either to cost or safety concerns, averaging points tied into the EMCS system may be used.



7.9.4.3.2.1 Internal duct sensors are expressly for use only when required for direct sequencing of the control system.

7.9.4.3.3 Whenever relief air is to be used in a system, it shall be designed as part of the system requiring it, e.g. 100% outside air, full economizer, etc. No design requiring outside air shall be accepted without a design or re-design of the main outside airflow system.

7.9.4.3.4 Provide relative humidity sensors only where there is a humidification or dehumidification sequence that requires their use. Provide these sensors in all applicable ducts and spaces

7.9.4.3.4.1 High duct humidity control shall be included in any sequencing that is developed for these systems.

7.9.4.3.4.2 Air-proving switches shall be provided for ducted humidifiers.

7.9.4.3.5 Do not provide user setpoint adjustment control for comfort heating and cooling applications. Comfort heating and cooling setpoints are established at 65-70°F (typically 68°F) for heating and 75-80°F (Typically 76°F) for cooling. Alternate setpoints must be justified by mission requirements.

7.9.4.3.5.1 Lab spaces, cleanrooms, specialized storage spaces, paint / depaint / chemical booths, production spaces, and lodging and service areas are exempt from this requirement.

7.9.4.3.6 Only provide feedback for damper and control valve actuators where there is a critical need and no other sensor can be used to provide adequate proof of correct equipment operation, e.g. return water temperature for the return side of a coil, mixed or supply air temperature in an air handler, etc.).

7.9.4.3.7 Only provide flow sensors where there is a defined need in the sequence of operation. Ensure that upstream / downstream distances are sufficient for use with these sensors.

7.9.4.3.7.1 Use OEM provided flow sensors whenever possible.

7.9.4.3.8 Radiant burner control relays and amp sensors must be accessible from ground level. To accomplish this, the electrical contractor shall route individual conductors through a DDC-Installer-provided enclosure to each burner.

7.9.4.3.9 Provide systems that utilize an automatic fill/drain valve control sequence with an outdoor thermostat and interlock to prevent freeze-ups for those valves.

7.9.4.3.9.1 Utilize only full-port, line-sized, 2-way ball valves for these valves.

7.9.4.3.9.2 Ensure any fill lines are also drained as part of this control scheme. This may involve additional valves.

7.9.4.3.9.3 Heat tape is to be used with status monitoring where outdoor lines remain active during cold weather. Alarm such through EMCS.

7.9.4.3.10 Heat Tape, if used, is to be monitored through EMCS. If controlled locally, a thermostat allowing for operation to be cut off when ambient temperature indicates use is not required shall be installed. Moisture sensor shall be installed to detect the presence of snow and ice. Amp sensors are to be provided to show operation state. Alarms are to be configured to notify EMCS of operational state, to include a call to run as well as a failure to run.

7.9.4.3.10.1 In general, heat tape is to be used only when no other option can be utilized to keep lines from freezing. Avoid heat tape for all other applications, unless cleared by EMCS, as no other alternatives may be available.

7.9.4.4 BAS Control Systems shall pay particular attention to detail for the application of safety interlocks into mechanical devices. These safety interlocks deal with force protection and equipment maintenance. Such interlocks are to be specially commissioned with EMCS prior to acceptance for proper administration and handling.

7.9.4.4.1 Provide safety interlocks where failure conditions may cause equipment damage. Software shutdown and override commands are acceptable where failure conditions are insufficient to cause damage to equipment or personnel.

7.9.4.4.2 Fire shutdown and other life safety controls are disallowed from implementation by the DDC installer. Such will typically be installed by the life safety control system installer.

7.9.4.4.3 Freeze low limit thermostats are required for all water coils on 100% economizer and outside air units.

7.9.4.4.4 Control all Force Protection Shutdown dampers using the same control power or line voltage source as the unit fan. This is required for all fractional horsepower exhaust and ventilation fans as well.

7.9.4.4.5 Force Protection Shutdown shall be specifically prohibited where such action would create a life hazard.

7.9.4.4.5.1 Examples of this situation include paint booths, scrubbers, vent hoods, etc.

#### 7.9.5 Control System Required Points

7.9.5.1 All design of mechanical systems shall include a set of minimum points for the controls system to monitor and control. The I/O listed shall represent the minimum required control points for the listed type of equipment setup. Provide appropriate adaptations as necessary to compensate for systems design. For example, if a system has no heating capability, do not provide heating controls. Provide additional points as needed for stability to the required control sequences.

7.9.5.1.1 DDC shall control, either directly or indirectly, all equipment unless stated otherwise, such as with manual user control.

7.9.5.1.2 Designers may select additional points based on a clear need in the sequence of operation, construction codes, etc.

7.9.5.1.3 Where multiple independent systems exist with similar parts and pieces, monitor and control each independently of the other. Combine sensors where applicable and reasonably sound.

7.9.5.1.4 Analog sensors are to be used whenever possible

7.9.5.2 Use these points / point packages for use in the design and implementation of control systems.

7.9.5.2.1 General / All-Purpose

7.9.5.2.1.1 Force Protection HVAC Shutdown

7.9.5.2.1.2 Glycol Makeup Tank Level Alarm

7.9.5.2.1.3 All Gas, Water, and Steam Meters

7.9.5.2.1.4 Digital Monitoring Interface with all power meters

7.9.5.2.1.5 Digital Monitoring Interface with all VFDs over 10 HP

7.9.5.2.1.6 Dedicated interface for all VFD / Soft Start / Motor Protectors for all motors over 100 HP

7.9.5.2.2 Airside HVAC (10+ Tons or 20,000+ CFM with Evap / no cooling)

- 7.9.5.2.2.1 BACNet-Communicating Thermostats Optional
- 7.9.5.2.2.2 Digital Interface, for monitoring only
- 7.9.5.2.2.3 Supply Air Temperature
- 7.9.5.2.2.4 Return Air Temperature
- 7.9.5.2.2.5 Mixed Air Temperature
- 7.9.5.2.2.6 Space Temperature
- 7.9.5.2.2.7 Analog Filter Differential Pressure
- 7.9.5.2.2.8 Analog Fan Amps
  - 7.9.5.2.2.8.1 Do not use amp switches for feedback
- 7.9.5.2.2.9 Differential Pressure Fan Proving Switch
  - 7.9.5.2.2.9.1 Do not use these devices for feedback to propeller-type, exhaust, or other low DP fans
- 7.9.5.2.2.10 Analog Valve and Damper Actuators
- 7.9.5.2.2.11 Valve and Damper Feedback
- 7.9.5.2.2.12 Supply Water Temperature
- 7.9.5.2.2.13 Return Water Temperature
- 7.9.5.2.2.14 DX Suction Line Temperature
- 7.9.5.2.2.15 Analog Compressor Amps
  - 7.9.5.2.2.15.1 Only use this if the compressor is over 10 HP
- 7.9.5.2.2.16 Outdoor Unit Total Amps
- 7.9.5.2.3 Airside HVAC (<10 Tons or <20,000 CFM with Evap / No Cooling)
  - 7.9.5.2.3.1 Do not use BACNet-Communicating Thermostats
  - 7.9.5.2.3.2 Digital Interface, for monitoring only
  - 7.9.5.2.3.3 Supply Air Temperature
  - 7.9.5.2.3.4 Return Air Temperature
  - 7.9.5.2.3.5 Mixed Air Temperature
  - 7.9.5.2.3.6 Space Temperature
  - 7.9.5.2.3.7 Analog Filter Differential Pressure
  - 7.9.5.2.3.8 Analog Fan Amps, Amp Switch, or Differential Pressure Fan Proving Switch.
    - 7.9.5.2.3.8.1 Pick one
  - 7.9.5.2.3.9 DX Suction Line Temperature
  - 7.9.5.2.3.10 Outdoor Unit Total Amps
- 7.9.5.2.4 Airside HVAC (<3Tons or (2,000 CFM with Evap / No Cooling)
  - 7.9.5.2.4.1 Space Temperature

- 7.9.5.2.4.2 Supply Air Temperature
- 7.9.5.2.4.3 Fan Control
- 7.9.5.2.4.4 BACNet-Communicating Thermostat Optional
- 7.9.5.2.5 Unit Heater / Radiant Heater
  - 7.9.5.2.5.1 Space Temperature
  - 7.9.5.2.5.2 Analog Amps or Amp Switch
    - 7.9.5.2.5.2.1 Pick one
- 7.9.5.2.6 Mini Split DX Systems
  - 7.9.5.2.6.1 Space Temperature
  - 7.9.5.2.6.2 Do not provide other sensors for these systems
- 7.9.5.2.7 VAV Terminal Unit
  - 7.9.5.2.7.1 Dedicated Purpose Controller
  - 7.9.5.2.7.2 Space Temperature
  - 7.9.5.2.7.3 Analog Damper Actuator
  - 7.9.5.2.7.4 Analog Reheat Valve Actuator
  - 7.9.5.2.7.5 Supply Air Flow
  - 7.9.5.2.7.6 Supply Air Temperature
  - 7.9.5.2.7.7 Analog Filter Differential Pressure
    - 7.9.5.2.7.7.1 For Fan-Powered Boxes
- 7.9.5.2.8 VRF, VRV, or Water-Source Heat Pump Manufactured Systems
  - 7.9.5.2.8.1 Digital Interface Only
    - 7.9.5.2.8.1.1 One interface for all centrally-controlled components is required.
  - 7.9.5.2.8.2 Do not provide other sensors for these systems.
- 7.9.5.2.9 Chiller (10+ Tons)
  - 7.9.5.2.9.1 Digital Interface
  - 7.9.5.2.9.2 Outdoor Air Temperature
  - 7.9.5.2.9.3 Supply Water Temperature
  - 7.9.5.2.9.4 Return Water Temperature
  - 7.9.5.2.9.5 Analog Compressor Amps
  - 7.9.5.2.9.6 Outdoor Unit Total Amps
  - 7.9.5.2.9.7 Analog Pump Amps
  - 7.9.5.2.9.8 Pump Differential Pressure Proving Switch
  - 7.9.5.2.9.9 Control and Feedback for Any Valves

- 7.9.5.2.9.10 Wire any flow switches to the chiller
- 7.9.5.2.10 Chiller (<10 Tons)
  - 7.9.5.2.10.1 Supply Water Temperature
  - 7.9.5.2.10.2 Analog Pump Amps or Pump Differential Pressure Proving Switch
    - 7.9.5.2.10.2.1 Pick One
  - 7.9.5.2.10.3 Outdoor Unit Total Amps
- 7.9.5.2.11 Cooling Tower
  - 7.9.5.2.11.1 Analog Fan Amps
  - 7.9.5.2.11.2 Supply Water Temperature
  - 7.9.5.2.11.3 Return Water Temperature
  - 7.9.5.2.11.4 Evap Sump TDS
  - 7.9.5.2.11.5 Evap Automatic Fill/Drain
  - 7.9.5.2.11.6 Evap Sump Full Float or Analog Sump Level
- 7.9.5.2.12 Boiler or Steam / Hot Water Heat Exchanger (1,000+ kBTU/h)
  - 7.9.5.2.12.1 Supply Water Temperature
  - 7.9.5.2.12.2 Outdoor Air Temperature
  - 7.9.5.2.12.3 Supply Water Temperature
  - 7.9.5.2.12.4 Return Water Temperature
  - 7.9.5.2.12.5 Analog Burner Fan Amps
  - 7.9.5.2.12.6 Control and Feedback for Any Valves
  - 7.9.5.2.12.7 Steam Pressure
- 7.9.5.2.13 Boiler or Steam / Hot Water Heat Exchanger (<1,000) kBTU/h
  - 7.9.5.2.13.1 Supply Water Temperature
  - 7.9.5.2.13.2 Return Water Temperature
  - 7.9.5.2.13.3 Analog Pump Amps or Pump Differential Pressure Switch
    - 7.9.5.2.13.3.1 Pick One
- 7.9.5.2.14 Domestic Hot Water
  - 7.9.5.2.14.1 Monitor Only
  - 7.9.5.2.14.2 Analog Pump Amps
  - 7.9.5.2.14.3 Supply Water Temperature
- 7.9.5.2.15 Industrial Air Compressors (100+HP)
  - 7.9.5.2.15.1 Digital Interface
    - 7.9.5.2.15.1.1 Control via interface is permitted

### 7.9.5.2.15.2 Alarm Status

### 7.9.5.2.15.3 Supply Air Pressure Setpoint

### 7.9.5.2.15.4 Supply Air Pressure

7.9.5.2.15.4.1 Critical input point. Do not provide via interface.

### 7.9.6 Documentation

7.9.6.1 BAS Control System Installers shall provide documentation regarding the construction of their product into Hill AFB.

7.9.6.1.1 All parts, pieces, and equipment installed shall be documented and included in any construction drawings generated.

7.9.6.1.2 In addition to copies generated for maintenance authorities, physical copies of the control system shall be generated for EMCS. Electronic copies of these files may be included if desired.

7.9.6.1.2.1 Physical copies of the control system field device current programming shall be included in every control systems panel, to include panel electrical layouts, field device wiring, bills of material, and sequences of operation. Provide the most current, up-to-date, red-line construction drawings for this purpose.

7.9.6.1.3 Provide copies, or documentation links, to all vendor equipment directly tied to the control system. Include all parts and pieces relevant to the control system in this requirement as well.

