



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

DESIGN REQUIREMENTS

March 31, 2015

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1.0 GENERAL

1.1 General

- A. These Design Requirements apply to all plans, processes, and procedures required for compliance with the Design Process.

1.2 Procedure

- A. Complete the Design Requirement/Variance Form to make recommendations for additions, deletions, and changes to the Design Requirements.
- B. Complete the Design Requirement/Variance Form to request approval by the Director to vary from these Design Requirements based upon the specific project needs.
- C. All Design Requirement modifications require approval by the Director. If the Design Requirement is approved by the Director, then the DFCM's Designated Representative shall distribute the Design Requirements Procedure document to the appropriate project participants and shall file it in the project file.
 - (1) If the Design Requirement is approved by the Director and has general applicability to other projects, then the Director shall request that the proposed modifications be considered by the Utah State Building Board.
 - a. Verify with the DFCM person responsible for the specific professional discipline and the appropriate DFCM maintenance person that the proposed Design Requirement meets their requirements.

1.3 Hierarchy of Requirements

- A. The hierarchy of requirements is as follows:
 - (1) Comply with the minimum requirements of all applicable laws, rules, and regulatory requirements.
 - a. Exceptions: Wherever there are practical difficulties involved in carrying out these provisions, the State Building Official with the approval of the Director of DFCM and/or the State Fire Marshall shall have authority to grant modifications. The modifications granted by the State Building Official shall be documented in this standard under the heading "Design Requirements."
 - (2) Comply with the consensus based ANSI standards for design, products, installation, and services unless the applicable laws, rules, and regulatory requirements are more stringent.
 - (3) Comply with the "Performance Requirements: Design Requirements" unless the ANSI standards or the applicable laws, rules, and regulatory requirements are more stringent.
 - (4) Comply with the Contract Documents, unless the "Performance Requirements: Design Requirements", the ANSI standards, or the applicable laws, rules, and regulatory requirements are more stringent.

1.4 Changes and Additions to Design Requirements

- A. Complete the following document and submit it to the person to whom you are responsible to for ultimate decision by the Director, for requested changes/additions to the Design Requirements.

Design Requirement/Variance Change Request	
Project Name	Date
	DFCM Project Number
	Risk Management Number
Requested by	Entity
Brief Description of the Problem	
Design Requirements	
Justification	
Director Approval	Date
Action to Include This Design Requirements in the Design Requirements	
Professional Reviewer	Position
Maintenance Reviewer	Position
Director Approval	Date

2.0 CODES / LAWS/ RULES AND REGULATORY REQUIREMENTS

- 2.1 General
 - A. Comply with adopted State Codes and all other applicable Standards and Codes at the time submitted to the State Building Official, including but not limited to Section 0 through Section 0.
- 2.2 DFCM requirements include (but are not limited to):
 - A. Administrative Services: Comply with Title R23: Administrative Services, Facilities Construction and Management. Refer to rules.utah.gov/publicat/code/r023/r023.htm
 - B. DFCM Services: Comply with Services requirements. Refer to dfcm.utah.gov. Services requirements include:
 - (1) Inspections and Testing, refer to dfcm.utah.gov/building-official/
 - (2) Standards and Standard Project Documents, refer to dfcm.utah.gov/dfcm-standard-documents/
 - (3) Roofing, Paving, and Hazardous Materials, refer to dfcm.utah.gov/construction-management/
 - (4) Other requirements which may be added after this document is published.
- 2.3 Building Code Commission
 - A. Comply with Utah State Construction and Fire Codes Act. Refer to Utah Code Title 15A. Enforcement of these codes is the responsibility of the State Building Official.
- 2.4 Fire Prevention Board
 - A. Comply with Fire Codes in accordance with “Laws, Rules” of the State Fire Marshal. Refer to firemarshal.utah.gov. Enforcement of these codes is the responsibility of the Utah Fire Marshal.
- 2.5 Accessibility Code
 - A. Comply with the US Department of Justice Federal Registers – Americans with Disabilities Act. Refer to ada.gov/
- 2.6 Labor Commission
 - A. Comply with requirements of the Labor Commission. Refer to <http://www.laborcommission.utah.gov/>
 - (1) Boiler and Pressure Vessel Compliance Manual, Refer to laborcommission.utah.gov/media/pdfs/boilerelevatormine/pubs/Boiler%20Compliance%20Manual.pdf
 - (2) Utah Occupational Safety and Health, refer to rules.utah.gov/publicat/code/r614/r614-001.htm
 - (3) Elevator Rules: American National Standard Safety Code for Elevators and Escalators, ANSI/ASME A17.1 with amendments administered by Labor-Industrial Commission of Utah, Department of Occupational Safety and Health Elevator Division. Refer to rules.utah.gov/publicat/code/r616/r616-003.htm
- 2.7 Department of Health
 - A. Comply with requirements of Department of Health. Refer to <http://www.health.utah.gov>.
 - (1) Health Care Rules, refer to <http://health.utah.gov/hflcra>.
 - (2) Utah Indoor Clean Air Act, refer to rules.utah.gov/publicat/code/r392/r392-510.htm.
- 2.8 Department of Environmental Quality

- A. Comply with requirements of Department of Environmental Quality. Refer to <http://www.deq.utah.gov>.
- (1) Public Drinking Water Rules, refer to <http://www.drinkingwater.utah.gov/>.
 - (2) Utah Division of Air Quality: R307-801, Asbestos, refer to rules.utah.gov/publicat/code/r307/r307.htm Environmental Protection Agency (EPA): Regulations for Asbestos – Code of Federal Regulations Title 40, Part 61 Subpart M; and Toxic Substances Control Act PART 763 (Updated 1997) – ASBESTOS: OSHA Standards 1910.1001, 1915.1001, and 1926.1101
 - (3) Underground Storage Tank Act, refer to <http://www.undergroundtanks.utah.gov/>.
 - (4) Air Conservation Act, refer to <http://www.le.utah.gov/UtahCode/section.jsp?code=19-2>
 - (5) Fugitive Dust Plan, Refer to rules.utah.gov/publicat/code/r307/r307-309.htm Utah
 - (6) Pollutant Discharge Elimination System, Refer to rules.utah.gov/publicat/code/r317/r317.htm
 - (7) Operating Permits of the Division of Air Quality, refer to rules.utah.gov/publicat/code/r307/r307-415.htm
 - (8) For all new buildings larger than 10,000 gross square feet and renovations to existing buildings affecting more than 10,000 gross square feet that are subject to an Air Emissions permit or the State Implementation Plan (SIP), consultant shall determine the total annual natural gas consumption for the project and submit that to DFCM and the state entity associated with the project at least 90 days prior to completion of contract documents so that compliance can be confirmed with Air Emissions permits and the SIP. Failure to do so will jeopardize approval for the startup and operation of any new natural gas equipment or increases in output of existing natural gas fired equipment.
- 2.9 County Health Department (for the county where the facility is located)
- A. Food Service Sanitation Rules
- 2.10 Department of Commerce
- A. Pipeline Safety, refer rules.utah.gov/publicat/code/r746/r746-409.htm
- B. Qualifications: Refer to the Project Participants heading of this document.

3.0 DFCM REQUIREMENTS

These requirements are enhancements of code requirements that DFCM has initiated for best practices for State owned facilities.

3.1 General

A. Enhanced Accessibility

- (1) “It is the policy of the Utah State Building Board that, when appropriate for the intended use of the building and achievable within the project budget, the following accessibility enhancements beyond those required by the Americans with Disabilities Act be provided for in state owned buildings and buildings leased by DFCM: (1) powered door openers for the primary entrance designated for use by people with disabilities, and (2) powered door openers for one uni-sex restroom or for one male and one female restroom in the building unless restrooms with a door-less entry are provided. This policy is not intended to limit the use of powered door openers to the standard set forth herein. This policy applies to the construction or major renovation of state-owned facilities and new leases where the entire building is being leased by DFCM. This policy is not intended to create any rights to any third parties.
- (2) Determinations that this enhancement is not appropriate for the intended use of the building or not possible within the project or lease budget shall be made by the Director or his designee. Determinations of whether this enhancement to accessibility is appropriate should consider the potential of access by people with disabilities. The Director may determine that powered door openers are appropriate for the primary entrance while not warranted or not possible within the budget for access to restrooms. The Director may also determine that one or both of these enhancements are not feasible in (a) the renovation of an existing building due to its design or configuration or (b) in a leased facility due to the nature and circumstances of the lease.”

B. Energy Efficient Products

- (1) Select, where life-cycle cost-effective, products that are in the upper 25 percent range of the energy efficiency rating. Energy efficient products include:
 - a. Heating and cooling equipment;
 - b. Motors;
 - c. Lighting fixtures, compact fluorescent light bulbs, exit signs;
 - d. Windows, doors and skylights;
 - e. Roof products;
 - f. Food service equipment;
 - g. Transformers;
 - h. Office equipment;
 - i. Electronics; and
 - j. Appliances.
- (2) Exceptions
 - a. Energy efficient products that have been stipulated as life-cycle cost-effective by DFCM.
 - b. ENERGY STAR® products that are certified and labeled through the US Environmental Protection Agency.
 - c. Energy Efficient Products listed items on General Service Administration, GSA Advantage website. “Energy Efficient Products” mean items that meet Federal Energy Management Program (FEMP) energy efficiency levels as required by the Federal Acquisition Regulation (FAR) Subpart 23.203, Executive Order 13123, and Executive Order 13221.

C. Energy Design Standards: See Section 5.0 High Performance Building System

D. Hazardous Materials

- (1) DFCM shall procure a qualified abatement consultant during the Schematic Design phase of the Design stage. The abatement consultant shall survey all renovation and demolition projects for hazardous materials such as asbestos-containing building materials, lead-based paint, mold, universal wastes such as PCBs, CFCs, mercury, household/janitorial cleaning products, identified/unidentified containers of chemicals or products, or any other materials or waste that may be environmentally unsafe.
- (2) Prior to the start of a survey by the abatement consultant, the A/E shall provide drawings at the design development phase of the design stage to the abatement consultant with sufficient information to define the building or facility areas affected by the renovation or demolition. The abatement consultant shall coordinate abatement documents with the updated Contract Documents prior to final preparation. The abatement consultant shall prepare a complying and comprehensive hazardous materials survey report identifying and quantifying all hazardous and non-hazardous building materials to include asbestos-containing building materials, lead-based paint, mold and universal wastes that affect the areas of renovation or demolition.
- (3) DFCM shall procure a qualified abatement contractor to remove all hazardous materials prior to the beginning of any building demolition or renovation.

E. Vibration

- (1) Design structure in accordance with the following minimum requirements for vibration:

Space Category	Vibration Sensitivity
Laboratories with equipment sensitive to vibration	Comply with manufacturer's requirements for vibration.
Offices, classrooms, and other similar spaces.	There are no vibrations from machines or traffic which are detectable by people.
Common Area spaces.	There is occasional movement in the floor when heavy equipment are moved nearby.
Storage spaces.	There is obvious and annoying movement when people walk by or equipment is being moved nearby.

F. Utah Space Standards

- (1) Comply with the "Utah Space Standards," August 1994. Refer to dfcm.utah.gov/wp-content/uploads/State-of-Utah-Office-Standards_2016.02.26.pdf

G. Infrastructure Flexibility

- (1) Interior Shear Walls: Minimize interior shear walls, bearing walls and braced frames which may disrupt future additions or modifications to the facility.
- (2) Spare Mechanical Space: Provide 25% spare space in pipe chases and for mechanical equipment (except air handlers).
- (3) Main Electrical Room: Locate main electrical room close to transformer and near the center of the load (which is usually located near where central mechanical equipment is located). Locate panel boards in satellite electrical rooms dedicated for electrical equipment and which stack vertically in the facility.
- (4) Spare Electrical Capacity: Provide 25% future space for additional overcurrent protection devices in panel boards and switchboards. Provide 25% additional load capacity in addition to the capacity required for continuous loads in panel boards and switchboards.
- (5) Communication Rooms: Locate communications rooms so they stack vertically and comply with TIA/EIA standards.

- (6) Spare Communication System Capacities: Provide 100% future space (this is not necessarily horizontal space, but may be vertical space in racks for future equipment) for cabling, data, and communications electronic equipment.
- (7) Equipment Access: In new facilities, provide access for replacement of equipment which does not require demolition.
- (8) Storage Space: Provide a minimum 6' X 6' space for storage of janitorial supplies or .2% of the gross square footage, whichever is greater.

H. Standard Building Plaque

- (1) For development projects provide a design for a building plaque to be mounted on a prominent wall near the entrance to the building in compliance with the DFCM plaque standard. Refer to dfcm.utah.gov/wp-content/uploads/plaque_policy.pdf

3.2 Civil

A. Paving

- (1) Use untreated base course under all curbs and gutters. Use untreated base course material under all sidewalks exterior flatwork and paved areas.
- (2) Untreated base course under asphalt paving: Asphalt - 8" minimum compacted base (96%)
- (3) Concrete – curbs, gutters, sidewalks, exterior flatwork – Minimum 6" compacted base (96%) or minimum 4-3/4" crushed gravel.

Untreated Base Course	
Size	% by Weight Paving Sieve
1"	100
1/2"	70 to 100
#4	41 to 68
#16	21 to 41
#50	10 to 27
#200	4 to 13

- (4) Surface course (asphalt) aggregate:

Surface Course (asphalt)	
Size	% by Weight Paving Sieve
1/2"	100
3/8"	70 to 100
#4	50 to 78
#16	30 to 48
#50	18 to 31
#200	7 to 13

- (5) Base course (lower lift) can be 3/4" asphalt if placed in more than 1 lift.
- (6) Construct asphalt paving only when atmospheric temperature is above 50 degree F and underlying base is from moisture. Permit no vehicular traffic for at least 24 hours after laying asphalt pavements.
- (7) Striping paint: State of Utah #780. Spread at the rate of 103-113 sf/gal. Minimum thickness shall be 7 dry mil.
- (8) Tack coat all adjoining materials, i.e. previously constructed asphalt, concrete, etc. except untreated base course.
- (9) Surface smoothness: variation in the finished surface must not exceed 1/8" in 10 ft. in any direction.
- (10) Asphalt shall comply with Marshall Design with voids 1.5% to 3.0%
- (11) Drainage: Slope all asphalt concrete paving surfaces for positive drainage a minimum of 1.5% and preferable 2%.

- (12) Minimum thickness for parking areas: 3". Minimum thickness for road areas and truck traffic is 3" including dumpster access.
- (13) Maximum thickness for lifts: 3"

3.3 Architectural

A. Daylight and Outside Views

- (1) Daylight and outside views are desirable for all occupied spaces. The needs of some occupied spaces may require special consideration for light control.

B. New Roofing Requirements

- (1) Comply with Contractor Roofing Warranty: Include DFCM requirements. Refer to dfcm.utah.gov/wp-content/uploads/CRWform.pdf
- (2) Comply with Guaranty for Bituminous Roofing: Include DFCM requirements. Refer to dfcm.utah.gov/wp-content/uploads/bituminous_roof_warranty.pdf
- (3) Comply with Guaranty for Single-Ply Roofing: Include DFCM requirements. Refer to dfcm.utah.gov/roofing-program/
- (4) Comply with the list of DFCM approved manufacturers and approved installers.
- (5) Where manufacturer's standards show one or more possible approach for compliance to the standard, provide their most stringent approach.
- (6) Eliminate conflict between roof penetrations (i.e. vents, exhausts) and roof crickets, flashing, and valleys. Consider relocating penetrations to less visible areas. Provide 18" access for replacing roofing components.
- (7) In new facilities, build slope into roof structure in lieu of built-up insulation to solve roof drainage issues.
- (8) Minimum slope for all roofing and waterproofing systems shall be a ¼" per foot along the longest drainage path.
- (9) Do not provide the following components, unless approved by the Director: Other Roofing Components: ballasted roofs.
- (10) All roofing systems and components should meet or exceed all ASTM, UL and FM requirements.
- (11) Minimum 60 mil thickness required for all single ply roofs.
- (12) Minimum 4-ply, type VI felts with type III asphalt for all built-up roofs.
- (13) All metal associated with the roof should be color clad, use standing seam joints where possible. Follow SMACNA guidelines for all metal work.
- (14) Provide reasonable access to all roof levels for maintenance personnel.
- (15) Steep slope roofing should be designed as directed by the DCM Program Manager.
- (16) Comply with all other minimum standards as published by the DFCM roofing group.

- C. Roofing Requirements – Please see the DFCM Roofing website for a detailed description of the latest roofing design criteria and requirements at dfcm.utah.gov/roofing-program/. If for any reason, you are having difficulty accessing the page above, please contact DFCM immediately.

D. Waterproofing and Sealants

- (1) Warranty: For sealant systems, guarantee both labor and materials for a minimum of two years. For waterproofing project, guarantee both labor and materials for a minimum five years.

- (2) Qualifications: For Damp proofing and Waterproofing, select products that have performed successfully for a minimum 15 years and select manufacturers that have been producing materials for 15 years.

F. Acoustical Quality

- (1) When possible, design spaces in accordance with following minimum requirements for “Privacy.”

Privacy	
Space Category	Measured NIC Rating
Confidential with high voice levels	58-60+
Confidential with slightly raised voice levels	52-58
Confidential with normal voice levels	50-52
Confidential with lowered voice levels	45-50

- (2) Design spaces in accordance with the following minimum requirements for “Ambient Background Noise.

Ambient Background Noise	
Space Category	Measured NC Rating
Critical Performing Spaces	<20
Performing Spaces, Courtrooms, Executive Offices	20-30
Sleeping, testing, or relaxing spaces	25-35
Private offices, small conference rooms, classrooms, libraries	30 -35
Open offices, reception areas, cafeterias, gymnasiums	35-40
Lobbies, laboratories, maintenance shops	40 -45
Kitchens, industrial shops, equipment rooms	45-55

3.4 Structural

A. Concrete

- (1) Warranty: Provide additional two-year written guarantee commencing on the date of substantial completion to promptly remove and/or repair defective concrete (pitting, spalling, cracking, honeycombing, etc.).
- (2) Concrete Strengths & Testing: Provide minimum compressive strength measured at 28 days of 3000 psi for foundations, stem walls, piers, miscellaneous interior walls, etc., and 4000 psi minimum for all exterior flatwork, ramps, curbs, gutters catch basins, concrete pavements, interior floor slabs, elevated slabs, shear walls and columns. DFCM allows shear wall and columns to be specified in excess of 4000 psi. Specify pre-cast concrete with a minimum strength of 5000 psi.
- (3) Cement Types: Comply with the recommendations of the Geotechnical report. DFCM requires one of these types: Type I or Type II (both low alkali) and Type V. In southern Utah, usually select Type V. In other parts of the state select Type I or Type II (low alkali).
- (4) Concrete Mix: Provide low alkali cement for all concrete in direct contact with earth. Specify water/cement ratios in accordance with ACI 318. Specify number of bags of cement per/yard in accordance with C150. Provide admixtures complying with the requirements of ASTM C260 for air entrained concrete. Do not use “IA”, “IIA”, etc. For frost resistant concrete, the following minimum air contents are required for concrete in direct contact with soils or exposed to severe salting: for ¾” maximum aggregate size per C33, provide air content per ASTM C260 of 6-1/2%+ 1-1/2%; for 1”, provide 6%+ 1-1/2%; for 1-1/2”, provide 5-1/2”+1%. Water cement ratios shall be limited to 0.50. (excluding grout mixes) The slump of all concrete shall be limited to 4” unless plasticizers are used. A maximum of 10% fly ash is allowed.