7.9.6.1.4 Follow the Base Facility Design Standard instructions found in section 15 and 16 for the generation of these drawings, with the following exceptions:

7.9.6.1.4.1 Electronic copies, if provided to EMCS, may be in the PDF file format.

## 7.10 Systems Testing and Balancing:

7.10.1 Balancing Valves and Cocks. Provide calibrated balancing valves for hydronic balance. The designer shall specify the size of the balancing valves required in each application, cognizant of the required differential pressure requirements in the pipe systems; do not assume line size valves as appropriate for the application. A balancing device is required in coil bypasses only when coil drops are in excess of 6 kPa (2 feet w.g.).

7.10.2 Flow Control Balancing Valves. Provide flow control balancing valves in the discharges of all closed circuit pumps and at all hydronic terminals. For pipe sizes larger than 80 mm (3 inches), a flow orifice combined with a butterfly valve shall be specified. Install all flow control balancing valves in accordance with the manufacturer's recommendations regarding the minimum straight lengths of pipe up and downstream of the device. Designers shall select the proper size flow control-balancing valve for each application to ensure the devices are not oversized; valves shall be selected using the median flow rating indicated in the manufacturer's published performance data. Oversized flow control balancing valves yield inaccurate flow readings.

7.10.3 Balancing Dampers. Provide manual volume dampers for all main and branch ducts; these should include all supply, return, and exhaust ducts. Do not use splitter dampers or air extractors for air balancing; neither are endorsed by SMACNA for balancing applications. Provide opposed blade manual balancing damper for outside air. Indicate opposed blade manual balancing dampers for both the main supply and return duct and the main relief duct on all return air fans; dampers shall be in close proximity to the automatic return and relief dampers.

7.10.4 Duct Leakage and Testing. All new duct systems, except ducts under 1 inch static pressure, shall be leak tested, unless the requirement is waived by the Government.

7.10.5 Variable Speed Drives. Variable speed drives on pumps or fans shall not be manually adjusted to achieve system balance. Balance systems to deliver design flows with variable speed drives operating at between 55 and 60 Hz so that maximum operational flexibility is maintained. Replace or adjust fan drive sheaves and throttle pump discharges to achieve system balance. Consider trimming pump impellers on larger systems.

### 7.11 Other HVAC Systems and Equipment:

7.11.1 Antiterrorism. Design all inhabited buildings to meet the requirements of UFC 4-010-01, DoD *Minimum Antiterrorism Standards for Buildings*.

7.11.2 Conflicts. Avoid conflicts with other disciplines and building features. Most common are: electric lights and diffusers; electric duplex outlets and fin radiation; rain leaders or soil stacks and ductwork; bond beams or joists and ducts, etc.

7.11.3 Clearances and Equipment Service Space. Ensure that all equipment will fit allotted space with manufacturers' recommendations for service and maintenance space adopted. Indicate on drawings filter and tube or coil pull areas for all major equipment, including chillers, boilers, converters, etc. Verify adequate door dimensions to permit passage of equipment into mechanical spaces.

7.11.3.1 Electrical Rooms. No pipes (pressure or gravity) shall be installed within, or pass through, electrical or communication rooms.

7.11.4 Seismic. Seismic Restraint of all equipment shall comply with UFC 3-310-04 *Seismic Design for Buildings*. Provide details to structural engineer for support verification and sizing.

### 7.12 Design Analysis and Design Documentation:

7.12.1 Field Investigation. Conduct detailed field investigation and interview the appropriate field personnel. Do not rely solely on the as-built drawings.

7.12.2 Energy Studies. The design A&E shall satisfy the energy conservation requirements in accordance with UFC 3-400-01, *Energy Conservation*.

7.12.3 Energy Standard. All new facilities shall exceed ASHRAE/IESNA Standard 90.1 by 30% if cost effective. Note that compliance with this Standard imposes Architectural, Mechanical, and Electrical requirements on the design of the facility. In addition, all renovation projects where the programmed amount exceeds the building replacement value by 25% or more, shall also meet the 30% better requirement.

7.12.3.1 Energy Analysis and Compliance Form. Provide Energy Analysis and Compliance Forms. The number and type of alternatives to be analyzed shall be based on project information provided in the scope of work. The Energy Analysis Forms shall be submitted with the proposed alternatives and zones and shall be accompanied with the best available floor plan clearly depicting the zones. Upon submission to the Government by the design agent at the project concept stage, the Government will review the recommendations and return the form to the agent marked: "Approved", "Approved as Noted", or "Disapproved". Contact the Government Project Manager prior to submitting Forms if you have any questions.



7.12.3.2 Solar Analysis. When required by the Scope of Work, the economic feasibility of incorporating an active solar domestic water preheating system will be evaluated by the Government with building information provided by the A&E via submission of the Solar Analysis Form (Form S-1) at the project concept stage.

7.12.4 Computerized Energy Analysis. After receiving the approved forms from the Government, the A&E shall perform a computerized energy analysis and a life cycle cost analysis in accordance with the Scope of Work and UFC 3-400-01 Energy Conservation.

7.12.5 Units: List equipment sizes in Watts or Btu/h. The symbol k may be used for thousands as in kBtu/h or kWatts.

**Do not use MBTU or MBTUH.**

**The symbol “M” in this use is ill defined and easily confused.**

### 7.13 Design Conditions:

7.13.1 Outside Design Temperatures. Utilize the Unified Facility Criteria document, UFC 3-400-2, Design Engineering Weather Data, and utilize the Design Criteria Data available from the referenced Air Force Combat Climatology Center website. For Design/Build projects, the data may be defined in the RFP documents.

#### 7.13.1.1 Cooling Systems:

7.13.1.1.1 Mission-Critical Facilities, where equipment failure due to high heat would be unacceptable: For design utilize the “0.4% Occurrence” value for outside air Dry Bulb Temperature (T) Design Value (F) and the “Mean Coincident (Average) Values” Wet Bulb Temperature (F) for the Design Cooling Day.

7.13.1.1.2 Humid Area Facilities, Specialized De-humidification Systems, and 100% Outside Air Systems: For design, utilize the “1% Occurrence” value of outside air Dry Bulb Temperature (T) Design Value (F) and the “Mean Coincident (Average) Values” Wet Bulb Temperature (F) for the Design Cooling Day. Also, design for Maximum Humidity conditions, using the “1.0% Occurrence” value of outside air Humidity Ratio (HR) Design Value (gr/lb) and the “Mean Coincident (Average) Values” Dry Bulb Temperature (F).

7.13.1.1.3 Other Typical Facilities and Systems: For design, utilize the “1% Occurrence” value of outside air Dry Bulb Temperature (T) Design Value (F) and the “Mean Coincident (Average) Values” Wet Bulb Temperature (F) for the Design Cooling Day.

7.13.1.1.4 Cooling Towers or Evaporative Cooling Equipment: For sizing, utilize the “Median of Extreme Highs” value for outside air Wet Bulb Temperature (T) Design Value (F)” and the “Mean Coincident (Average) Values” Dry Bulb Temperature (T) for the Design Cooling Day.

7.13.1.2 Heating Indoor Design Conditions. Space Design conditions shall be 21.1 Cdb (70 Fdb) & a minimum of 30% RH, during the Design Heating Day outside air conditions. At all other than design day, occupied times, maintain the space within the Winter conditions shown in ASHRAE Handbook of Fundamentals 2001, Chapter 8, Figure 5, but not more than 21.1 Cdb (70 Fdb).

7.13.1.2.1 Heating Equipment: For design, utilize the “99% Occurrence” value for outside air “Dry Bulb Temperature (T)” “Design Value (øF).”

7.13.1.2.2 Heating Inside Design Conditions for Laboratories, Shops, Warehouses, etc.: Space Design conditions shall be 18.3 Cdb (65 Fdb) during the Design Heating Day outside air conditions for areas with

moderate activity employment, 15.5 Cdb (60 Fdb) for areas with heavy activity employment, and 10 Cdb (50 Fdb) for storage areas.

7.13.1.3 Cooling Indoor Design Conditions. Space Design conditions shall be 24.4 Cdb (76 Fdb) & 50% RH, during the Design Cooling Day outside air conditions. At all other than design day, occupied times, maintain the space within the Summer conditions shown in the latest edition of ASHRAE Handbook of Fundamentals, but not less than 24.4 Cdb (76 Fdb). 100% Outside Air systems shall operate continuously in Humid Areas, to prevent mold growth.

Process cooling conditions are determined by the respective process requirements.

Note: Spaces authorized comfort cooling shall be designed for inside temperatures no lower than 24.4 Cdb (76 Fdb). During unoccupied hours, cooling systems shall be secured where appropriate.

### 7.14 Basis of Design:

7.14.1 Mechanical Basis of Design. Address the following:

7.14.1.1 Design Criteria. Identify the governing codes and criteria, including federal and military handbooks, being utilized for the design. Include the titles and the date of the latest edition or publication. References to codes and criteria should be made in the narratives of the “Basis of Design”.

7.14.1.2 Design Conditions. Provide a tabulation of the design indoor and outdoor heating and cooling conditions for all occupied and unoccupied areas.

7.14.1.3 Base Utilities. Describe the source of thermal energy that will be used (i.e. extension of central high pressure steam, hot water, natural gas, or stand-alone heat source with the type of fuel utilized). Where more than one source of thermal energy is considered economically feasible, or where a facility is deemed appropriate for study as defined under the heading entitled “Energy Computations”, include a computerized Life Cycle Cost Analysis to justify the selection.

7.14.1.4 Heating System. Provide a description of the heating system proposed, including an explanation of why this system is preferred over others. Indicate locations of major components of the system. Resistance electricity and L.P. gas are not allowed for space comfort heating, except with approval of the mechanical branch head.

7.14.1.5 Ventilation System. State what type of system is to be used and provide a brief description of the ventilation system proposed. Indicate the outside air ventilation rates in cfm/person (L/s/person) for various room types. The prescribed rates must be in compliance with the latest edition of ASHRAE 62. Describe the operation of the ventilation system in summer and winter modes. Indicate the number of outside air changes per hour in various areas, the type of infiltration, and whether OSHA requirements are applicable.

7.14.1.6 Cooling System. Provide a description of the cooling system proposed including an explanation of why this system is preferred over others. Indicate locations of major components of the system. Identify special humidification or dehumidification requirements. Indicate ASHRAE Standard filter efficiencies and any other special filtration requirements.

7.14.1.7 HVAC Control System. Briefly describe the HVAC control system type and its functions. If applicable, indicate a requirement to tie into an existing Base-wide EMCS.

7.14.1.8 Sustainable Design. Briefly describe all energy and water conservation features, systems, and components used in the project and the expected energy savings. Describe all features being utilized for lead credits and include the completed LEED forms.

7.14.1.9 Energy Conservation. Provide mechanical system based on lowest life cycle cost. Provide completed and signed compliance forms provided in attachment 1. Provide all documentation required by ASHRAE 90.1 Appendix G for all new construction. Provide any documentation to support basic compliance with appropriate sections of this Standard for renovation and repair projects including a narrative describing the method of compliance, descriptions of building systems and components to be incorporated. Provide a signed statement by a registered mechanical engineer indicating compliance with ASHRAE Standard 90.1.

### 7.15 Mechanical Calculations:

7.15.1 The following calculations are required as a minimum:

7.15.1.1 “U” Factor Calculations. Utilize the latest edition of ASHRAE Standard 90.1 to determine the minimum U factors. Calculate U factors for all composite wall and roof systems using the latest edition of ASHRAE Fundamentals. Include cross sections drawings of all wall and roof systems to supplement the calculations. For Wood frame structures, U factors shall be calculated using the Parallel Path Method. For steel frame structures the U factors shall be calculated using the Modified Zone Method. Alternatively the average result of the Series Method, and Parallel Path Method may be used.

7.15.1.2 Building Exhaust Calculations. Calculate exhaust requirements for removal of heat, fumes, dust, and vapors in various spaces in accordance with ASHRAE. Provide a building exhaust summary.

7.15.1.3 Outside Air Requirements Calculations. Calculate the outside air ventilation requirements as prescribed by the latest edition of ASHRAE Standard 62. Calculations must consider the factors of “Multiple Spaces”, “Ventilation Effectiveness” and “Intermittent or Variable Occupancy” as specified in ASHRAE Standard 62. Provide a summary showing compliance with the ventilation requirements.

7.15.1.4 Building Air Balance Calculations. Provide air balance calculations addressing the relationship between supply, return, outside air, and exhaust air quantities and indicating pressurization. Special requirements for space pressurization shall be reflected and referenced in the air balance calculations.

7.15.1.5 Heating and Cooling Load Calculations. Use of professionally recognized, nationally used computerized load calculating program is required. Load calculations are required for each room or zone by the ASHRAE method indicated in the latest edition of the Fundamentals Handbook. Copies of input and output data are required. Psychometric calculations shall be illustrated on psychometric charts and submitted with the 100% submittal. Computer disks may also be requested (see 100% submittal requirements).

7.15.1.6 Duct Pressure Drop Calculations. Provide pressure drop calculations for all supply, return, outside and exhaust air systems. All Variable Air Volume (VAV) supply duct systems shall be sized by the static regain method. Equal friction method shall be used for VAV return ducts. The static regain, equal velocity or equal friction methods may be performed on non-VAV supply duct systems.