- (5) Testing: DFCM shall pay for testing, unless other procedures are specified. The frequency and minimum numbers of test cylinders shall be as outlined in the IBC, however at least three test cylinders must be taken from each pour related to a structural member. The intent is to not to do testing on concrete for items such as curb, gutter, sidewalk, mow strips, light pole bases, etc. Concrete testing shall not be required where allowed by the currently adopted building code.
- (6) Reinforcement: Reinforce all concrete with conventional rebar or welded wire fabric. Slabs on grade supporting less than 400 psf uniform loads and no rack loads may be un-reinforced. The sub-base for all un-reinforced slabs must be uniformly compacted with on-site observation and per requirements specified in the project specifications.

3.5 Electrical

The latest adopted edition of the following Codes and Standards are to be considered a minimum requirement for Section 3.6. Where items contained in this section are in conflict with any of the following codes or standards, the more stringent requirement shall apply: National Electrical Code – NEC; International Building Code – IBC; International Energy Conservation Code; Illuminating Engineering Society of North America – IESNA Handbook; UL 96A; NFPA 780; Utah State Fire Marshal’s Rules R710; National Fire Alarm Code – NFPA 72; and Agency/Institution Design Standards (comply with the latest edition of the design standards of the project agency or institution. If conflicts exist between DFCM and these design standards, obtain written clarification from representatives of DFCM and the agency/institution).

A. Lighting

- (1) All lighting shall meet or exceed the current energy code for lighting power density, control requirements, and other requirements. All lighting shall utilize the most efficient fixtures available to meet the project requirements and budget. Incandescent lighting shall generally not be used, but may be used with the approval of the DFCM representative in the following applications: theaters/stages, television studios, and art galleries. However, in these applications, LED lighting shall be strongly considered. Exterior Lighting shall be LED unless approved by the DFCM Director. Refer to Section 5.0 for additional requirements on lighting energy requirements.
- (2) Light Pollution Reduction: Use full cut-off outdoor lighting fixtures for luminaries with more than 3,000 lumens and locate so that the maximum candela value falls within the property. Provide shielding or controlled distribution for any luminaries within a distance of 2.25 times its mounting height from the property boundary so that minimal light from the luminaire illuminates past the property boundary. Interior lighting shall be positioned so that the maximum candela value does not fall outside the interior space, such as out through a window).
- (3) Lighting Fixtures. Provide lenses that will not yellow due to exposure to sunlight or to the light sources in the fixture. When acrylic diffusers are specified, provide 100% virgin acrylic. Provide electronic ballast suitable for the load type, energy savings, and starting temperatures required. Provide program start ballasts if available for the lamp type. Connect equipment grounding conductor to fixture housing. Provide 10% spare lamps, diffusers, or glass for each light fixture type with not less than one for less than 10 lighting fixtures.
- (4) Interior Lighting: Provide T-8 lamps in fluorescent fixtures, except for areas requiring special lighting. Dimming of fluorescent fixtures should be avoided. Consideration shall be given to LED lighting for most applications. Provide independent safety-wires attached to structure in compliance with seismic requirements. For recessed fixtures that are removable, locate outlet box with 3’ of steel flexible conduit to the fixture to aid in removing and relocating fixture.

- (5) Exterior Lighting: Exterior Lighting shall be LED unless approved by the DFCM Director. Provide break-way fuses for all phase conductors for all outside pole-mounted lighting fixtures. Provide a shorting fuse insert for neutral fuse holder. Do not use common neutral multi-wire circuits for this type of lighting.
- (6) Reflected Ceiling Plan Coordination: Coordinate the lighting fixture with the reflected ceiling plan for suspended, lay-in, and surface-mounted fixtures. Recessed lighting fixtures in acoustical tile ceiling shall be located centered on a single tile.
- (7) Lighting Fixture Supports: Provide swivel bases for stems supporting lighting fixtures which exceed 12" in length.
- (8) HID Sources: Use metal halide sources. Provide Pulse Start Metal Halide lamps and electronic ballasts. Where High Pressure Sodium sources are approved, use auto-regulating ballasts.
- (9) LED Sources: Individual LEDs shall be tested in compliance with IES LM-79-08, and rated life shall be as determined by IES LM-80-08 and IES TM-21-11. The complete reports shall be available if requested. Specify high-CRI (85 or higher) sources. CRI (Ra) shall be based on CIE/IES definition using 8 color criteria. Driver and LED modules shall operate without measurable flicker below 25 kHz. Provide high power factor drivers (>.90). LED modules and drivers shall be replaceable in the field.

B. Raceways to 600 V

- (1) Raceways, Fittings, and Boxes. Provide steel raceway, fitting, and box system for all wiring, except that plastic conduit (minimum schedule 40) may be installed underground and aluminum cable trays may be installed for communications cabling. For steel raceway when installed in contact with soil, provide rigid or IMC PVC coated or wrapped raceways, fittings, etc. Provide steel raceways for penetrating structural elements (minimum 6" each side) and rigid steel conduit (PVC coated or wrapped) for bends greater than 30 degrees. Provide minimum 1/2" raceways except communications raceways shall be 1" minimum. Larger sizes may be required depending on users' cabling requirements. Provide flexible steel conduit (minimum 1/2") in short lengths where movement, vibration, misalignment, or cramped quarters exist. Provide insulated throat or equal type plastic bushings for box connections. Provide liquid-tight flexible conduit with approved moisture-tight fittings for wet, humid, corrosive, or oily locations. Provide a minimum 18" liquid-tight flexible conduit at each motor.
- (2) Electrical Supports: All raceways, boxes, and conductors shall be supported independently from all other electrical or mechanical systems, directly from building structure by a listed supporting device. Provide outlet boxes with rigid support using metal bar hangers between studs.
- (3) Equipment Pads. Provide concrete pads a minimum of 6" beyond the dimensions of the equipment. Extend equipment pad a minimum of 4" above finished floor or grade.
- (4) Future Raceways: Provide five capped spare 3/4" conduits from each section of a flush-mounted branch panel board into the ceiling and floor space. If the floor space is not accessible, provide an additional 3/4" conduit from each section of a branch panel board into the ceiling. Provide 200-lb. nylon pull cord in all empty conduit, then cap raceway using a blank cover similar to adjacent wiring device covers.
- (5) Underground Raceway Identification and Installation: Provide direct buried conduit in an area outside a building not less than 24" deep, with magnetic "yellow warning" ribbon 12" directly above and 6" below finished grade measured from the top of the conduit or duct bank.
- (6) Do not provide the following, unless approved by the DFCM Director: exposed cable wiring; other raceways systems (electrical non-metallic tubing, aluminum conduit, die cast fittings, or steel cable trays).

- C. Conductors
- (1) Provide copper conductors for all wiring in sizes not less than #12 AWG.
 - (2) Aluminum conductors may be considered for feeders and services in sizes #1/0 and larger where approved by the DFCM Director and the user/agency of the project.
 - (3) Size conductors such that total voltage drop on feeders and branch circuits will not be greater than 5%.
 - (4) Metal Clad Cable. Type MC Cable is allowed only when concealed in ceilings or walls. MC Cable must be protected from physical damage and supported directly from the building or structure by use of a listed support. MC Cable home runs are not allowed. Home runs must be in conduit from the electrical panel or cabinet to the first junction or pull box. MC Cable Used for Fire Alarm System Signaling or Initiation Circuits must have an overall outer coating of red.
 - (5) Non-metallic sheathed cable may be used only for residential single or multi-family housing unless approved by the DFCM Director.
 - (6) Do not provide the following unless approved by the DFCM Director: exposed cable wiring; splices in panel board, switchboard enclosures, or in conduit bodies.
- D. Grounding: Provide a separate green grounding conductor enclosed with phase conductors in all raceways on the load side of the service entrance.
- E. Medium Voltage
- (1) Medium Voltage Conductors: Provide copper conductors with copper tape shields and EPR insulation and copper neutral in Medium Voltage Duct banks; or, in utility tunnels or other areas without public access, provide armored cable or rigid conduit. Comply, as a minimum, with the installation requirements for Medium Voltage Cable standard NECA 600-2003. Perform Hi-Pot test after terminations have been made, but before connections have been made to buses or apparatus. Perform continuity tests of all cables after entire installation and terminations have been completed. If a cable fails to perform, replace faulty cable and retest. All tests will be recorded and submitted with O&M manuals at project conclusion.
 - (2) Medium Voltage Duct Banks. For above-ground or interior of buildings in non-public areas, provide rigid galvanized conduit or armored cable marked with red HIGH VOLTAGE. For underground, exterior applications, or public areas, provide concrete encased duct banks (red dye) with raceways in multi-les of two and a minimum of one spare conduit (with polypropylene pull wire) per feeder. Provide rigid metal conduit for the first 10 feet or duct bank from a facility or manhole. Provide minimum 4" raceway.
 - (3) Lighting Protection: Provide lightning (surge) arresters for medium voltage transformers and switchgear located above ground outside.
- F. Motor Controllers
- (1) Provide NEMA rated magnetic motor controllers with thermal overload relays for each phase.
 - (2) Variable Frequency Drives: Provide variable frequency drives suitable for the application, factory pre-wired with integral disconnect, input filter, and integral ventilation. For interior location VFDs, size ventilation for ambient temperature of 32 degrees F. to 90 degrees F. Avoid outdoor location mounted VFDs; but, if required, provide ventilation for ambient temperatures from -30 degrees F. to 120 degrees F. Fault current rating shall be sized based upon the fault current analysis of the nearest upstream overcurrent device. Include factory startup and tune to optimize life of motor.
 - (3) Provide a manual bypass of the VFD as part of controller where motor redundancy is not provided. For fan motor applications, coordinate with mechanical engineer to determine if a bypass should be provided.

- G. Electrical Distribution
- (1) Overcurrent and Ground Fault Protection: Set overcurrent and ground fault protection based upon Fault Current Protection and Coordination Study prepared by a licensed engineer. Submit study with O&M manuals.
 - (2) Arc Flash Analysis: For new construction and where main panel size exceeds 400 amps, provide an Arc Flash Assessment in accordance with NFPA 70E. Specify labels to be provided at each panel indicating incident energy and arc flash category level.
 - (3) Transformers: Provide transformers with copper or aluminum conductors. Provide transformer taps of 4 taps – 2.5% above normal and 2 taps – 2.5% below normal. Adjust voltage output to obtain the proper value at the main disconnect.
 - (4) Metering: Provide secondary digital metering (including demand monitoring) at the main distribution panel(s) in each facility. For secondary digital metering of services of 800 Amps or greater, include Harmonic monitoring and an option for building automation or remote monitoring.
 - (5) Utility Metering: Comply with serving utility’s regulations, if applicable. Comply with utility’s metering requirements. Include cost assessed by serving utility.
 - (6) Switchboards and Panel Boards: Provide bus hardware installed on the bus for future over-current devices of not less than 25% minimum. Provide over-current devices in the same sequence as shown on the panel schedules or one-line diagrams.
 - (7) Panel Boards. Provide listed panel board construction for all branch panels and circuit breaker distribution panels. Load Centers and plug in circuit breakers may be used only in Residential Single and Multi-family residences unless approved by the DFCM Director. Key all panel boards alike and provide three keys.
 - (8) Circuit Breakers: Provide one-, two, or three-pole over-current devices with common handle (not field modifiable).
- H. Power Quality: The A/E shall design for power quality by following either the performance-based requirements for the prescriptive-based requirements as indicated below.
- (1) Performance Approach
 - a. The A/E shall include as a basis of design, an evaluation of potential Harmonic Risks to the Electrical Distribution System and provide a plan to mitigate these risks. The Power Quality Plan shall be approved by the DFCM representative. Power Quality Testing may be performed by the DFCM after the facility is occupied to determine the effectiveness of the Power Quality Mitigation approach.
 - i. The Plan shall address each of the items listed in the Prescriptive Approach below.
 - ii. In no case shall the voltage harmonic distortion be greater than 3% THD at the building’s main service or feeder panel, and at other points in the system where sensitive loads may be adversely affected by harmonic distortion.
 - iii. Electrical Distribution System components shall be sized for and/or mitigate the anticipated current harmonic distortion produced by the loads on the system.
 - iv. The effects of the approach on the overall energy efficiency of the building shall be considered.
 - (2) Prescriptive Approach
 - a. Electrical Services
 - i. Services of 300 KVA or larger shall be 277/480 volt at the Service Main Disconnecting means except for those proven to be unnecessary and approved by the DFCM Director.

- ii. Harmonic producing (nonlinear) loads such as lighting, VFDs, UPSs and computer rooms shall be separated or grouped as far as reasonably cost effective.
 - iii. All panels fed from a step down transformer with 120/208V 3-phase/4-wire secondary shall have 200% neutral feeders.
 - iv. All multi-wire branch circuits shall have dedicated neutrals or oversized shared neutrals that are at least one trade size larger than the phase conductors. Circuits with shared neutral conductors shall have multi-pole breakers per the NEC.
 - v. Provide 277 volt lighting wherever there is a 277/480 volt wye service available.
- b. Existing Electrical Services. Power Quality Testing should be performed prior to the Upgrade, Addition, or Alteration of any of the following Electrical Components or Systems, VFDs, UPSs, Step down Transformers and Generators. It shall be determined from this testing the proper equipment and method to be used that will insure that the existing system will not be adversely affected by the work to be performed. Power Quality Testing should be performed after completion to determine the effectiveness of the material and methods used.
- c. Power Factor. All new Construction or Upgrade of existing Electrical Services shall meet the minimum requirement of 95% and maximum of 98% Power Factor. The DFCM representative shall approve the method and layout of Power Factor Correction Capacitors prior to installation.
- d. Step down Transformers
- i. All step down transformers shall be Energy Star NEMA TPI K rated or HMT with 200% neutral capability, unless proven unnecessary and approved by the DFCM representative. The K rating shall be as determined by Manufacturer recommendations for the equipment they serve.
 - ii. All step down transformers feeding computer rooms or areas subject to high non-linear loads shall be fed from a Harmonic Mitigating Transformer with 200% neutral.
- e. Variable Frequency Drives. For motors 15 hp and larger, provide a minimum power quality performance of 12% current THD and 3% voltage THD measured at the VFD input terminals. This shall be accomplished by using Harmonic filters or a minimum of 12 pulse drive that will comply with the power quality performance requirements. For motors less than 15 hp, provide AC Line Reactors and/or DC link chokes with a minimum of 3% impedance. Provide output filtering if the motor is located more than 50 feet from the drive.
- f. Lighting. Electronic Ballasts shall have <20% THD for 277 volt lighting systems and <10% THD for 120 volt lighting systems. In existing buildings where high Harmonic Currents are present, provide <10% THD ballasts.
- g. Generators. For new construction, a service that is to be backed up by a generator shall be designed to have no more than 12% current THD or 3% voltage THD when measured at the point where the generator connects to the system, while loads are running on generator. For existing services to be backed up by a generator, power quality testing shall be performed to determine that there is not more than 12% current THD or 3% voltage THD and that there is not a leading power factor. If there is, it shall be corrected prior to bringing the generator on line.
- h. Uninterruptible Power Supplies. Provide a minimum power quality performance of 12% current THD and 3% voltage THD measured at the UPS input terminals. Provide filtering if necessary.

- i. Transient Voltage Suppression System. TVSS shall be provided for the main service of each facility with services greater than 200 amps. A second level of TVSS shall be provided for panels serving primarily computer or non-linear loads.
- (3) Miscellaneous Electrical
- a. Lightning Protection. If the risk analysis performed per HFGA 780 or UL 96A exceeds moderate risk, provide a lightning protection system. Minimum qualifications required: LPI-certified installer, designer, and inspector. Obtain a UL Master Label of LPI Label for the facility.
 - b. Generator Fuel Tank Size. When generators are provided, size fuel tank to comply with the needs of the facility or a minimum of 24 hours of operation at full load capacity.
 - c. Hazardous Classifications. Coordinate with the State Fire Marshal hazardous classifications and requirements, including class, division, and group requirements.
 - d. Electrical Penetrations: All mechanical or electrical penetrations of the exterior envelope must be sealed air tight to the air barrier of the exterior wall assembly. If the building does not have an air barrier then the penetrations must be sealed air tight to the existing exterior sheathing and cladding in order to prevent excess air leakage.
- (4) Structured Cabling
- a. Coordinate structured cabling requirements with the IT departments of DFCM, the institution, and the user groups.
 - b. Test all structured cabling systems to demonstrate compliance with TIA/EIA standards for the category of system selected. Include warranty and the test results in the Project Resource Manual.
- (5) Fire Alarm
- a. Provide addressable fire alarm systems as required by State Fire Marshal's Rules R710. The installation shall comply with the State Fire Marshal's Rules R710 and NFPA 72.
 - b. For DFCM-managed buildings, specify non-proprietary manufacturers. Examples of approved types are: Fire-Lite and Silent Knight. All other manufacturers shall be approved by the DFCM Director.
 - c. For institutional buildings, comply with the requirements of the institution.
 - d. Install class "A" looped systems or as approved by the Fire Marshal.
 - e. Fire alarm wiring shall be installed in conduit.
 - f. Do not use the following components unless approved by the DFCM Director: other manufacturers, zoned fire alarm panels, ionization smoke detectors, MC Cable.
6. Miscellaneous Systems: Coordinate requirements for other systems such as security, CCTV, audio/visual, etc. with DFCM, the institution, and user groups.