7.15.1.7 Hydronic System Pressure Drop Calculations. Provide pressure drop calculations for all supply and return piping systems.

7.15.1.8 Pipe Expansion Calculations. Provide pipe stress calculations for all low-pressure 103 kPa (15 psi) steam, condensate and hot water piping systems where pipe diameters exceed 100 mm (4 inches) and/or the length exceeds 30 m (100 linear feet) without a directional change. Provide pipe stress calculations for all medium and high-pressure steam and high temperature hot water systems.

7.15.1.9 Equipment Sizing Calculations. Provide equipment sizing calculations and psychometric calculations and charts, if applicable, to justify the selection of equipment, including the following:

- a. Terminal equipment including VAV boxes, fan coil units, etc.
- b. Pumps.
- c. Control valves and dampers.
- d. Meters and metering devices.
- e. Fans.
- f. Air Handling Units.
- g. Chillers.
- h. Boilers.
- i. Closed Circuit Coolers and Cooling Towers.

7.15.1.10 Heat Gain Calculations. Perform heat gain calculations for duct systems using 90% insulation efficiency. Include heat gain from chilled water pumps on the chilled water system. Size terminal cooling coils with the effects of pump heat gain considered.

7.15.1.11 Duct Leakage Calculations. Provide for high pressure systems 746 Pascals or greater (3 inches of water column or greater). Calculate the expectant duct leakage based on the designer's requirements for the duct, seal, and leakage classes for each duct system using the latest edition of the SMACNA *HVAC Air Duct Leakage Test Manual*.

### 7.16 Mechanical Drawings:

Drawings shall be sufficiently complete to indicate all aspects of installation. Where alternate methods or systems are intended, drawings must detail both alternatives. Judgment should be exercised to avoid overly congested drawings.

7.16.1 Seismic. Show all pertinent seismic detailing on the contract drawings.

7.16.2 Plumbing Drawings

7.16.3 Legend. Provide legends to clarify all symbols and abbreviations used on the plumbing drawings.

7.16.4 Enlarged Plans. Enlarged plans shall be drawn at no less than  $\frac{1}{2}'' = 1'-0''$ .

7.16.5 Riser Diagrams. Provide separate waste and water riser diagrams for all fixture groupings. All riser diagrams shall be drawn 3-dimensional (flat, 2-dimensional risers are unacceptable) and shall account for all pipe directional changes indicated on the floor plans.

7.16.6 Plumbing Fixture Schedule. Provide a fixture schedule utilizing fixture designations coordinated with the contract specifications.

7.16.7 Mechanical Drawings

7.16.7.1 Demolition. "Demolition" plans must be separate and distinct from "new work" plans.

7.16.7.2 Orientation. Provide north arrows on all building and site plans. The orientation of mechanical drawings shall be arranged with the north arrow toward the top of the plotted sheets, unless overriding circumstances dictate otherwise. The orientation of all partial building or site plans shall be identical to that of the larger plan from which it is derived or referenced. Consistency in drawing orientation shall be maintained with all disciplines.

7.16.7.3 Legend. Provide legends to clarify all symbols and abbreviations used on the mechanical drawings.

7.16.7.4 Design Conditions. Provide a schedule indicating indoor and outdoor design temperatures for each room type.

7.16.7.5 Floor Plans. Exercise judgment to avoid overly congested drawings. When drawing congestion is likely, ductwork and piping should not be shown on the same plan.

7.16.7.6 Sections and Elevations. Provide as required to supplement plan views.

7.16.7.7 Enlarged Plans. Mechanical rooms should be drawn at no less than  $\frac{1}{4}" = 1'-0"$ . Congested mechanical rooms shall be drawn at no less than  $\frac{1}{2}" = 1'-0"$ . Mechanical room plans should be supplemented by at least one section; at least two sections for more complex, congested applications.

7.16.7.8 Schematic Diagrams. Provide a 3-dimensional isometric diagram representing the mechanical room piping or a 2-dimensional diagram indicating the entire system.

7.16.7.9 Kitchen Hood Diagram. Provide a detailed air balance diagram on the drawings for every kitchen/dining facility design to show compliance with the ventilation requirements. Indicate required capture velocities and capture distances for all hoods on the drawings. Provide notes and contractor instructions on plans indicating that fan airflows shown for hoods are approximate and requiring the contractor to balance the system to achieve the capture velocities indicated. The scheduled fan and motor size shall allow for adjustment of the airflow.

7.16.7.10 Details. Details shall be edited to reflect the configurations and construction materials shown on the plans.

7.16.7.11 Pipe Identification. Indicate the flow direction of pipe on the drawings. Show slope direction and rate of slope on all piping systems. As required by code some piping systems required pressure identification.

7.16.7.12 Duct Construction Classifications. Indicate duct static pressure, seal and leakage classifications on the drawings in accordance with SMACNA-HVAC Air Duct Leakage Test Manual.

7.16.7.13 Guides for Piping. Show pipe guide locations on all aboveground anchored piping.

7.16.7.14 Pipe Anchors. Show anchor locations on plans. Provide anchor detail(s).

7.16.7.15 Lining. Indicate acoustical duct lining where required on the drawings. Drawings shall indicate the inside clear dimensions of ducts with acoustical duct lining.

7.16.7.16 Door Louvers. Show location or coordinate with architectural drawings.

7.16.7.17 Roof Fans. Details of roof exhaust fans shall include a requirement for airtight seals between the fan frame and the wood nailer of the roof curb. The details shall require the duct of ducted exhaust fans to extend up through the fan curb to a flanged and sealed termination at the top of the curb.

7.16.7.18 Equipment Supports. Show hanger rods and structural supports for all ceiling or roof-mounted air handling units, heating/ventilating units, fan coil units, exhaust or supply fans, expansion tanks, etc. in drawing details.

7.16.7.19 Pressure Gauges. Indicate pressure gauge ranges; system operating pressures should be midrange on the graduated scale.

7.16.7.20 Cold Water Make-up. Detail all accessories, to include pressure reducing valves (PRV), relief valves, and backflow preventers. Show pressure reducing and relief valve pressure settings.

7.16.7.21 Air Vents. Show location of automatic and manual air vents required in piping systems.

7.16.7.22 Drain Lines. Show drain lines from air handling units, fan coil units, etc.

7.16.7.23 Fouling Factors. Indicate fouling factors for all water-to-air and water-to-water heat exchangers (i.e. coils, converters, chillers, etc.). Indicate in the appropriate equipment schedule. Fouling factors shall be accompanied with their appropriate English or SI units.

7.16.7.24 Equipment Schedules. The HVAC equipment actually installed on a project may be different from that used as your basis of design. Therefore, mechanical equipment schedules shall reflect actual required equipment capacities as calculated, not capacities provided by manufacturers' catalog data. This helps ensure that the installed equipment is optimally sized for the application.

7.16.7.25 Motor Starters. Indicate motor starter NEMA sizes in the mechanical equipment schedules.

7.16.7.26 Control Valves. Indicate flow rates, minimum Cv or maximum pressure drop, nominal valve size, service (i.e. steam, hot water, etc.), configuration (i.e. 2-way or 3-way), and action (i.e. modulating or 2-position). Use a "Control Valve Schedule".

7.16.7.27 Metric Valve Coefficient. The metric version of the valve coefficient, Kv, is calculated in cubic meters per second at 1 kPa pressure drop. Do not use Cv, the English version, on a metric project.

7.16.7.28 Balance Valves. Contract drawings shall specify the valve size and flow for each application. When an existing system is modified, provide all information required for re-balancing in the construction documents. Detail installation of all flow control balancing valves.

7.16.7.29 Balance Dampers. All dampers and their intended locations shall be clearly delineated on the floor plans.

7.16.7.30 Control Diagrams. Provide for all HVAC systems. Show controller functions, such as normally open (NO), normally closed (NC), common (C), etc. Indicate all set points.

7.16.7.31 Thermostats. Show thermostat locations on the plans. Identify heating, cooling, heating/cooling and ventilation thermostats. Indicate thermometer temperature ranges; system operating temperature should be midrange on the graduated scale.

7.16.7.32 Humidistats. Show locations on drawings, when required.

7.16.7.33 Controls. Show system control schematics and a detailed written sequence of controls on the drawings for each mechanical system. Describe all controlled equipment operating modes, sequence of events, set points, and alarms. For Direct Digital Control (DDC) systems, include an input/output points list and a system architecture schematic. UFC-3-400-10N Table 3-1 indicates a minimum points list per system (to be used as applicable).

7.16.7.34 Ductwork Testing. Indicate those HVAC duct systems to be leak tested on the contract drawings. Specify the test type and test pressure for each duct system (supply air, return air, exhaust air, and outside air ductwork) subject to testing. See "Duct Construction Classifications".

7.16.7.35 Site Work. Show the type and routing of the heat source conveyance system on the drawings. Exterior above and below grade steam and condensate distribution and below grade chilled and hot water distribution plans shall be accompanied by profile drawings. Profile drawings shall clearly depict all other utilities in the proximity of the new work.



## 8. PLUMBING:

### 8.1 Plumbing Design General:

Comply with the most current version of UFC 3-420-01, *Plumbing Systems*. The International Plumbing Code and other Federal, State, and local regulations pertaining to safe drinking water laws also apply if and when they are the more stringent law. The most restrictive requirement shall govern. Acceptable materials for service connections shall be ductile iron, type K copper, and High Density Polyethylene (HDPE) pipe. Acceptable material for interior piping is type L copper. A Watts, Wilkins DC, or equal type back-flow preventer (Reduced Pressure Principal Assembly) shall be installed on all systems where cross contamination is possible, and before any industrial process plumbing. A back-flow preventer is not required for non-potable water systems. Water lines shall be installed inside the buildings thermal envelope. Water piping and drinking fountains shall not be located or installed outdoors and the piping shall not be mounted to outside walls. This is to prevent the water from freezing in the pipes or inside the drinking fountains. Do not block any outside air vent openings.

Grey water recycling systems are not desired and any request for a grey water system shall be submitted to the 75th CEG Project Manager for review and approval consideration, prior to including in a proposal or a project.

Natural gas fired hot water heaters are subject to Utah State Construction and Fire Codes Act, Subsection 15A-6-102 Nitrogen Oxide emission limits for natural gas fired water heaters. Source [https://le.utah.gov/xcode/Title15A/C15A\\_1800010118000101.pdf](https://le.utah.gov/xcode/Title15A/C15A_1800010118000101.pdf).

### 8.2 Fixtures:

Determine Plumbing fixture requirements by the number of occupants per UFC 3-420-01. For new facility construction, Siphon Jet type urinals shall be installed and all urinals shall have plumbing clean outs with a minimal allowable clean out diameter pipe of 1-1/2". All urinals shall be of the manual flush meter type. Do not install automatic metered flush type urinals. Lavatories/sinks shall be equipped with manual type water faucets and they shall have a minimum of 1.2 GPM water flow rate aerators. Do not install automatic metered type water faucets. FAR Subpart 23.2, *Energy and Water Efficiency and Renewable Energy*, requires that agencies acquire/purchase water-saving products designated by FEMP as being among the highest 25 percent for equivalent products as directed by E.P.A. 2005 and E.O. 13423. The FEMP Website provides performance requirements for all federal purchases:

[http://www1.eere.energy.gov/femp/procurement/eeep\\_faucets.html](http://www1.eere.energy.gov/femp/procurement/eeep_faucets.html).

### 8.3 Roof Drains:

Horizontal roof drains shall be kept at a minimum to prevent freezing. Roof drains shall not be less than 3 inches diameter.

### 8.4 Cross Connections:

8.4.1 Cross connections (any connection or arrangement of piping between two otherwise separate piping systems, one of which contains potable water and the other non-potable water or industrial fluids of questionable safety) may cause non-potable fluid to enter the potable water system by either backflow, backpressure, or back-siphonage, and shall not be allowed without implementation of an adequate



approved method of protection by means of internal plumbing controls. The internal plumbing control method involves the installation of the appropriate device at the point of EACH potential cross connection. This requires the use of air gaps, vacuum breakers, etc., at each plumbing fixture, equipment, tank, sink, etc., to protect the potable water system from backflow.

8.4.2 Water injecting trap primers shall not be installed on Hill AFB. Experience has shown the tendency for these devices to be improperly installed. This creates an unchecked cross-connection with potential water contamination. If a sewer gas problem exists, installation of a waterless trap device with a self-coiled internal rubber hose mechanism (equal to a Trap Guard) is allowed to seal off sewer gas but permits water to drain.

### 8.5 Clearance:

Provide sufficient space and access, 24 inches where possible, for maintenance of fixtures, valves, and piping.

### 8.6 Water Treatment:

If a current water analysis is not available, obtain a sample of the raw water and have the sample tested. Provide test results in project specifications. Design water treatment systems for boilers in accordance with UFC 3-430-02FA *Central Steam Boiler Plants*. Provide appropriate water treatment for steam generators, humidifiers, and cooling towers for prevention of excessive scale, corrosion and biological formations. In most cases water treatment is required for closed loop systems as well like hot water and chilled water distribution systems.

### 8.7 Plumbing Basis of Design:

Address the following:

8.7.1 Design Criteria. Identify the governing codes and criteria, including federal and military handbooks, utilized for the design. Include the titles and the date of the latest edition or publication. References to codes and criteria should be made in the narratives of the Basis of Design.