3.6 Mechanical - General

A. Standards

- (1) The latest editions of publications and standards listed here are intended as guidelines for design. They are mandatory only where referenced as such in the text of this chapter or in applicable codes. The list is not meant to restrict the use of additional guides or standards.

When publications and standards are referenced as mandatory, any recommended practices or features shall be considered required.

- a. Most recent adopted version of International Code Council
- b. ASHRAE: Handbook of Fundamentals.
- c. ASHRAE: Handbook of HVAC Applications.
- d. ASHRAE: Handbook of HVAC Systems and Equipment.
- e. ASHRAE: Standard 15: Safety Code for Mechanical Refrigeration.
- f. ASHRAE: Standard 52: Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- g. ASHRAE: Standard 55: Thermal Environmental Conditions for Human Occupancy.
- h. ASHRAE: Standard 62: Ventilation for Acceptable Indoor Air Quality.
- i. ASHRAE: Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings.
- j. ASHRAE: Standard 100: Energy Conservation in Existing Buildings.
- k. ASHRAE: Standard 105: Standard Method of Measuring and Expressing Building Energy Performance.
- l. ASHRAE: Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC Systems.
- m. ASHRAE: Standard 113: Method of Testing for Room Air Diffusion
- n. ASHRAE: Standard 114: Energy Management Control Systems Instrumentation.
- o. ASHRAE: Standard 135: BACnet: A Data Communication Protocol for Building Automation and Control Networks.
- p. ASHRAE: Standard 202: Commissioning Process for Buildings and Systems
- q. ASHRAE: Guideline #4: Preparation of Operating and Maintenance Documentation for Building Systems.
- r. American National Standards Association: ANSI Z 223.1.
- s. National Fuel Gas Code Standard 54.
- t. American Society of Mechanical Engineers: ASME Manuals.
- u. American Society of Plumbing Engineers: ASPE Data Books.
- v. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):
- w. ASHRAE HVAC System Duct Design.
- x. SMACNA HVAC Duct Construction Standards: Metal and Flexible.
- y. SMACNA HVAC Air Duct Leakage Test Manual.
- z. SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
- aa. Seismic Restraint Manual Guidelines for Mechanical Systems.
- bb. NFPA Standard 96.
- cc. ASTM A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- dd. ASTM A74: Standard Specification for Cast Iron Soil Pipe and Fittings
- ee. ASTM A106/: Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- ff. ASTM A197: Standard Specification for Cupola Malleable Iron
- gg. ASTM A234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- hh. ASTM A888: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- ii. ASTM B32: Standard Specification for Solder Metal
- jj. ASTM B88: Standard Specification for Seamless Copper Water Tube
- kk. ASTM C564: Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

- ll. ASTM C1540: Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings
- mm. ASTM D1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- nn. ASTM D2444: Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
- oo. ASTM D2661: Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
- pp. ASTM D2665: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- qq. ASTM D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- rr. ASTM D3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- ss. ASTM E336: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
- tt. ASTM E779: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
- uu. ASTM F876: Standard Specification for Crosslinked Polyethylene (PEX) Tubing
- vv. ASTM F877: Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems
- ww. All applicable regulations and requirements of local utility companies having jurisdiction.

B. Criteria

(1) Design Conditions

- a. Outdoor air design criteria is from weather data tabulated in the latest edition of the ASHRAE Handbook of Fundamentals.
 - i. Heating design conditions: 99 percent column heating dry bulb temperature.
 - ii. Cooling design conditions for sensible, latent and ventilation load calculations: 1 percent column dry bulb temperature, with its mean coincident wet bulb temperatures
 - iii. Cooling tower selection, and dehumidification load: 1 percent dew point, with its mean coincident dry bulb temperature.
- b. Occupancy:
 - i. Determine occupant density (persons/ft²) from the occupancy schedule of the Program.
 - ii. If this information is not available, use the occupancy density values in ASHRAE 62.1.
 - iii. For dining areas, auditoriums, and other high occupancy spaces, base occupancy densities on the number of available seats.
 - iv. Base sensible and latent loads per person on the latest edition of the ASHRAE Handbook of Fundamentals.

(2) Load Calculation Software Requirements

- a. Perform HVAC load calculations with a computer-based program using the latest ASHRAE Handbook of Fundamentals Heat Balance (HB) Method, Radiant Time Series (RTS) Method, or Transfer Function Method (TFM).
- b. The program must be capable of calculating each zone's peak heating and cooling loads as well as the whole-building simultaneous peak load.
- c. The program must calculate solar gains through fenestration, internal gains from occupants, including latent heat for cooling purposes, internal gains from lighting and equipment, outside air loads (sensible and latent) from ventilation and

- infiltration, and heat and moisture gains or losses through fenestration, walls, floors, and roofs.
 - d. Calculate the heating load without credit for occupants and internal gains.
 - e. Do not include safety factors in the HVAC load calculations unless specifically asked for in the Program.
- (3) Temperature
- a. Design for indoor setpoints specified in the Program.
 - b. Ensure control of dry bulb temperature range, allowing for seasonal and unoccupied set point adjustment.
 - c. Control surface temperatures surrounding the occupants to limit the detrimental effects of radiant temperature asymmetry. Use passive methods such as better R-values in materials, and active methods such as delivery of heating and cooling media (air, water, electricity, refrigerant) to offset undesirable surface temperatures.
- (4) Humidity Control
- a. Unless specific control ranges are required by the Program to protect materials or processes, humidity control is neither required nor encouraged
- (5) Air Movement
- a. Occupant comfort: Design to deliver air at less than 30 fpm air speed in heating and 50 fpm air speed in cooling at the occupied level.
 - b. Stratification: Reference ASHRAE 55 for allowable vertical air temperature stratification.
 - c. Airflow noise: Design to meet space and occupant noise level criteria as specified in the Program and or Section Noise Control below.
- (6) Building Pressure
- a. Manage the flow rates of building outdoor air, exhaust air and relief air by the HVAC equipment, reset as determined by the pressure differential of ground floor's exterior space with the outdoor, to achieve 0.02" - 0.05" wc positive building pressure when occupied.
 - b. Maintain positive building pressure when occupied, when outside dew point is higher than 47°F when unoccupied, and/or when specific space humidity control requirements must be maintained.
- (7) Ventilation
- a. Design ventilation rates to comply with ASHRAE Standard 62.1, latest edition, using the Ventilation Rate Procedure
 - b. Provide devices to measure and control minimum outdoor air flow for all variable air volume systems. Provide means for the outdoor air flow rate to be reported to the building DDC system.
 - c. Comply with all the technical requirements of Section 5.0 HPBS.
- (8) HVAC Noise Control
- a. Design all systems so that space RC is equal to or less than those listed in ASHRAE Applications, Noise and Vibration Control Chapter, Design Guidelines for HVAC-Related Background Sound in Rooms
 - b. Confirm design sound levels are achieved through field measurements in accordance with ASTM E336 "Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings"
- (9) Redundancy
- a. Provide for continuous operation through redundancy and/or modularization for facilities greater than 30,000 sf or which have critical functions or critical care residents.
 - b. The loss of one half or less of the design cooling or heating system for the entire facility shall be tolerated temporarily in the event of equipment failure for: heat

pumps, boilers, refrigeration machinery (excluding cooling towers), and condensate pumps.

- (10) Low-Load Operating Conditions (Shoulder seasons)
 - a. Design mechanical systems to be capable of stable operation at 10% of peak load capacity while maintaining space temperature requirements without equipment cycling that is outside of the equipment manufacturer's design and operating recommendations or that will shorten equipment life.

C. High Performance Building System

- (1) Reference High Performance Building System requirements

D. Operability and Maintainability

- (1) Locate mechanical rooms to take advantage of ductwork and piping proximities to major loads.
- (2) Locate all mechanical equipment within the building or on the property in areas not subject to flooding and 5 feet above the 100-year flood plain.
- (3) Accessible for Maintenance
 - a. Install equipment so that it can be safely and easily maintained and inspected.
 - b. Comply with OSHA and other access requirements (step height, reach length, railing and catwalks).
 - c. Comply with requirements for mechanical room sizes and manufacturer's recommended clearances around installed equipment.
 - d. Provide stair access to equipment installed on roof.
 - e. Provide disassembly access for all valves, piping, and equipment.
 - f. Do not locate equipment, panels, damper motors, or other elements more than three feet above a ceiling where access is required with a ladder. Provide walkways and /or catwalks for equipment above these heights.
- (4) Provide means such as overhead rails or structure for attaching winches, lifts, etc. for temporary lifting and support for removal of heavy and /or large parts.
- (5) Simple/Understandable to Operate
 - a. Design the HVAC system design to minimize the need for overly complex control systems.
 - b. Clearly describe and comprehensively document the sequence of operation for the control systems in Operator's manuals, as-built documents, and by posting as-build documents within the control panels.
- (6) Operations
 - a. Select equipment components, spare parts, and materials so that they are readily available and repairable by local technicians. Avoid special order and/or long lead items when other options are available.