8.7.2 Estimated Water Demand. Estimate the water demand in L/s (gpm) based on the type and number of fixtures required for each building.

8.7.3 Water Pressure. Indicate the minimum and maximum water pressure in kPa (psi) at each building. Indicate if booster pumping will be required.

8.7.4 Domestic Hot Water. Indicate the type, size and design water temperature of the domestic water heater and the distribution system. Indicate the extent of domestic hot water recirculation within the building. Install a water softener system for the water supply going to a steam heat exchanger. If a steam heat exchanger is used to provide hot water for a building, install a water softener system upstream of the water supply entering the heat exchanger. Do not connect the building water supply directly to a heat exchanger without providing a water softener system upstream of the connection point. If shown economically feasible by life cycle cost analysis, state whether heat recovery will be utilized.

8.7.5 Special Mechanical Systems. Provide a description of special mechanical systems such as compressed air, hydraulic, nitrogen, lubrication oil, etc.

8.7.6 Backflow Prevention. Identify the systems and fixtures requiring backflow preventers and install a Watts, Wilkins, or equal type backflow prevention device (reduced pressure principal assembly).

### **8.8 Plumbing Calculations**

Plumbing system design shall comply with the requirements of UFC 3-420-01, Plumbing Systems. The following calculations are required:

8.8.1 Domestic Hot Water Heating. Calculate the hot water storage and demand requirements of the facility. Indicate the basis for the calculations including the incoming and storage water temperatures, the facility type, fixture types, fixture quantities, and the demand and storage factors.

8.8.2 Domestic Water Pressure Calculations. Determine the sufficiency of the water pressure available at the building to meet the required minimum fixture outlet pressure. Provide detailed pressure loss calculations including losses attributed to meters, fittings, pipe, backflow preventers, and pipe risers.

8.8.3 Domestic Hot Water Recirculation. Reference the plumbing code by which the domestic hot water recirculation rate is calculated. Calculate the recirculation rate and the recirculation pump head.

## **9. FIRE PROTECTION:**

### **9.1 Fire Suppression Systems:**

9.1.1 All sprinkler systems shall be hydraulically designed. Pipe sizes, sprinkler locations, and data for hydraulic calculations shall be shown on the drawings.

9.1.2 The design shall be in compliance with the most current versions of Unified Facilities Criteria UFC 3-600-01, Fire Protection Engineering for Facilities, UFC 4-211-01 Aircraft Maintenance Hangers, Fire Protection Engineering Criteria - Electronic Equipment Installations, AF ETL 01-18; Backflow Prevention Program; and National Fire Protection Association (NFPA 13) Installation of Sprinkler Systems.

9.1.3 The project specifications shall include a copy of the appropriate UFGS. The UFGS needs to be edited and modified, by the designer, to meet the specific local requirements found in this design guide.

9.1.4 All new and reconfigured dry/wet fire suppression systems connected to potable water supplies and using water only as a fire suppressant shall have an approved double check valve backflow preventer and test station. All new dry/wet and reconfigured fire suppression systems connected to potable water supplies and using water with antifreeze or other chemical as a fire suppressant shall have an approved reduced pressure principle backflow preventer and test station. Installation of a backflow preventer in a vertical position shall be approved by the State of Utah. Install valves and piping as needed to allow the backflow preventer to be forward flow tested (piping sized for sprinkler system demand flow) on a periodic basis. Piping shall be directed to the building exterior in an area where pavement exists to minimize erosion during flow testing. Piping at the exterior wall shall terminate with a threaded hose connection(s) and a threaded cap that has labeling to identify the port function as flow testing of the backflow assembly. All backflow assemblies that are install over 6 feet from floor or ground level shall require a floor mounted platform for testing and maintenance.

9.1.5 All aboveground sprinkler piping shall be Schedule 40 black steel pipe or Type "K" copper tubing. All trim on alarm valves will be Type "K" copper, brass or galvanized piping per manufactures recommendations. All underground piping connected to portable water systems shall be AWWA approved for domestic water supply and installed to the first connection of the alarm valve or backflow device.

9.1.6 All fire suppression control valves including post indicator valves (PIV's) require mechanical tamper protection (lock). Control valves associated with the riser shall be butterfly type with integral tamper switch; OS & Y type valves are not to be used at the riser. Fire suppression risers located in a suppression room having direct exterior access shall not have a PIV unless required by code or if a single control valve that is capable of shutting the entire buildings fire suppression systems is installed and located within the fire suppression room specifically required by code. Riser rooms that do not have a direct access exterior door, but are located adjacent to an exterior wall, shall use a wall mounted indicating valve. When wall mount PIV's are installed on fire risers, they must be located under the alarm valve or backflow assembly and a minimum of 28" from the floor or ground level. PIVs shall only be used when the other options are not available.

9.1.7 Each riser shall have a separate flow switch and tampered control valve for each to include Shotgun type risers and for each floor level, located below the main drain on each riser.

9.1.8 Water-filled piping shall be protected from freezing.

9.1.8.1 Risers shall be located in a heated space that will not drop below 40 degrees F.

9.1.8.2 All other wet pipe fire sprinkler piping shall be located either in 1) a heated space that will not drop below 40 degrees F or 2) an insulated attic where calculations performed by a professional engineer verify that the piping will not freeze.

9.1.9 HALON and CO2 type fire suppression systems shall not be used.

9.1.10 Location of inspector test valves, as required by NFPA 13, shall be coordinated with the architectural requirements of the building including but not limited to concealed access boxes of adequate size with cover plates painted to match surroundings and located in a manner compatible with the architectural and furniture configuration of the building. Code required signage shall be provided. Additional piping and finishes on both the exterior and interior may be required. Details shall be coordinated through the shop drawing process. For wet-type sprinkler systems the inspector test valve shall be downstream of the flow switch and located on a case-by-case basis.

9.1.11 Fire Extinguishers shall only be installed when required by Air Force Instruction, National Fire Protection Association (NFPA) 101 Life Safety Code; Unified Facilities Criteria (UFC) or Engineering Technical Letter (ETL). If required, NFPA STD 10 will be enforced for spacing, height and location. Semi-recessed fire extinguisher cabinets are required for all required fire extinguishers except in Industrial, storage occupancies and were authorized by the fire department.

9.1.12 High Expansion Foam Generator systems require inspection or maintenance to be performed IAW UFC 3-601-02. Systems shall be equipped with platforms, walkways, or access ways as applicable to facilitate this requirement.

## **9.2 Water Supply:**

9.2.1 Install a 5 inch Storz type adaptor and cap on the 4-1/2 inch steamer port of every new fire hydrant installed. Bollards are required to protect hydrants from vehicle and aircraft traffic.

9.2.2 Buried fire protection water service lines shall be buried at least 5 1/2-feet below grade

## **9.3 Fire Alarm Systems:**

9.3.1 Fire Alarm system designs shall be in compliance with UFC 3-600-01, UFC 4-021-01, UFC 4-211-01, NFPA 72, NFPA 101, ADA and this Base Facility Design Standard. The system designer shall be a certified NICET level III/IV. New fire alarm systems with less than 25 devices and appliances shall include an analysis per UFC 3-600-01, Para 1-4. A Fire Protection Engineer shall provide an analysis per UFC 3-600-01 Para 1-5 and shall sign and stamp construction/shop drawings when the new system includes 25 or more devices and appliances. Determination of required acoustically distinguishable spaces (ADS) shall be determined by this analysis and shall be approved by the fire department. Designs shall be submitted to the CE project manager for review by the 75<sup>th</sup> CES Electric/Alarm Shop and fire department prior to construction notice to proceed. The installation and programming shall be accomplished by a factory certified fire alarm system installer and be at least a NICET level II or higher.

9.3.2 Advance notice must be provided to the Base Fire Department prior to any work on active Fire Alarm systems. Notice shall also be provided at the end of each workday and must include information for any off normal conditions.

9.3.3 New Fire Alarm systems shall be analog/addressable only. Where a mass notification system is required, fire alarm notification must be via voice evacuation and shall be installed per UFC 4-021-01. This system must include, but not limited to, Local Operation Console(s), Annunciator(s), devices and appliances as required by current standards previously listed. All voice systems shall include all standard

HAFB emergency messages. Local Operation Consoles shall be installed per NFPA 72 (section 24.5) and UFC 4-021-01 (section 4-5.2). Remote annunciators shall be installed per UFC 3-600-01 (section 9-18.4.4) All systems require a separate external input for a low level audio source and contact closure to allow for wide area notification.

9.3.4 Fire Alarm Control Panels, ancillary control panels and Monaco Transceivers shall only be installed in clean, dry, temperature controlled environments such as communications rooms or electrical rooms. Under no circumstances will they be installed in mechanical rooms with a chance of exposure to steam, condensation, etc. Panel, LOC and remote annunciator locations shall be coordinated with 75<sup>th</sup> CES Electric/Alarm Shop during site walk.

The following Control Panels and equipment are approved for installation at Hill AFB and UTTR:

Fire Control Instruments (FCI) Model E3

Siemens Model Cerberus Pro Modular

Edwards Systems Technologies (EST) Model III

Notifier Model NFS2-640

Det-tronics Eagle Quantum Premier high expansion foam releasing panel

Det-tronics X3301 triple IR flame detector

Monaco BT2-8NB Transceiver

VESDA air aspirating system

9.3.5 The radio fire alarm transceiver shall be a Monaco BT2-8NB (16 position) compatible with the existing Monaco D-21 Radio Fire Alarm Monitoring Systems. A Monaco BT2-8NB (32 position) transceiver may be required on larger facilities. The transceivers shall operate on a frequency of 141.000 MHz for HAFB and Little mountain and at 141.3625 MHz for UTTR. The contractor shall provide and install a new antenna system per manufactures recommendations. Antenna location shall be approved by the 75<sup>th</sup> CES Electric/Alarm Shop. Request for Unit number and Position descriptors shall be routed thru 75<sup>th</sup> CES Electric/Alarm Shop for approval. The installed system shall maintain reliable communication to the appropriate central receiving station for a minimum of 7 days before being accepted. At Hill AFB the Monaco D-21 central receiving stations are located in Bldg. 408 & Bldg. 1151. At UTTR the central receiving station is located in Bldg. 40030.

9.3.6 The contractor shall provide all new equipment, including panels, enclosures, boxes, wiring, conduit, devices and all installation, programming and testing. Class B pathways for addressable detection, notification, and signaling line circuits meet all minimum/necessary DOD performance requirements. All Fire Alarm conductors must be installed in conduit (EMT minimum) and shall be properly identified by a continuous red coating or properly spaced labeling. System wiring shall be consistent with manufacturer instructions and sized per National Electrical Codes. Stranded conductors are preferred. Exposed fire alarm cable (rope) shall not be used.

9.3.7 Magnetic door holders and addressable relays shall be installed in areas where a fire separation is required and must be controlled by the Fire System. Install relays and system controls for Monaco interface, maintenance bypass switches for Fan Shutdown, NAC, and SLC circuits. All devices and ancillary panels shall be monitored separately.

9.3.8 An addressable smoke detector is required above the FACP and any externally powered equipment associated with the system. Carbon monoxide detection must be provided in facilities with

combustible fuel burning equipment and is required to be “centrally located on every habitable level and in every HVAC zone of the building” per NFPA 720 and UFC 3-600-01.

9.3.9 The contractor shall provide a lockable disconnecting means along with surge protection on all separate power circuits at or within a reasonable distance of the equipment that it services and must meet the following minimum specifications: Approved for 20A circuit breakers, SCCR rating of 10kAIC which complies with NEC Article 285.6, NEMA 4X weatherproof enclosure, UL1449 4th Edition Type 1 SPD, Diagnostic LED. The preferred Surge Protection model is Ditek DTK-120HW. Dedicated circuits are required and shall not be shared with other general purpose equipment. The circuit disconnecting means shall have a red marking.

9.3.10 Audio and Visual Notification must be provided throughout the entire facility as required by NFPA 101, UFC 3-600-01 and 4-021-01. The preferred method of installation is ceiling mount only.

9.3.11 The contractor shall install separate water flow, tamper and PIV monitor modules. New PIV, water flow switches and electronic water bells are required for all suppression systems. All modules shall be readily accessible, protected from water incursion and routed in a water tight flexible raceway. If an electronic bell is installed in lieu of a water gong, all power circuits shall be monitored and a lockable disconnecting means shall be installed on circuits over 50 volts.

9.3.12 Install addressable duct detectors with sample tubes, visual indicator lights and fan shutdowns “ONLY” were required per current Base, NFPA 72 and NFPA 90A guidelines. Duct Detectors must be latching, report a supervisory alarm, shut down fans to prevent smoke spread and shall be resettable via the fire alarm panel. Remote test switches and visual indicator lights shall be installed if detectors are not readily accessible.

9.3.13 Ultrasensitive Smoke Detection (air aspirating system) shall be installed in areas where very early warning detection has been suggested (typically IT rooms) per NFPA 75 and 76 and must be monitored by the FACP. This system shall be consistent with and integrated into the current systems main control panel and shall have readily accessible test ports for all zones. The preferred system is VESDA, manufactured by Xtralis.