E. Alterations in Existing Buildings and Historic Structures

- (1) Design HVAC systems to avoid affecting other systems and historic finishes, elements, and spaces.
- (2) Place exterior equipment where it is not visible. Recess equipment from the edge of the roof to minimize visibility of the equipment from grade. Alternatively, explore creating a vault for easier access to large mechanical equipment. If equipment cannot be concealed, specify equipment housings in a color that will blend with the historic face. As a last resort, enclose equipment in screening designed to blend visually with the facade.
- (3) Locate equipment with particular care for weight and vibration on older building materials.
- (4) Retain original plaster ceilings in significant spaces, such as lobbies and corridors, to the extent possible and modified only as necessary to accommodate horizontal distribution. Use soffits and false beams where necessary to minimize the alteration of overall ceiling

heights. In buildings containing ornamental or inaccessible ceilings, route piping and ductwork in furred wall space or exposed in the occupied building area. Consider exposed ducts in historic industrial buildings with open plan, tall ceiling, and high window spaces suited to flexible grid/flexible density treatments.

- (5) If new vertical air distribution risers are required, locate adjacent to existing shafts.
- (6) Select system types, components, and placement to minimize the alteration of significant spaces. In previously altered spaces, design systems to allow historic surfaces, ceiling heights, and configurations to be restored.
- (7) Retain decorative elements of historic systems such as ornamental grilles and radiators where possible.
- (8) Retain and enhance the performance of the original type of system where a new one cannot be totally concealed or would adversely affect historic spaces or features. For example, adapt existing radiators with modern heating and cooling units, rather than adding another type of system that would require the addition of new ceilings or other non-original elements.
- (9) To the greatest extent possible, ensure that space is available to maintain and replace equipment without damaging significant features and select components that can be installed without dismantling window or door openings.
- (10) Select temperature and humidity conditions that do not cause deterioration of building materials.
- (11) Locate and construct all mechanical rooms so that equipment can be replaced and repaired with standard, normally available equipment, without special or custom built dimensional requirements, and minimal disassembly.
- (12) Avoid locations requiring difficult lifting and / or heavy crane requirements that will interfere with occupant activities in an occupied building.

3.7 Plumbing

A. Domestic Water Supply Systems

- (1) Cold Water Service
 - a. Cold water service consists of a pressurized piping distribution system incorporating a separate supply line from the tap in the existing outside water main to the equipment area inside the building.
- (2) Materials
 - a. Exterior Buried
 - i. Copper tube: ASTM B88 Type K with wrought copper and bronze solder joint fittings in conformance with ANSI B16.22 or cast bronze solder joint fittings in conformance with ANSI B16.18.
 - ii. Ductile Iron Pipe Fittings and Joints, Class 150, with mechanical joints and fittings with set screw retaining glands conforming to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11.
 - iii. Polyvinylchloride Water Pipe, Fittings, and Joints conforming with NSF Standards #14 and #61 and cell classification 12454-A or -B per ASTM D-1784.
 - (a) Solvent cement to be low volatile organic compound (VOC) to meet South Coast Air Quality Management District (SCAQMD) Rule #1168.
 - b. Interior Buried
 - i. ASTM B88 Type K annealed (soft) copper water tube with 95% tin 5% antimony solder joints using wrought fittings.
 - ii. No joints below grade.
 - c. Interior Tube Supported by Hangers and Clamps

- i. ASTM B88 Type L hard drawn copper tube with wrought copper fittings and couplers up to 6", cast brass or bronze fittings and couplers for sizes 6" and larger.
 - ii. Joints:
 - (a) 95-5 Class SnSb solder
 - (b) Roll-grooved couplers and fittings for 3" and larger tube.
 - iii. Copper ProPress fittings conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117
 - iv. Crosslinked polyethylene tubing in accordance with ASTM F 876 and ASTM F 877.
- d. Penetrations
- i. All mechanical or electrical penetrations of the exterior envelope must be sealed air tight to the air barrier of the exterior wall assembly. If the building does not have an air barrier then the penetrations must be sealed air tight to the existing exterior sheathing and cladding in order to prevent excess air leakage.
- (3) Soil Cover
- a. For outside services greater than 6000 HDD, provide minimum cover of 48" or preferred cover of 60". In no instance shall the minimum depth be less than the frost line.
 - b. For outside services less than 6000 HDD: Provide minimum cover of 36" or preferred cover of 48".
- (4) Meters
- a. Meter water service with compound meter(s) furnished by the local department of public works.
 - b. Provide double check valves on incoming service.
 - c. Provide remote reading capability of meters.
 - d. Sub-meter irrigation systems.
 - e. Campus Water Meters.
 - i. Install meter in the main mechanical room or within easy access of mechanical spaces.
 - (a) If conditions do not permit inside installation, provide meter box outside.
 - (b) The meter box shall be 52" x 81" x 71" high with a concrete base under the meter, but the rest of the floor shall be gravel. Top shall have recessed eyes. Top to be poured separate so it can be moved off with a crane and the eyes shall be left large enough to insert a chain by which it can be lifted. Cover to have a 24 inch locking meter lid in center. Position meter so it can be read without personnel entering the vault. Water meter indicator shall be the totalize type reading directly in gallons of water. Water meter shall be installed with valves on both sides so meter can be removed and a bypass line installed. Sleeve around pipes passing through walls of meter box.
 - f. Where fire sprinklers are installed, connect the fire main ahead of the meter.
- (5) Gauges
- a. Provide pressure gauges with gauge cocks on each side of equipment and devices which have a pressure drop, such as PRVs, strainers, and heat exchangers.
- (6) Internal distribution to supply domestic cold water to all plumbing fixtures, water heaters and all mechanical make-up water needs.
- (7) Design distribution system to maintain adequate pressure and flow in all parts of the system under all operating conditions.

- (8) Use duplex booster pumping system if the water pressure is not adequate to provide sufficient pressure at highest, most remote fixture. Ensure that the water pressure at the fixture is in accordance with the International Plumbing Code.
- (9) Completely insulate, with vapor barrier, all domestic cold water piping above ceiling and where concealed in walls, or any location where condensation could cause mold growth or damage.
- (10) Provide water hammer arrestors at every branch to multiple fixtures and on every floor.
- (11) Valves
 - a. Use ball valves with full opening ports and adequate pressure and temperature rating up to three inches in size, and butterfly valves with wheel and gear operator for 4 inches and larger.
 - b. Provide valves near the main with a union for all branch lines of water which supply more than one outlet or unit.
 - i. Provide isolation valves as necessary and provide, as a minimum, valves for each toilet group outside of the toilet room, each floor, and each branch line that is 2" or greater
 - ii. Provide a quarter-turn ball shutoff valve on all water supply lines on the room side of the fixture.
 - iii. Supply lines from the valve shall be 3/8" brass, chrome plated.
 - iv. Provide chases or access panels to access valves, with proper identification on or near panel.
 - v. Water relief valves: Connect water relief valve exhaust or discharge to nearby floor drain. Provide sump in pipe tunnels at each cleanout.

B. Hot Water Service

- (1) Materials and valves: Same as cold water
- (2) Generate hot water with heaters utilizing natural gas, electricity or steam as an energy source. Support selection by an economic evaluation incorporating first cost, operating costs and life cycle costs in conjunction with the HVAC energy provisions.
- (3) Generate and store domestic hot water at 140°F, and temper to 120°F using a three-way mixing valve, before supplying to all plumbing fixtures.
- (4) Provide secondary drain pans under water heaters and hot water tanks, piped to the nearest floor drain.
- (5) Boost supply water temperature from 140°F to 180°F to dishwasher(s).
- (6) Evaluate heat pump hot water heaters where possible to save energy.
- (7) Ensure that hot water is available at the furthest fixture from the heating source within 15 seconds of the time of operation.
- (8) Distribution system consists of a piping system which connects water heater or heaters to all plumbing fixtures as required. Circulation systems or temperature maintenance systems are included.
 - a. Design and balance circulation systems to less than 4 fps velocity to minimize piping erosion.
 - b. Control circulation systems based on water return temperature and building occupancy.
 - c. Monitor domestic hot water supply and return temperatures and circulation pump status by the building automation controls system.
- (9) Provide water hammer arrestors at every branch to multiple fixtures and on every floor
- (10) Solar Water Heating
 - a. If lifecycle cost effective based on Program directive or five year ROI, meet at least 30 percent of the hot water demand for each new building or building undergoing a major renovation through the installation and use of solar hot water heaters.
- (11) Insulate hot water distribution systems per ASHRAE 90.1 and provide all exposed piping with PVC jacketing.

- (12) Coordinate installation to allow access for maintenance and replacement.
- (13) Provide combination temperature and pressure relief valve piped to adequate drain.
- (14) Specify flexible connections and tie-down straps to accommodate movement during seismic events.

C. Sanitary Waste and Vent System

(1) General

- a. Cast iron pipe centrifugally cast service weight (SV) soil pipe with cast iron drainage fittings conforming to ASTM A 74.
- b. Joint materials and systems
 - i. Hub and spigot with neoprene gaskets and lubricant conforming to ASA 021 and ASTM C 564 SV pattern.
 - ii. Cast iron hubless pipe and fittings conforming to ASTM A 888, CISPI 301.
 - (a) Hubless couplings shall conform to ASTM C 1277 for standard and ASTM C 1540 for heavy duty or CISPI 310.
- c. Polyvinylchloride (PVC) sewer pipe and fittings conforming to DR 35, ASTM D3034, bell and spigot type with reinforced rubber ring gasket integral with bell joint, material to meet ASTM D1784, D2444 and joint tightness in accordance with ASTM D3212.
 - i. Solvent cement to be low volatile organic compound (VOC) to meet South Coast Air Quality Management District (SCAQMD) Rule #1168.