9.3.14 Newly installed systems shall be 100% tested per all NFPA, UFC, and manufactures recommendations. A copy of the NFPA Record of Completion and HAFB inspection checklist shall be signed by the factory certified fire alarm contractor. Both forms shall be completed and placed in the FACP document cabinet. The old system, if installed, shall be removed only after these requirements are met and then final acceptance test can be scheduled.

9.3.15 Provide digital and hard copies of panel programming, system installation red line drawings and O&M manuals to the Project Manager and 75<sup>th</sup> CES Electric/Alarm Shop upon final inspection. A hard copy set of drawings shall be placed at the FACP. An electronic copy of panel programming, AutoCAD drawings and O&M manuals shall be provided in an approved documentation cabinet. Provide an additional 10% of devices used during project (minimum of 1 each type) for spare equipment.

9.3.16 All work must be done in a “neat and workmanlike manner” as per NFPA 70 and 72. All equipment must be clean and in new condition at the conclusion of the project.

9.3.17 All holes, penetrations, or damage to any surface that occurred during construction must be repaired to match existing building decor. Any fire wall penetrations must be sealed with fire caulk.



## 10. NATURAL GAS AND LPG

### 10.1 General Gas Pipe Design:

Natural Gas distribution systems design and installation shall comply with 49 CFR Part 192 and NFPA 54 National Fuel Gas Code. Distribution pressures at HAFB will vary with location but are typically 35 psi. All new risers must not need corrosion protection (anode less) and shall have an isolation valve with dielectric protection. All subgrade piping containing natural gas shall be medium density polyethylene (see ASTM D2513) with only electro fusion, socket weld or butt fusion type fittings. Mechanical fittings are prohibited.

### 10.2 Line Location:

Gas distribution system lines shall never be installed or allowed to remain under buildings. They shall not be laid in the same trench with other utilities to preclude the possibility of leaking gas following along or collecting in other pipe lines or conduits. For the same reason, gas lines will be placed above other utilities whenever they cross, if practicable. Gas lines shall not be laid under paved streets or in other locations subject to heavy traffic whenever practicably avoidable. Whenever it is necessary to locate gas lines in such locations, the lines must be protected by suitable casing and by burying to a depth to provide at least 2 feet of cover over the top of the pipe. Sufficient clearance must be maintained between plastic mains and steam, hot water, power lines, and other sources of heat, to avoid temperatures in excess of 60 degrees C (140 degrees F) for thermoplastics or 66 degrees C (150 degrees F) for thermo-setting epoxy resin pipe. Natural gas lines must be bedded and buried in sand, buried deep enough to provide no less than 30 inches of cover and shall have an insulated 10 Gage wire (tracer wire) placed 6 inches above the pipe and a warning tape 12 inches above that or no more than 24 inches above the pipe. Caution: The tracer wire, when in contact with pipe, may burn through pipe in a lighting event. The tracer wire must not contact the polyethylene pipe!

### 10.3 Inspection:

All new pipe must be inspected before concealment.

### 10.4 Gas Meters:

New meter sets shall not be positioned under roof valleys or other places where excessive amounts of water, snow or ice can drip on it from the roof. New meter sets shall be protected from water, ice and snow.

Automatic Meter Reading (AMR) compatible gas meters and pressure regulators shall be installed for all new and renovated facilities or when gas service to existing facilities is installed, replaced, or upgraded and connected to the EMCS system. Meters shall be Dresser Roots rotary style meter or equivalent and meet the requirements of UFGS 33 51 13.00 30, Natural Gas Metering. To facilitate maintainability, all new meter set piping must have a meter bypass loop with a plug valve and plug valves on each side of the meter. All new meter set piping shall also include two test tees, one on each side of the pressure regulator, and a wye strainer with 100 count mesh stainless steel screen prior to the meter and regulator.

Gas meters shall be installed for each building with pressure regulators. Gas meters serving dormitories or other residential type structures shall have earthquake sensitive automatic shut off valves or excess gas flow shut off valves. Earthquake valves shall comply with the American Society of Civil Engineers



Standard ASCE 25-97, Earthquake Actuated Automatic Gas Shutoff Devices. The manifold assembly must be designed with supports and appropriate barriers to isolate the valve. Recommended manufacturer is KOSO. In addition to the pressure regulating devices, all newly installed meters regardless of location shall have suitable protective devices to prevent accidental over pressurizing. Suitable protective devices are as follows:

- (a) Spring-loaded relief valves conforming to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- (b) Pilot-loaded back pressure regulators used as relief valves and designed so that pilot system or control line failure will open the regulator.
- (c) Weight-loaded relief valves.
- (d) A monitoring regulator installed in series with the primary pressure regulator.
- (e) A series regulator installed upstream from the primary regulator and set to continuously limit the pressure on the inlet of the primary regulator to the maximum allowable operating pressure of the distribution system, or less.
- (f) An automatic shutoff device installed in series with the primary pressure regulator and set to shut off when the pressure on the distribution system reaches the maximum allowable operating pressure, or less. This device must remain closed until reset manually. It should not be used where it might cause an interruption in service to a large number of mains or service lines.
- (g) Spring-loaded diaphragm type relief valves.

### 10.5 Pressure Regulators:

Controlling and limiting pressure in low pressure gas distribution systems. Each low pressure distribution system or low-pressure main supplied from a gas source which is at a higher pressure than the maximum allowable operating pressure for the low-pressure system will be equipped with pressure regulating devices of adequate capacity. Other devices will be designed to meet the pressure, load, and other service conditions under which they will have to operate. In addition to the pressure regulating devices, a suitable protective device to prevent accidental over pressurizing must be provided and may include:

- (a) A liquid seal relief device that can be set to open accurately and consistently at the desired pressure.
- (b) Weight-loaded relief valves.
- (c) An automatic shutoff device as described above.
- (d) A pilot-loaded back pressure regulator as described above.
- (e) A monitoring regulator as described above.

### 10.6 Liquefied Petroleum Gas:

LPG usually includes butane, propane or mixtures of both which can be stored as liquids under moderate pressures of 80-250 psig at ambient temperature. Use of LPG gas systems is discouraged and must be preapproved. LPG gas distribution systems when used will be designed to comply with the requirements of NFPA 58 instead of ANSI B31.8. Polyethylene and fiberglass pipe will not be used in LPG systems.

### 11. COMPRESSED AIR

#### 11.1 Economic Analysis:

Use life cycle economic analysis to select between multiple individual compressors at each work site or a single centrally located compressor.

#### 11.2 Moisture and Contaminant Removal:

The design of a compressed air system shall include a means to properly remove moisture and contaminants from the system. This includes after coolers, air dryers, filters, automatic drains on the storage receiver, drain valves at all points, etc.

#### 11.3 Other Considerations:

Additional items which will be considered for a compressed air system are: The compressor should be sized for anticipated future expansion. Provide noise suppression to keep compressor noise within Occupational Safety and Health Administration (OSHA) limitations. Reclaim exhausted heat to supplement space or water heating.

#### 11.4 Piping:

Piping used for compressed air systems shall be schedule 40 black steel or copper pipe. If the piping is to be placed underground it shall have a factory installed 50-mil polyethylene coating, and shall be cathodically protected.

## 12. CORROSION CONTROL:

**12.1 Cathodic Protection:** Comply with UFC 3-570-01, Cathodic Protection, and UFC 3-570-06 O&M, Cathodic Protection Systems. Cathodic protection is required for the following items as a minimum: Any ferrous material that comes in contact with the earth. This includes but is not limited to the exterior surface of underground pipes. The interior surface of water storage tanks.

**12.2 Water Treatment:** The following items shall be included as part of water treatment for HVAC facilities: Conductivity meters and chemical feed equipment for condenser water systems on chillers (Open loop system with cooling tower). A pot feeder for closed loop hydronic systems (both hot and chilled water systems). Conductivity metering and chemical feed equipment for boiler water. A bleed-off line with an adjustable flow meter on evaporative coolers. This includes direct as well as multiple stage evaporative cooling units. Sampling ports for the analysis of water conditions.

### **13. LIQUID FUELS STORAGE AND DISTRIBUTION.**

#### **13.1 Tanks:**

Fuel storage tanks shall comply with applicable standards of American Petroleum Institute and be aboveground within a concrete lined containment area. Exceptions to the above ground installation must be approved by 75 CEG/CEV. If tanks must be placed underground they shall be double walled Plasteel (steel inner wall and fiberglass-coated steel for the outer wall) and have leak monitoring equipment installed, which meets all Environmental Protection Agency (EPA) and State of Utah requirements.

#### **13.2 Piping:**

All underground fuel piping shall be double walled pipe. The carrier pipe shall be schedule 40 black steel and the outer layer shall be fiberglass.

#### **13.3 Valves:**

All valves in liquid fuel systems shall have fire rated seals to shut off bubble tight in case of fire.

#### **13.4 Grounding:**

Fuel system grounding shall comply with the National Fire Protection Association (NFPA) 30, Flammable and Combustible Liquids Code.

#### **13.5 Tank Cleaning:**

Cleaning of fuel storage tanks shall comply with American Petroleum Institute API Standard 2015.

### 14. ELECTRICAL:

#### 14.1 General:

14.1.1 Applicable Design Criteria: All installations shall comply with the following criteria as applicable including but not limited to UFC 3-501-01, *Electrical Engineering* which provides minimum requirements for design analyses and calculations, UFC 3-550-01 *Exterior Electrical Power Distribution* which provides minimum requirements for underground distribution system design (AF ETL 11-10: *Electrical Manhole Design Considerations* clarifies these requirements and provides additional recommendations), NFPA 70 *National Electric Code* (NEC), NFPA 70E *Standard for Electrical Safety in the Work Place*, the *Lineman's and Cableman's Handbook* and City Light & Power (CLP) *Electric Service Connection Standards Manual*. Note that CLP specifications take precedence over UFC requirements. UFC 3-550-01 Section 1-6 states, "This UFC does not apply to ... Military installations that have privatized their electrical distribution system." Electrical distribution segments/appurtenances which will become ownership of the system owner, CLP, shall comply with their service connection manual, available from CLP. (See URL <https://clp.exavault.com/share/view/m6nc-eyf62h1y> using access code: CLPscp101!).

14.1.2 Coordination Requirements: Prior to the installation or modification of any existing exterior electrical service the system owner, City Light & Power (CLP), and the 75th CES Exterior Electrical shop shall be consulted for overall scope and equipment locations. CLP will also be the authority having jurisdiction (AHJ) on all exterior/outdoor electrical installations.

14.1.3 Service Connection to CLP: Contractors may construct the exterior electrical service and related scope or pay CLP to do so. However, the contractor may be required to pay for compliance inspections and other fees as documented by CLP. In addition, the contractor will have to transfer the real property via the DD1354 to the government. It is recommended that the prime contractor contract with CLP to construct transformers, switches, electrical lines, etc. that will be owned by them. To obtain a bid from CLP the contractor may request a Service Connection Application/Quote Request form at [rh@CLPinc.com](mailto:rh@CLPinc.com), [tjc@CLPinc.com](mailto:tjc@CLPinc.com) and/or [rmk@CLPinc.com](mailto:rmk@CLPinc.com).

14.1.4 Protection of facilities: When required by the City Light & Power and 75th Exterior Electrical section, bollards will be installed by the contractor to protect temporary and permanent exterior electrical services.

14.1.5 Temporary Power: All temporary power will be run at the expense of the contractor that is performing the work. CLP will be notified by the project manager and a connection location will be determined. CLP may require bollards to protect temporary facilities as stated in 14.1.4.

#### 14.2 Hill AFB Exterior Distribution:

14.2.1 Primary Voltage: The Primary voltage at Hill AFB is 12,470 volts.

14.2.2 Transformers: All new transformers shall be 3-phase pad mounted. Primary voltage is 12470 volts delta. Primary case shall be grounded by a ground conductor back to the source switch. Transformers shall have loop feed with elbow arrestors, dead front, bushing wells with inserts installed, 4 hole spades, 3-phase gang operated on/off loadbreak switch, bayonet fusing, top level oil temperature

gages, liquid level & pressure vacuum gages, drain valve with sampler, copper windings and two each 2-1/2% taps above and below normal. This will assure that the user voltage can be regulated within proper limits. Lightning arrestors will be installed on all unused high voltage well bushings. No Parking stands or Y splitters will be installed unless deemed necessary by 75th CES Exterior Electrical section or CLP. The majority of high voltage exterior transformers and switches are owned by CLP will be turned over to CLP.

14.2.3 High Voltage Conductors: High voltage primary conductors may be copper or aluminum, unless specified in construction project documents.

14.2.4 Buried High Voltage Cable: All buried high voltage cable (over 600 volts) shall be placed in conduit with a minimum of 3-inches of concrete encasing around the conduit. Depth of burial shall be 36 inches below grade. All high voltage conductor installations will be 36 inches deep minimum to the top of the conduit and they will be encased in concrete to include airfield runway lighting circuits. A 6-inch wide, red plastic marker tape with the words "Danger-Buried High Voltage Cable" shall be placed directly over the high voltage line at a depth of 12 inches below finished grade or 6 inches below the top of sub grade whichever is deeper. Any change of direction that is more than 5 degrees will require the installation of a manhole. Maximum spacing between manholes or equipment shall not exceed 500 feet.

14.2.5 Buried Conductors Below Traffic: All conduit containing conductors of any voltage including communication circuits that run under streets or parking lots shall be concrete encased 3 inches thick on all sides.