(2) Buried Pipe

- a. SV hub and spigot cast iron pipe and fittings
- b. No-Hub standard weight cast iron pipe with either M-G couplings or heavy-duty stainless steel shielded couplings. The heavy-duty shielded couplings shall comply with ASTM C1540, with ASTM C564 neoprene gaskets,

(3) Interior Pipe Supported By Hangers and Clamps

- a. Hubless cast iron pipe using hubless cast iron soil pipe couplings certified to withstand a minimum of 50 psi internal pressure, or higher if required by application.
- b. Sump pump discharge shall be Schedule 40 galvanized steel pipe with NPT threaded joints and fittings.

(4) Plastic Drain, Waste and Vent Piping

- a. Plastic DWV may be either P.V.C. or A.B.S. as required by code, utilizing drainage pattern fittings.
 - i. P.V.C. (polyvinylchloride) pipe and fittings shall conform to ASTM D2665 with a flame spread rating of 25 or less
 - ii. A.B.S. (acrylonitrile butadiene styrene) pipe and fittings shall conform to ASTM D2661, CS 270 65
- b. Solvents for plastic piping
 - i. Solvents for plastic piping joints shall be certified to meet SCAQMD Rule #1168/316A. This includes but is not limited to PVC, CPVC, and ABS piping, all grades and sizes.

(5) Vent Piping and Fittings

- a. Same as waste piping above.

(6) Floor Drains.

- a. Provide floor drains in multi-toilet fixture restrooms, kitchen areas, mechanical equipment rooms, locations where condensate from equipment collects, and parking garages and ramps.
- b. Single fixture toilet rooms do not require floor drains.
- c. Provide cast iron body type floor drains with 6 inch diameter nickel-bronze strainers for public toilets, kitchen areas and other public areas.

- d. Equipment Room Floor Drains
 - i. Trenches with grating covers with bottoms sloped to drain are preferred but not required over multiple floor drains in mechanical equipment rooms and some laboratories
 - e. Parking Garages
 - i. Large diameter tractor grates or trench drains inlets when exposed to rainfall.
 - f. Water Still Drains
 - i. Provide Kimax glass to nearest main drain from water still drains or provide glass pipe for the first 20 feet horizontally or to the floor below.
 - ii. Provide cleanout at water still and at main drain line before glass is connected with soil piping
 - g. Provide drains indirectly connected to building drainage system for walk-in refrigerators and other places where food is stored.
 - h. Use deep seal traps or trap seals. Do not use trap primers.
- (7) Sanitary Waste Equipment
- a. Discharge specific drains in kitchen areas into a grease interceptor before connecting into the sanitary sewer in accordance with the requirements of the state health department and local authorities will determine which drains.
 - b. Discharge floor drains and/or trench drains in garage locations into sand/oil interceptors.
- (8) Automatic Sewage Ejectors
- a. Only use sewage ejectors where gravity drainage is not possible. If they are required, connect only the lowest floors of the building to the sewage ejector; for fixtures on upper floors use gravity flow to the public sewer.
 - b. Non-clog, screen less duplex pumps, with each discharge not less than 4 inches in diameter.
 - c. Connect to the emergency power system.
- (9) Pipe Tunnel Sumps
- a. Provide sump in pipe tunnels at each cleanout.
 - b. Three foot square and four feet deep with grating cover and porous walls.
 - c. Floor drains may be used in lieu of sump if depth of waste line is such that drains may be tied in.
- (10) Waterproofing Pans
- a. Provide membrane waterproofing pans for shower stalls and custodial floor sinks so they are 100% water tight.
 - b. Provide clamping device which clamps drain to pans.
 - c. Provide a mastic seal between floor drain bottom and lead or membrane so when clamping device is tightened there is a complete seal so no water can get through.
 - d. Do not clog weep holes.
 - e. Test pans by placing test plug in drain and filling with water overnight.
- (11) Dishwasher Connections
- a. Provide indirect connection for waste on automatic dishwashing machines. Install minimum 3" drain in an accessible location under conveyor table.
- (12) Cleanouts
- a. Provide cleanouts at base of each vertical rise, each turn in excess of 45 degrees and on straight runs every 50 feet.
- (13) Horizontal Waste lines:
- a. Provide dedicated minimum 3" horizontal waste lines with adequate cleanouts for garbage disposals and dishwashers.

D. Rainwater Drainage System

- (1) Size piping system based upon local rainfall intensity, with minimum pipe size = 3"
- (2) Roof Drains
 - a. Cast iron body type with cast iron high dome grates and membrane clamping rings.
 - b. Provide a separate overflow drain located adjacent to primary roof drain.
 - c. Overflow drains are the same drains as the roof drains except that a damming weir extension is included.
- (3) Rainwater Drainage Equipment.
 - a. Foundation drainage system with perforated drain tile collecting into a sump containing a pumping system as required by the applicable codes shall be provided.

E. Plumbing Fixtures

- (1) In compliance with the International Plumbing Code and local building codes.
- (2) Apply water conservation technologies to the extent that the technologies are life-cycle cost-effective, based on criteria established in Program, or 5 year ROI
- (3) Use plumbing products labeled under the EPA WaterSense program.
- (4) Reference the Architectural Barriers Act Accessibility Standard (ABAAS) for plumbing fixture accessibility clearances, installation, and accessories requirements.
- (5) Showers
 - a. Non-scald type shower valve with integral stops.
 - b. Vandal-proof institutional type shower heads with flow adjustment and adjustable head and spray.
 - c. Extend head out from wall so water does not run down wall when valve is turned off.
 - d. Provide watertight shower escutcheon with weep hole in bottom.
- (6) Drinking Fountains
 - a. Refrigerated type, wall hung drinking fountains with stainless basins.
 - b. Provide removable grid strainer to enable cable-style cleaning without having to dismantle the fountain.
- (7) Water Closets (Toilets)
 - a. Flushometer valve type
 - i. Either dual-flush or low-flow type, manually controlled. For single flush, maximum flush volume when determined in accordance with ASME A112.19.2 (1.28 gallon).
 - ii. For dual-flush, effective flush volume determined in accordance with ASME A112.19.14 and USEPA WaterSense Tank-Type High Efficiency Toilet Specification -1.28 gal.
 - iii. Exposed type flush valves with lever operator (no push buttons or floor operators), diaphragm type only.
 - iv. Screwdriver stop valves.
 - v. Concealed flush valves in restrooms subject to vandalism.
 - b. High Efficiency Toilets (HET) Water Closets Tank-Type
 - i. Do not specify unless approved by the Director
 - ii. If used, comply with the performance criteria of the U.S. EPA WaterSense Tank-Type High-Efficiency Toilet Specification.
- (8) High Efficiency Urinals (HEU)
 - a. Low-flow, flush-type fixtures.
 - b. Maximum flush volume when determined in accordance with ASME A112.19.2: 0.125 gallon.
 - c. Sensor valves are acceptable
- (9) Public Lavatory Faucets

- a. Use metered-type faucets for lavatories. Maximum water use: 0.25 gallon per metering cycle when tested in accordance with ASME 112.18.1 / CSA B125.1.
- (10) Emergency Fixtures
 - a. Eyewash (0.4 gpm per fountain), face wash (3 gpm each), or shower (20 gpm each) must be tempered immediately at the fixture or group of fixtures within 25 feet to deliver tepid water between 85°F and 100°F, at 30 psi, within 10 seconds, for a minimum period of 15 minutes, and must account for temperature drop across the valve (generally 20°F) at flow.
- (11) Faucets and Hose Bibs
 - a. Provide non-freeze type hose bibs with shut-off valves for the lines serving the hose bib located inside facility.
 - b. Provide faucet with hose attachment and vacuum breaker in each restroom so floor can be washed with clean water.
 - c. Provide hose bib with vacuum breaker in mechanical rooms and chiller rooms.
 - d. Provide non-freeze hose bib with vacuum breaker near cooling tower.
 - e. Provide hose bibs outside building for window washing, walk and area way washdown (generally not more than 150' on center).
- F. Natural Gas Systems
 - (1) Service Entrance.
 - a. Protect gas piping entering the building from accidental damage by vehicles, foundation settlement or vibration.
 - b. Where practical, the entrance should be above grade and provided with a self-tightening swing joint prior to entering the building.
 - c. Do not locate gas piping in unventilated spaces, such as trenches or unventilated shafts, where leaking gas could accumulate and explode.
 - (2) Gas Piping within Building Spaces.
 - a. Do not route gas piping through confined spaces, such as trenches or unventilated shafts.
 - b. Ventilate vertical shafts carrying gas piping
 - c. Locate gas meters in a gas meter room.
 - d. Use plenum rated fittings for all gas piping inside ceiling spaces.
 - e. Vent all diaphragms and regulators in gas piping to outdoors.
 - f. Provide seismic bracing for all gas piping within building
- G. Fuel Oil Systems
 - (1) Fuel Oil Piping
 - a. Schedule 40 black steel or black iron piping. Fittings of the same grade as the pipe material.
 - b. Bronze, steel or iron valves, may be screwed, welded, flanged or grooved.
 - c. Use double-wall piping with a leak detection system for buried fuel piping.
 - (2) Use duplex fuel-oil pumps with basket strainers and exterior enclosures for pumping the oil to the fuel burning equipment.
 - (3) Underground Fuel Oil Tanks
 - a. Double wall, non-metallic construction or contained in lined vaults.
 - b. Size for sufficient capacity to provide 48 hours of system operation under emergency conditions (72 hours for remote locations).
 - c. Provide a leak detection system, with monitors and alarms for both
 - d. Provide emergency power to all components of the Fuel Oil Storage system
 - e. Comply with local, State and Federal requirements, as well as EPA 40 CFR 280 and 281.