14.2.6 Only Rigid Galvanized Steel (RGS) 90 degree elbows and Rigid Galvanized Steel (RGS) conduit or fiberglass sweeps for high voltage shall be used when making the transition from underground to overhead high voltage power lines. Always use a minimum of two layers of PVC pipe wrap tape to protect the entire elbow against corrosion. Before wrapping with tape, coat the pipe or other metal surfaces with Pipe Primer to enhance adhesion. Wrap the last layer in a more relaxed manner to prevent this layer from flagging. Only one high voltage riser in rigid galvanized steel per utility pole will be installed.

14.2.7 Support Structures: All power poles, steel support structures and their foundations shall be rated for a 100 mph wind load. The minimum dimensions for cross arms will be 8-ft long by 3 1/4-inches wide by 4 1/2-inches deep.

14.2.8 All new high voltage cable shall be 15 KV, 133 percent insulation.

14.2.9 Watt-hour meters shall be installed on all facilities requiring new service and modifications to existing facility power requirements. AMR compatible watt hour meters shall be used and be connected to the EMCS system. Meter shall be a Shark 200 v2 or equivalent and meet the requirements of UFGS 26 27 13.10 30, Electric Meters and ASHRAE Standard 90.1. All new meter installations shall have a meter test switch installed.

14.2.10 Exterior equipment shall not be placed-near the drip lines of roof overhangs or rain gutters.

**14.3 Hill AFB Interior Distribution: Do not use aluminum conductors or bus bars inside any facility at Hill AFB. Only copper conductors and bus bars should be used. All dry type transformers shall have copper windings.**

14.3.1 All new building wiring systems shall be designed using 277/480 volts unless uneconomical to accomplish and shall be in rigid conduit or central open raceways.

14.3.2 Lighting shall be installed using 277 volts if available.

14.3.3 Do not use any polystyrene lenses in light fixtures.

14.3.4 Comply with federal energy requirements when designing lighting systems. See section 5 Mandatory Energy and Water Conservation Requirements above.

14.2.5 In office buildings or other buildings that will have a considerable amount of computer equipment installed, or will have systems furniture:

a. Run oversized neutral conductors from the transformer to service equipment, and from service equipment through the distribution panels to the branch circuit panels (double sized neutral conductors are recommended).

b. From the branch circuit panel boards, run eight conductor circuits (three hot conductors, three neutral conductors one ground conductor, and one isolated ground conductor) to all receptacle outlets, including those receptacle outlets in pre-wired systems furniture.

c. Run all other circuits as per the National Electric Code requirements.

14.3.6 All installed electrical gear placed on mechanical room floors will be placed on a 4-inch tall concrete maintenance pad.

#### **14.4 Exterior Lighting:**

14.4.1 Light Poles: All light poles and foundations shall be rated for a 100 mph wind load.

14.4.2 Comply with federal energy requirements when designing lighting systems. See Section 6, Mandatory Energy and Water Conservation Requirements above. Use white LED lights for exterior lighting when economically viable.

14.4.3 Photoelectric Controls: Use photoelectric controls on exterior lighting where possible to save energy. Where practical fixtures shall be grouped together using contactors, which are controlled by a single photocell.

#### **14.5 Interior Lighting:**

14.5.1 Lighting power levels shall comply with ANSI/ASHRAE/IESNA Standard 90.1

14.5.2 Interior Lighting Calculations: Computer-generated photometric plans for each space are required to verify proposed luminaires and locations meet the required performance criteria of the design using a light loss factor (LLF) of 0.7. Photometric plan submittals must include:

- Horizontal illuminance measurements at workplane or other designated height above finished floor.
- Minimum and maximum illuminance levels.
- Average maintained illuminance level.
- Average to minimum and maximum to minimum ratios for horizontal illuminance
- Lighting power density (Watts per square foot or per square meter)

14.5.3 Use a color rendering index (CRI) of no less than 80 for interior applications.



14.5.4 Use a correlated color temperature (CCT) of no greater than 4100K as stated on the manufacturer's cut sheet for all interior spaces.

14.5.5 Do not mix source CCTs within a single building with the purpose of minimizing maintenance staff from having to keep track of specific CCTs.

14.5.6 Daylighting Controls- Control the electric lighting in response to daylight.

- Continuously dim electric light in task oriented areas such as offices, conference rooms, classrooms, or turning it off in non-task areas such as circulation and lounge areas.
- Control primary and secondary daylight zones separately. Refer to Daylighting Best Practices in APPENDIX C of UFC 3-530 for additional information.

14.5.7 Exit signs shall be the photo-luminescent type.

### 14.6 Permitted Lighting Technology:

14.6.1 Solid State Lighting (SSL):

- LED luminaires must be dimmable or capable of multi-level control according to the control strategy.
- LED light source replacements (screw base) are only permitted for the replacement of incandescent or compact fluorescent light sources.
- IES LM-79, LM-80, and TM-21 testing reports must be supplied from manufacturer and include all relevant information.
- Consistent with industry standard, all LED luminaires require a 10-year warranty.
- Ballasts, Drivers, Generators and Power Supplies
  - Total current harmonic distortion (THD) less than or equal to 20%.
  - Power factor (PF) greater than or equal to 0.9
  - For current and future dimming requirements (i.e. smart grid, curfew, adaptive), use dimmable or bi-level drivers compatible with standard dimming control circuit of 0-10V. Other dimming protocols must comply with Network Certification requirements.

Note: For LED applications, provide built in failure detection in the luminaire or include labor costs to measure light levels (baseline and 70% output - before the end of the warranty) in the LCCA.

14.6.2 Compact Fluorescent Light (CFL):

- Do not use CFL sources less than 13 watts.
- Do not use u-bent fluorescent light sources.
- Do not use in cold temperature environments (colder than 50 degrees Fahrenheit), except where alternatives such as SSL are unavailable
- Ballasts, Drivers, Generators and Power Supplies

- Provide dimmable ballasts.
- Provide programmed start ballasts for compact fluorescent light sources that include end of life protection

### 14.6.3 Linear Fluorescents:

- Do not use LED linear fluorescent light source replacements.
- Do not use T12 light sources.
- Do not use in cold temperature environments (colder than 50 degrees Fahrenheit), except where alternatives such as SSL are unavailable.
- Ballasts, Drivers, Generators and Power Supplies
  - Provide dimmable or bi-level ballasts in spaces
  - Use programmed start ballasts with end of life protection.
  - NEMA premium electronic ballasts must be specified where applicable.
  - Do not use instant start ballasts.

### 14.6.4 Induction (Electrodeless Fluorescent)

- All induction light sources must be dimmable.

### 14.6.5 Metal Halide

- No restrictions.

### 14.6.6 Mercury Vapor

- Do not use mercury vapor light sources.

### 14.6.7 High and Low Pressure Sodium

- Do not use for interior applications.

### 14.6.8 Incandescent and Tungsten Halogen

- Do not use incandescent or tungsten halogen light sources, except where alternatives such as SSL are unavailable.

### 14.6.9 High Intensity Discharge

- Power factor (PF) greater than or equal to 0.9.
- Provide electronic ballasts for all available wattages.

## 14.7 Additional Lighting Guidelines:

14.7.1 A new design must ensure reduced energy consumption, reduced maintenance, and improved lighting quality at the lowest life cycle cost. A lighting redesign is required when a renovation involves changing lighting technologies such as fluorescent to LED and when renovation involves changing lighting with more efficient lighting within the same technology.

14.7.2 Lighting control requirements must meet ASHRAE 90.1, ASHRAE 189.1 and UFC 3-530-01. Refer to UFC 1-200-02 for publication year of ASHRAE. Refer to CHAPTER 3 (Interior Applications) of UFC 3-530-01 for control requirements. Provide commissioning per ASHRAE requirements. Refer to IES DG-29 for commission guidance for specific applications.

14.7.3 Select light sources, power supplies, and controls that are rated and warranted for long useful lives to increase the amount of time between maintenance cycles. Minimize light source types on an individual project. Locate luminaires in locations to improve access for regular servicing such as light source replacement.

14.7.4 Reference UFC 3-530-01 for further instruction on control strategies, project specific design guides, and design specific performance requirements.

### 14.8 Communications:

Comply with UFC 3-580-1, Telecommunications Interior Infrastructure. Comply also with Hill AFB Instruction 17-201.

For all HVAC system installations that require EMCS run and terminate the CAT6 cable(s) from the HVAC monitoring device to the designated communications room.

### 14.9 TEMPEST:

All Electromagnetic Interference related problems should be referred to the Base Electromagnetic Emissions Security Officer, Lori Prendergast, 75 CS/SCBS, 777-0362.

### 14.10 Special Protection for Rotating Electrical Equipment:

Three-phase electrical motors shall have phase failure and ground fault-protection when such protection costs are equal to or less than one-fourth the cost of the motor. This protection will be in addition to all protective devices required by the National Electric Code. Where there are a number of smaller three-phase motors within a particular building, the building will be protected at the service entrance with phase failure protection.

### 14.11 Lightning, Static & Surge Protection

14.11.1 Provide a complete lightning protection system as required by NFPA 70, NFPA 780, Mil-HDBK-419, AFMAN 91-201 Explosive Safety Standards, DOD 6055.9, Ammunition and Explosives Safety Standards, AFI 32-1065 Grounding Systems, LPI-175, and UL 96A. The system shall be installed by a certified lightning protection installer who is listed with the National Recognized Testing Laboratory (NRTL) and is actively engaged in the installation of UL Master Labeled lightning protection systems or who is certified by the Lightning Protection Institute (LPI) as a master Installer/designer and be so listed by the Lightning Protection Institute and by Underwriters Laboratories, Inc. For the complete scope of the installation of a lightning protection system the installer shall provide a UL certification stating

compliance with AFI 32-1065 *Grounding Systems*, and if applicable a UL Master Label. All antennae installations will be bonded to the lightning protection system. A complete drawing showing connections and initial test results will be forwarded to the 75<sup>th</sup> CES Exterior Electrical section. All lightning protection system installations and modifications shall be of copper materials. The exception will be the use of connections with dissimilar metals, and then aluminum may be used. All lightning protection systems will have surge protection at all points where electrical or electronic system conductors enter or exit a facility.

### 14.12 Intrusion Detection Systems (IDS)

14.12.1 If an Intrusion Detection System (IDS) is necessary it must include sufficient levels of protection as per AFI 31-101, AFI 31-401, AFI 31-601, DEPARTMENT OF DEFENSE MANUAL 5205.07V3/AIR FORCE MANUAL 16-703V3 or TECHNICAL SPECIFICATIONS FOR CONSTRUCTION AND MANAGEMENT OF SENSITIVE COMPARTMENTED INFORMATION FACILITIES VERSION 1.3 for the respective asset. See section 2.5 General Security in this document for further guidance.

14.12.2 Prior to system design the following offices shall be consulted for their requirements: 75 ABW/IP; and 75 SFS/S5. All IDS system requirements MUST have a letter of authorization on file.

14.12.3 The alarm system must be compatible with the existing base alarm system. The authorized IDS system for Hill AFB is a Honeywell/Vindicator V5 w/TDEA. All connections must be completed by a Honeywell/Vindicator certified installer prior to the final survey. After verification by 75 SFS/S5 that the system is ready, a 72-hour acceptance test must be accomplished with 75 SFS/S5. A final survey of the building will be accomplished at this time prior to normal operation starting.

14.12.4 Hill AFB utilizes standards for all IDS components and this list is made available by the 75 SFS/S5.

14.12.5 In the event that Intrusion Detection (IDS) and Card Access are required in the same facility both systems will be completely independent of one another; they must not share wiring, conduits, junction boxes, power supplies or enclosures.

### 14.13 Access Control System (ACS)

14.13.1 The authorized ACS system for Hill AFB is a Honeywell/Vindicator utilizing the V5 Network Security Appliance with the Access Control Server UHS/TDEA option. The system server terminal (SST) shall be either a WYSE terminal or Security Archive Workstation (SAW) based on customer requirements.

14.13.2 All doors will be equipped with electronic strikes that fail-secure in a “locked” position upon extended power failures that exceed the battery backup capability. Magnetic locks will not be allowed. Door frames must be manufactured of steel and prefabricated with appropriate “Mud Box” along with proper cutout or backing for approved electric strike. No onsite modifications are allowed.

14.13.3 Hill AFB utilizes standards for all ACS components and this list is made available by the 75<sup>th</sup> CES Electric/Electronic Shop.

14.13.4 Typical Custom enclosure from Vindicator shall be installed no higher than 6’ to the top and shall be a minimum dimension of 24’X36”X6”.

14.13.5 Custom enclosures shall have a lockable disconnecting means along with surge protection on all separate power circuits at or within a reasonable distance of the equipment that it services. The preferred Surge Protection is a Ditek DTK-120HW. Dedicated circuits are required and shall not be shared with other general purpose equipment. All power supplies shall have a minimum of 12VDC 18Ah battery backup capacity. 14.13.6 The preferred door strikes shall be the Hess-9600 for crash bar style doors and the Adams Rite 7440-682 for handset style doors. All door strikes and associated equipment shall be 12VDC only.

14.13.7 All field wiring shall be installed in conduit and properly identified by a continuous blue coating or properly spaced labeling, exposed cabling shall not be used. Wiring types used are OAS 18/2, 18/4 and 18/6. All devices shall be installed on an individual circuit from the PD8 fuse block.

## **15. PROJECT DOCUMENTATION.**

### **15.1. As Built Drawings:**

A minimum of one set of Record Drawings in bound AutoCAD dwg format must be provided on all new construction and all major renovations. Drawings must be complete, accurate and comply with current Hill AFB CAD standard.

### **15.2 Basis of Design:**

At least one electronic set of all design and construction related information shown in the record drawings must be provided. As a minimum include engineering calculations, structural load assumptions and calculations, energy calculations, equipment sizing, test reports, including HVAC test and balance reports, commissioning reports, and any other related similar information. As a minimum, Mechanical drawings shall include the following information.

#### **15.2.1 Narrative Description of System**

A. System type(s), location, control type, efficiency features, outdoor air ventilation strategy, indoor air quality features, noise reduction features, environmental benefits, other special features

B. Describe how system meets any special requirements listed in the Project Requirements document.

#### **15.2.2 Reasons for System Selection**

A. Reasons that the selected system is a better choice than other possible alternatives. E.g. comfort performance, efficiency, reliability, flexibility, simplicity, cost, owner preferences, site constraints, climate, availability of maintenance, acoustics.

### **15.3 Equipment Operations and Maintenance Manuals:**

At least two hard copy sets and one electronic set in Adobe pdf format must be provided. Requirements for O&M manuals will be detailed in project specifications and must require as a minimum:

(a) A complete parts list and source of supply for each piece of equipment, and marked with model, size and plan symbol.

(b) Performance curves for all pumps and fans marked with model, size and plan symbol.

(c) Wiring diagrams

(d) Maintenance checklists provided by the manufacturer or- if not available then checklists adapted from those in the Federal Energy Managers Program (FEMP) O&M Best Practices Guide.

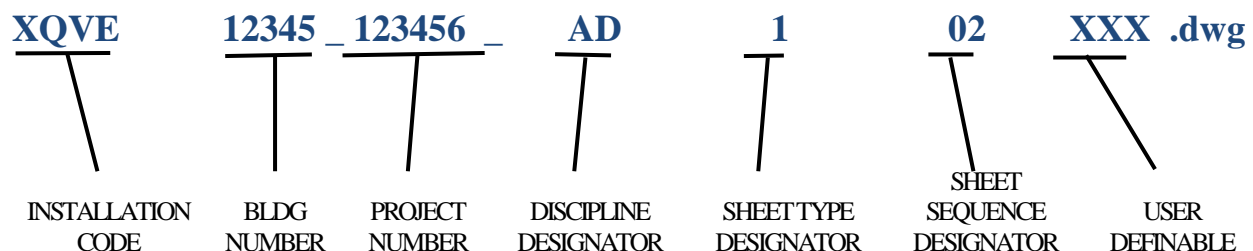
### 16. COMPUTER AIDED DRAFTING AND DESIGN (CADD)/ GEOGRAPHICAL INFORMATION SYSTEM (GIS):

#### 16.1 CADD File Naming Convention

The purpose of this standard is to set a basic file naming convention to ensure consistent electronic deliverables for information created and stored using Computer Aided Design and Drafting (CADD) software. This will ensure contract records, project deliverables, and As-Built and record drawings can be retained and archived as required by Federal Statute and remain easily retrievable. When following this convention, only uppercase alpha numeric characters should be used. No spaces or special characters are allowed. The three character suffix defining the file type may be lower case.

#### DESCRIPTION

The following is the description of a complete file name. It is composed of five parts. This naming convention is an extension of the A/E/C CADD Standard, Release 6.0 (Aug 2015) Sheet File Naming Convention and is in compliance with that document. Discipline Designators and Sheet Type Designators are as defined in that standard.



#### FILE NAME FORMAT DESCRIPTION

##### 1. INSTALLATION CODE - XQVE

Use the four alpha character installation code. Use KRSM for buildings at Hill AFB, XQVE for buildings at UTTR North, PGTL for buildings at Little Mountain, etc.

##### 2. BUILDING NUMBER - 12345

Do not precede building number with zeros. For example, project drawings for Building 1 at Hill Air Force Base would begin with KRSM1. While projects for Building 501 at Little Mountain would begin with PGTL501, etc.

##### 3. PROJECT NUMBER - \_123456\_

Use the assigned 6-digit project number preceded and followed by a \_ to separate it from the building number and the Discipline Designator. For projects with more than one project number, use the most recent. For example, KRSM992345 would be less recent than KRSM082345. Use extensions A B or C only if these are actual designations for projects awarded separately.

##### 4. DISCIPLINE DESIGNATOR - AB

As defined in the A/E/C CADD Standard, Release 6.0 (Aug 2015) Sheet File Naming Convention Table 2-3.

##### 5. SHEET TYPE DESIGNATOR - 1



As defined in the A/E/C CADD Standard, Release 6.0 (Aug 2015) Sheet File Naming Convention Table 2-4.

1 = Plans, 2 = Elevations, 3 = Sections, etc.

6. SHEET SEQUENCE NUMBER - 02

Self-Explanatory.

7. USER DEFINABLE XXX

If the sheets for an individual discipline such as Architectural are included in a single file then use SET as the three characters. In this case the discipline designator would be A- and the sheet type designator and sheet sequence number would be blank.

### 16.2 CADD Standards:

CADD drawings shall be developed in accordance with the A/E/C CADD Standard which was produced by the CADD/GIS Technology Center. The CADD standard is available at <https://cadbimcenter.erdcdren.mil>. To access the SDSFIE data models and tools, you need to register an account and be granted permission here: <https://www.sdsfieonline.org/>. USAF SDSFIE Data Models and Guidance are here: <https://www.sdsfieonline.org/Components/USAF>. Development and manipulation of drawings and reference files shall follow the standard. All drawings shall be digitized and must be delivered in printed form and on machine-readable media. The number, and type of materials for printed copies required for construction documents as-built and other uses will be specified by Hill AFB. All changes made to the design during construction must be posted in the electronic files. File names must comply with the Hill AFB CADD naming convention described above.

### 16.3 Drawing Format:

Drawings shall be produced and bound in AutoCAD format and be geo-referenced to Universal Transverse Mercator coordinates (UTM), Zone 12 North. The horizontal datum shall be the North American Datum 1983 reference frame, GRS 80 ellipsoid, 2011 realization, otherwise known as NAD 83 (2011). The basis for all elevations shall be the North American Vertical Datum of 1988 (NAVD 88). GPS derived orthometric heights shall be calculated using the Geoid 09 model with the EPOCH clearly defined. All units of measure shall be meters. Any drawings or drawing sets not complying with the aforesaid parameters will be rejected.

### 16.4 Media Format:

16.4.1 DVD. Machine-readable data may be submitted on a DVD. Must be compatible with latest DVD writers and readers. Each DVD must have an external label indicating the format, density, company/organization name, and creation date. Data may be uploaded to the ARL Safe Site: <https://safe.apps.mil/> if the capacity of the DVD is too small.

16.4.2 A documentation handbook must be submitted with the machine-readable media. This handbook shall contain the specifics of the database, the file names, reference file names, stroked plotter files, and cell library names. All other pertinent information used in constructing and managing the drawings and database, shall also be included. Metadata allows the CADD files overlay the GIS data and be easily incorporated into the database.

**17. COST ESTIMATING:**

**17.1 General:**

All cost estimates shall be based on recent documented bid data or the latest edition of Building Construction Cost Data as published by the Robert Snow Means Company, Inc. All estimates for the Military Construction Program (MCP) shall be based on the latest edition of the Military Pricing Guide or as directed by the Civil Engineer. Use 15 percent overhead and 10 percent profit.

**17.2 Procedures:**

All estimates shall be based on unit costs. Single line item estimates shall not be used. All estimates for change orders and the 8(a) Program shall be prepared in detail on an Air Force Form 3052, and shall include labor hours, material, and bonding costs.

**18. OTHER CONSIDERATIONS:**

**18.1 Ban on Use of Class I Ozone Depleting Substances (ODS):**

In 1999, the Air Force banned the purchase of Class I substances listed in the Clean Air Act including chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform.. These are generally found in HALON type fire suppression systems and in air conditioning refrigerants.

**18.2 Pest Management Mitigations:**

Ensure that pest management mitigation measures are taken into effect, including but not limited to bird screens, rodent proofing, and chemical pre-treatment of wood to prevent termite infestation.

## **ADDENDUM OF CHANGES**

1. 15 April 2008. Paragraph 9.1.2 Transformers. Altered by Ray Worthen to read: “12470 volts delta. Primary case shall be grounded by a ground conductor back to the source Switch.”
2. 18 April 2008. Paragraph 8.4. Altered by Ray Worthen to read: “Earthquake valves shall comply with the American Society of Civil Engineers Standard ASCE 25-97, Earthquake Actuated Automatic Gas Shutoff Devices.”
3. 25 August 2008. Section 6. Mechanical Systems Design Standard - revised by Ray Worthen to align with UFC 3-400-10N Mechanical Engineering.
4. 25 August 2008. Section 5.5 Meters revised by Ray Worthen to comply with new directions from Base Energy Office.
5. 4 Dec 2008. Appendix A on Security Requirements Revised in accordance with email from Gary Cordon 25 Sept 2008. Edited text highlighting shows changes. Removed requirement for Maintenance Contract Paragraph 10e. Added the following to paragraph 10 f. Depending on resource protected the motions will either be dual-tech or PIR or both. Removed first sentence of paragraph 10g. and removed paragraph 10.h.i. Added paragraphs to end of 11.
6. 3 Dec 2008. Added CADD file naming convention to section 15. Ray Worthen.
7. 3 Dec 2008 Added requirement to use Hill AFB Energy Compliance Forms to paragraph 5.2.2. Removed the option to use alternate energy forms. Ray Worthen.
8. 9 Dec 2008. Reformatted entire document and add interactive index for ease of use. Ray Worthen
10. 16 Jan 2009 Changed lock section to require cores to be purchased by contractor and shipped to Lock shop. Ray Worthen as directed by Jonathan Ramras. Further refinement still due from lock shop.
11. 16 Jan 2009 Corrections to prescriptive table to comply with latest AF ETL 08-13 and most recent Federal Guidance Energy Star Rated equipment. Ray Worthen.
12. 16 Jan 2009 Corrected wording on the window section to require ATFP film laminated safety glass. Per Paul Waite. Ray Worthen
13. 26 Jan 2009. Corrected acoustical ceilings to agree with Arch Comp Stand. All suspended acoustical ceilings shall have a recessed-grid with drop (tegular) edge tile. Tile shall be a 2 by 2 grid or 2x4 grid scored in the center so the 2x4 appears like a 2x2 grid. Per Dave Murray. Ray Worthen.
14. 26 Jan 2009 Corrected Landscaping section to comply with AF ETL 08-13. Ray Worthen

15. 26 Jan 2009 Added Sustainable Design and Development Section to comply with AF ETL 08-13 Ray Worthen.
16. 26 Aug 2009. Changed handicap access design requirements to ABA from UFAS Ray Worthen
17. 26 Aug 2009. Changed Energy Policy to clarify applicable energy code for low rise residential construction. Ray Worthen.
18. 26 Aug 2009 Changed Mechanical Design Requirements for ventilation to reference AF ETL 04-3 on Mold Growth. Ray Worthen
19. 26 Aug 2009 Added section on Indoor Air Quality (IAQ) standards and section for dorms and VOQ's Ray Worthen.
20. 15 April 2010 Extensive changes made to Fire Protection section. By Ray Worthen
21. 15 April 2010 Rearranged some sections to make the whole more consistent. By Ray Worthen
22. 15 April 2010. Major changes to the section on exterior locks and door hardware. By Ray Worthen
23. 15 April 2010. Moved section on security into the document rather than as an attached appendix A. By Ray Worthen
24. 15 April 2010. Included reference to AF ETL 10-2 Light Emitting Diodes 18 March 2010 in section 14 which disallows use of LEDs except in very limited applications.
25. 12 October 2010 Changed paragraph 14.1.8 *"Watt-hour meters shall be installed on all facilities requiring new service and modifications to existing facility power requirements. ASHRAE Standard 90.1 2004. Recommend using model "Sentinal" manufactured by Itron."* By Ray Worthen at direction from Harold Gulso.
26. 12 October 2010 Changed paragraph 14.2 to include: *All dry type transformers shall have copper windings.* Ray Worthen at direction from Robert Miller
27. 29 November 2010 Changed paragraph 14.7 to require contractor to run CAT5 cable from HVAC to comm. room. Ray Worthen at direction from Gary Cordon.
28. 4 Feb 2011 Changed paragraph 14.0 to reference new AF ETL 11-10 published 19 Jan 2011 on Electrical Manhole Design and to reference UFC 3-501-01, *Electrical Engineering Design*.
29. 22 Feb 2011. Corrected conflict with Natural Gas pipe line location wire in paragraphs 2.8 and 10.2. Ray Worthen
30. 9 March 2011. Changed paragraph 3.7.10 to require structural design to comply with IBC and UFC 3-301-01 with seismic design complying with IBC chap 16 and UFC 3-310-04. Ray Worthen at direction from Dave Murray.
31. 9 March 2011. Added clarification to definition of single family residential units excluded from ASHRAE 90.1 in paragraph 6.3.4. Ray Worthen.

32. 1 April 2011 Added” All strikes will be 12v dc only. Single exterior doors will have mechanical crash bars/handsets; double exterior doors will have 12vdc electronic crash bars.” Per direction Gary Cordon.
33. 13 April 2011 changed reference in paragraph 7.6 to read correctly UFC 3-600-01. Ray Worthen.
34. 13 April 2011 changed reference in paragraph 7.7.1 to delete old AFOSH standard and replace with reference to replacement regulation AFMAN 48-155 Occupational and Environmental Health Exposure Controls. Ray Worthen
35. 13 April 2011. Removed reference to Gas Piping standard that is no longer available. UFC 3-430-05FA Replaced with NFPA 54 National Fuel Gas Code. Ray Worthen.
36. 14 April 2011 Removed reference to AFM 88 -11 and AFM 88-5 and replaced with UFC 3-230-17FA. Ray Worthen
37. 14 April 2011 Removed reference to ETL 90-2 form paragraph 4.3.6 because it was not relevant to that paragraph. Ray Worthen.
38. 14 April 2011 Removed reference to AFPAM 32-1097 replaced with UFC 3-120-01. Ray Worthen
39. 8 July 2011 Added requirement to place Fire Alarm Control Panels in dry and temperature controlled environments. Dave Murray
40. 14 Dec 2011 Modified the naming convention for CADD drawings. Dave Murray
41. 6 Jan 2012 Added a requirement for tanks to also comply with State of Utah requirements, Para 13.1. Dave Murray
42. 18 Jan 2012 Changed requirements for drawing format in Para 16.3. Dave Murray
43. 20 Jan 2012 Construction and Demolition Waste Diversion Para 5.5. Dave Murray
44. 31 Jan 2012 Updated Airfields Section 3.1. Dave Murray
45. 23 Feb 2012 Modified Surveying Section 2.4. Dave Murray
46. 22 Mar 2012 Added UFC-3-400-10N, Section 7.16.7.33. Dave Murray
47. 28 Mar 2012 Revised CADD File Naming Convention, Section 16.1. Dave Murray
48. 18 May 2012 Cipher locks prohibited, Section 2.5.7. Dave Murray
49. 11 June 2012 Fall Protection Section 4.14.7. Dave Murray.
50. 12 June 2012 Included CE shops requirements Section 14. Dave Murray.
51. 14 June 2012 Added design criteria, Sections 3.1.2.11, 3.1.3, 3.2.1.4 and 3.7.10. Dave Murray

- 52. 15 June 2012 Updated Metering requirements, Section 6.5. Dave Murray
- 53. 18 June 2012 Metal halide lights specified, Section 14.4.2. Dave Murray.
- 54. 19 June 2012 Updated Storm water Pollution Prevention requirements, Section 2.6.2. Dave Murray
- 55. 3 August 2012 LED exterior lighting specified, Section 14.4.2, Dave Murray
- 56. 30 August 2012 Roofing Criteria updated Section 4.14.1, Dave Murray
- 57. 4 Sep 2012 Accessibility clarified Section 4.4, Dave Murray
- 58. 12 Sep 2012 Introduction updated to clarify order or precedence Section 1, Dave Murray
- 59. 14 Sep 2012 Foreign Nationals work area restrictions defined, Section 2.5.10, Dave Murray
- 60. 18 Sep 2012 Fire hydrant color specified, Section 4.8.1, Dave Murray
- 61. 28 Nov 2012 Introduction revised. Dave Murray
- 62. 12 Dec 2012 Revised heat tape requirements, Section 4.14.4, Dave Murray
- 63. 12 Mar 2013 Revised fire hydrant specifications, Section 9.2.1, Dave Murray
- 63. 29 Mar 2013 Revised fire hydrant specifications, Section 9.2.1, Dave Murray
- 64. 15 April 2013 Revised Control Systems, Section 7.9.1, Dave Murray
- 65. 25 April 2013 Added utility line corridor information, Section 3.0, Dave Murray
- 66. 11 June 2013 Revised design criteria, Section 3.7.10, Dave Murray
- 67. 1 Aug 2013 Revised system furniture criteria, Section 4.3.6 Dave Murray
- 68. 16 Sep 2013 Revised electric meter criteria requested by Dave Abbott, Section 14.2.9 Dave Murray
- 69. 16 Sep 2013 Revised the specification for system furniture, Section 4.3.6 Dave Murray
- 70. 6 Nov 2013 Revised the seeding mixture. Section 4.15.8 Dave Murray
- 71. 31 Jan 2014 Hot tap water connections prohibited. Section 3.3.7 Dave Murray
- 72. 14 Feb 2014 CDX-09 change it to CDX-10. Sections 2.5.9 and 4.5.1 Dave Murray
- 73. 18 Feb 2014 Utility outages changed to 21 days. Section 2.8.5 Dave Murray
- 74. 19 Mar 2014 Added utility privatization standards. Section 3.0 Dave Murray
- 70. 16 Jun 2014 Revised the seeding mixture. Section 4.15.8 Dave Murray



- 71. 20 Nov 2014 Revised fire extinguisher requirements. Section 9.1.11 Dave Murray
- 72. 11 Dec 2014 Revised fire alarms systems. Sections 9.3, 9.4 and 9.5 Pat Quinn
- 73. 11 Dec 2014 Revised IDS and ACS. Sections 14.12 and 14.13 Pat Quinn
- 74. 23 Jan 2015 Added EMCS screens requirement. Section 7.9.1 Dave Murray
- 75. 19 Feb 2015 Clarified the applicability of remote sites. Section 1 Dave Murray
- 76. 17 Mar 2015 Specified Augusta handles for Yale latches. Section 4.5.4 Dave Murray
- 77. 31 Mar 2015 Changed requirements for emergency lights, exit signs and LED lighting. Section 14.5. PIVs minimized. Section 9.1.6. Class B wire specified. Section 9.1.6. Eliminated galvanized steel pipe. Section 9.1.5 Dave Murray
- 78. 6 Apr 2015 Utility system defined. Section 2.8.1 Dave Murray
- 79. 29 Apr 2015 Added Missile Maintenance and Storage Facilities. Section 2.14 Dave Murray
- 80. 26 May 2015 Added requirement for STC rated wall penetrations. Section 4.3.2 Dave Murray
- 81. 29 Jun 2015 Added manual drain valve to strainers. Section 7.5.2.13 Dave Murray
- 82. 3 Sep 2015 Added Executive Order 13693 and utility incentives in Sections 6.1.1.3 and 6.1.4 respectively. Also updated LED lighting specifications in Sections 14.4 – 14.7 Dave Murray
- 83. 7 Jan 2016 Added security documents in Sections 2.5.4f and 2.5.4g Dave Murray
- 84. 7 Jan 2016 Updated IDS standards in Section 14.12.1 Dave Murray
- 85. 17 Feb 2016 Updated CADD File Naming Convention to A/E/C CADD Standard, Release 6.0 Section 16.1 Dave Murray
- 86. 5 Apr 2016 Update the Introduction Section 1 Dave Murray
- 87. 12 Apr 2016 Updated the fire alarm detection system in Sections 9.3.4, 9.3.6, 9.3.8, 9.3.11 and 9.4.1 Dave Murray
- 88. 29 Apr 2016 Updated interface requirements with utility privatization contractors. Sections 3.0 and 14.1.2 Dave Murray
- 89. 29 Apr 2016 Added paper towel and toilet paper dispensers. Section 4.3.8 Dave Murray
- 90. 5 May 2016 Clarified Sections 3.0 and 14.1.2 Dave Murray
- 91. 5 Jul 2016 Added requirement for inspection platforms for HEX Foam systems. Section 9.1.12 Dave Murray

- 92. 3 Nov 2016 Revise interaction with American Water. Section 3.0 Dave Murray
- 93. 22 Nov 2016 Revise interaction with American Water. Section 3.0 Dave Murray
- 94. 19 Jan 2017 Revised CLP requirements. Section 14.1.1 Dave Murray
- 95. 17 Feb 17 Added Service Connection Application/Quote Request verbiage. Section 14.1.2 Dave Murray
- 96. 17 Mar 17. Revised fire protection requirements. Section 9.1 Dave Murray
- 97. 13 April 17. Revised natural gas distribution/meter requirements. Sections 6.5.6, 6.5.8, 10.1, 10.2, 10.4. Dave Murray
- 98. 14 Jul 17. Revised plumbing requirements. Sections 8.1, 8.2, 8.7.4, and 8.7.6. Paul Waite
- 99. 18 Aug 17. Revised sustainability requirements. Sections 5.1, 5.2, and 5.3. Dave Murray
- 100. 8 Nov 17. Specified that CDX-10 locks are for interior doors in an environmentally controlled area. Sections 2.5.9 and 4.5.1. Dave Murray
- 101. 3 Jan 18. Updated numerous references. Dave Murray
- 102. 24 Jan 18. Updated coordination requirements with CLP. Section 14.1. Dave Murray
- 103. 26 Jan 18. Updated water meter type as required by the Energy office. Section 6.5.10. Dave Murray
- 104. 7 Feb 18. Updated American Water web site. Section 3.0 Dave Murray
- 105. 14 Feb 18 Updated communications requirements. Section 14.8 Dave Murray
- 106. 26 Feb 2018 Updated CLP requirements. Sections 14.1 and 14.2 Dave Murray
- 107. 29 Mar 2018 Updated Traffic Engineering. Section 3.8.2 and 3.8.3 Dave Murray
- 108. 26 Jun 2018 Added corrosive prevention. Section 14.2.6 Dave Murray
- 109. 16 Jul 2018 Added requirement for cam hinges on STC doors. Section 4.4.4 Dave Murray
- 110. 26 Jul 2018 Added the Water Quality Compliance Planning Checklist. Section 2.6.2 Dave Murray
- 111. 26 Sep 2018. Clarified Borrow and Disposal requirements. Section 2.7 Dave Murray
- 112. 1 Apr 2019. Updated Design Frost Penetration. Section 3.7.3 Dave Murray
- 113. 3 Apr 2019. Updated storm water requirements. Section 2.6.2 Dave Murray
- 114. 10 Jun 2019 Removed vehicle inspection requirement. Section 2.5.2 Dave Murray
- 115. 10 Jun 2019 Updated the Executive Order reference. Sections 5.4 and 6.3.3 Dave Murray

- 116. 10 Jun 2019 Clarified that all refrigerant technicians must be certified. Section 7.1.1.1 Dave Murray
- 117. 10 Jun 2019 Added that hot water heaters/boilers meet NOx emissions requirement. Sections 7.3.1 and 8.1 Dave Murray
- 118. 10 Jun 2019 Updated refrigerant servicing equipment standard. Section 7.4.6 Dave Murray
- 119. 10 Jun 2019 Updated ODS ban. Section 18.2 Dave Murray
- 120. 10 Jun 2019 Updated the type of pipe required. Section 3.2.2 Dave Murray
- 121. 11 Jun 2019 Added new section for doors. Section 4.9 Dave Murray
- 122. 11 Jun 2019 Specified the location of the inspector test valve. Section 9.1.10 Dave Murray
- 123. 12 Jun 2019 Controls and Instrumentation completely replaced. Section 7.9 Dave Murray
- 124. 12 Jun 2019 New Fire Alarm System replaced Section 9.3, 9.4 and 9.5. Dave Murray
- 125. 12 Jun 2019 IDS updated to show 75 SFS responsibilities. Section 14.12 Dave Murray
- 126. 12 Jun 2019 ACS updated including the addition of Sections 14.13.4 through 14.13.8. Dave Murray
- 127. 12 Jun 2019 Clarified the height of backflow assemblies. Section 9.1.4 Dave Murray
- 128. 12 Jun 2019 Clarified requirements for PIVs. Section 9.1.6 Dave Murray
- 129. 12 Jun 2019 Updated web sites. Sections 2.4.5 and 16.2 Dave Murray
- 131. 14 Jun 2019 Updated the required media format to DVD. Section 16.4.1 Dave Murray
- 132. 29 Jul 2019. Specified the type of fittings on natural gas piping. Section 10.1 Dave Murray
- 133. 6 Aug 2019 Updated cathodic protection references. Section 12.1 Dave Murray
- 134. 7 Aug 2019 Updated soil bearing capacity guidance. Section 3.7.1 Dave Murray
- 135. 31 Oct 2019 Updated surveying criteria. Sections 2.4.2, 2.4.3 and 2.4.5 Dave Murray
- 136. 1 Nov 2019 Updated freeze protection of wet pipe systems. Section 9.1.8 Dave Murray
- 137. 5 Dec 2019. Updated Design Frost Penetration. Sections 3.1.2.3 and 3.7.3 Dave Murray
- 138. 28 Feb 2020 Requirement to use photo-luminescent exit signs. Section 14.5.7 Dave Murray
- 139. 28 Feb 2020 Added removal abandoned utility lines. Section 3.0 and 3.9 Dave Murray

140. 2 Mar 2020 Added Facility Requirements, AFMAN 32-1084. Section 2.2 Dave Murray

141. 2 Apr 2020 Updated access control. Sections 4.4.2 and 14.13 Dave Murray

142. 2 Apr 2020 Updated Fire Alarm Systems. Sections 9.3.4, 9.3.8, 9.3.9 and 9.3.11 Dave Murray