A. Air Distribution Systems

- (1) Supply air distribution systems are to be fully ducted to the spaces that are served.
- (2) Coordinate the location of any exhaust or relief air with mechanical air intake systems to avoid short cycling
- (3) Provide dedicated relief air path for all systems which introduce outside air. Exfiltration through the building envelope does not comply with this requirement.
- (4) Ductwork Materials:
 - a. Provide rectangular and round ductwork from galvanized steel, stainless steel or aluminum.
 - b. Meet or exceed SMACNA and ASHRAE Standard 90.1 requirements for duct construction, installation and leakage.
- (5) Volume Adjusting Devices
 - a. Provide devices that can be securely locked in place and are accessible for adjustment after construction.
- (6) Do not provide the following components, unless approved by the Director:
 - a. Duct Lining in the following applications:
 - i. Outside air ducts,
 - ii. Ductwork within 10 feet downstream of any device that adds moisture to the air stream
 - iii. Ductwork exposed to humid air stream above 70% RH such as swimming pool applications.
 - b. Fiberboard ductwork.

B. Piping System

- (1) Materials:
 - a. Steel:
 - i. Pipe:
 - (a) 2 Inch & Smaller: ASTM A53, Grade A, Schedule 40 black butt-welded or continuous welded steel.
 - (b) 2 1/2 Inch & Larger: ASTM A53, Grade B, Schedule 40 black butt-welded or continuous welded steel.
 - ii. Fittings:
 - (a) 2 Inch & Smaller: ASTM A197, Class 150 black malleable iron screwed.
 - (b) 2 1/2 Inch & Larger: ASTM A234, Steel butt weld, standard weight forged fittings.
 - b. Copper:
 - i. Tube:
 - (a) Up to 4" inclusive ASTM B88, Type L, hard drawn.
 - ii. Fittings:
 - (a) ANSI/ASME B16.23 cast brass and/or
 - (b) ANSI/ASME B16.29 solder wrought copper
 - iii. Joints:
 - (a) ASTM B32, solder, Grade 95 TA.
 - iv. ProPress option for copper tubing, fittings, and joints:
 - (a) Conform to material requirements of ASME B16.18, ASME B16.22, and IAPMO PS 117.
 - (b) Joints conform to ASME B16.18, ASME B16.22, and IAPMO PS 117.
 - c. Penetrations:

- i. All mechanical or electrical penetrations of the exterior envelope must be sealed air tight to the air barrier of the exterior wall assembly. If the building does not have an air barrier then the penetrations must be sealed air tight to the existing exterior sheathing and cladding in order to prevent excess air leakage.
 - (2) Underground Pipe
 - a. Comply with ASTM A106.
 - (3) Air Vents
 - a. Provide suitable air vents for all heat producing equipment (converters, unit heaters, coils, etc.).
 - b. Provide with manual air vent valves at system high points and drain valves at system low points.
 - i. Furnish suitable provisions, such as access panels, to permit full access to these valves.
 - ii. Manual air vents shall be 3/8" globe valves with 1/4" copper tubing to near floor or to locations where water may be caught in bucket.
 - iii. Drain valves shall be threaded for 3/4" hose connections.
 - iv. Provide water-tight sleeve and caulking around pipe for all piping passing through floors.
 - (4) Valves
 - a. Provide valves near the main with a union for all branch lines of water or steam which supply more than one outlet or unit.
 - b. Ball valves with full opening ports and adequate pressure and temperature rating up to 3 inches in size, and butterfly valves with wheel and gear operator for 4 inches and larger.
 - c. Valves 2" and larger on systems greater than 200 degrees F shall be flanged or grooved.
 - d. Provide chases or access panels to access valves. Provide proper identification on or near panel.
 - (5) Insulation
 - a. Insulate piping in compliance with prevailing energy code or the requirements of the High Performance Building Standard, whichever is more stringent.
 - b. Provide PVC jacket on all piping exposed to view, and in mechanical rooms
 - c. On pipes subject to condensation, use non-permeable insulation of perm rating 0.10, such as cellular glass or preformed composite insulation system.
 - (6) If glycol is used for freeze protection, use propylene glycol. Do not use ethylene glycol.
- C. Steam
- (1) Motor Operated Steam Valve:
 - a. If the existing central plant serving the campus is a steam system, provide a motor operated steam valve for each new building.
 - b. Coordinate location with the Agency.
 - c. If equipment requires steam when the valve may be closed, connect equipment ahead of motor operated steam valve.
 - (2) Design for gravity flow of condensate in lieu of providing vacuum pumps.
 - (3) Provide tunnels, chases, access doors, or crawl spaces for accessing steam piping. Do not install underground or in split tile
 - (4) Provide properly dripped steam mains. Provide drip legs ahead of all steam pressure reducing valves and steam coils to ensure clean, dry steam at the valve.
 - (5) Valves

- a. Low pressure steam valves shall have a 200 psi rating and allow renewable seats and discs.
 - b. For 100 psi steam line use 250 psi flanges and 300 psi screwed valves.
 - c. Provide valves near the main with a union for all branch lines of steam which supply more than one outlet or unit.
- (6) Piping
- a. 2" and smaller: schedule 80 black steel.
 - b. 2-1/2" or larger: schedule 40 black steel for low pressure steam (15 psig or less) and schedule 80 black steel for medium and high pressure steam (greater than 15 psig).
 - c. Condensate piping: schedule 80 black steel pipe, including underground return lines.
- (7) Underground Steam Lines
- a. Use pre-insulated pipe for underground steam lines, materials as noted above, with separate insulated conduits for steam and condensate return piping.
- (8) Expansion Provisions
- a. Provide expansion loops, swing joints, offsets, etc., for expansion of piping.
 - b. Do not use expansion joints except when expansion loops, offsets, swing joints, etc., are not possible due to space constraints.
 - c. If expansion joints are provided, provide adequate internal or external guides that are properly supported anchored.
 - d. Do not provide swing joints on main runs; however, swing joints may be installed on risers off the main.
- (9) Pressure Reducing Stations
- a. Provide pilot-operated valve for pressure reducing stations.
 - b. Provide a three valve bypass at all reducing stations with ample clearance to permit normal maintenance and inspection.
 - c. Use parallel pressure reducing stations when low demand is expected.
 - d. Provide safety relief valves on the low pressure side of regulator stations. Provide discharge piping to facility exterior in a safe location.
 - i. For pipes discharging near grade, install pipes into an eight inch concrete tie set upright in the ground (buried) over a gravel base twelve inches deep.
 - e. Provide pressure gauges on both the high pressure and low pressure sides of all regulator stations. Locate gauges so they will function when bypass is used.
 - i. Provide gauge cocks and pig-tails.
- (10) Steam Meter
- a. Refer to section 5.0 HPBS.
- (11) If campus system hot water system is turned off during the summer, provide alternate heating system for equipment requiring a heating source.
- (12) Miscellaneous Requirements
- a. Provide eccentric reducers when steam piping changes pipe sizes with the flat side on the bottom of the pipe.
 - b. Provide water-tight sleeve and caulking around pipe for all piping passing through floors.
- D. High Temperature Water
- (1) Comply with the specific requirements of the high temperature water provider.
- E. Natural Gas
- (1) Seismic gas shut off valve:
 - a. Provide a seismic gas shut off for each natural gas system.
 - (2) Natural Gas Piping

- a. Weld all concealed natural gas piping if larger than 4”.
 - b. Install flexible connections and tie-down straps to accommodate movement during seismic events.
- (3) Soil cover for outside services: Provide minimum cover of 24” or preferred cover of 36” for gas.

F. Building Automation

(1) Direct Digital Control:

- a. For new construction, use DDC with an open BACnet or LonTalk communication protocol in accordance with ASHRAE Standard 135.
- b. For repair and alteration projects and new additions to existing projects, the following options are permitted:
 - i. Installation of DDC with the BACnet or LonTalk protocol,
 - ii. Integrating the existing system with customized gateways to the BACnet or LonTalk protocol.
 - iii. Pneumatic control as an extension of an existing system, if specifically required by operating personnel
- c. Provide digital metering of electrical, hot water, steam, and chilled water sources to each facility. Refer to section 5.0 HPBS.
- d. Provide flow metering devices for hot and chilled water heating systems. . Refer to section 5.0 HPBS.

(2) Zoning

- a. Provide as many thermal control zones as is practical, but a minimum:
 - i. Provide one zone per 1,000 ft² of internal space.
 - ii. Provide one zone for every three perimeter enclosed offices.
 - iii. Provide a separate control zone when a room has more than one external exposure (e.g. corner office).
 - iv. Provide separate control zone for densely occupied spaces such as classrooms, conference rooms.
 - v. Provide separate control zone for unusual occupancy zones such as dining halls, computer room, entryways, etc.
 - vi. For perimeter radiant systems, provide Hydronic piping sub circuits to match the cooling zones.

(3) Control Valves

- a. Provide characterized-type ball valves for modulating control valves up to 2-1/2”
- b. Provide visual position indicators.
- c. Provide control valves with stem in the vertical position.
- d. If possible, provide packless valves.

(4) Dampers

- a. Provide low leakage design of felt or neoprene edges for fresh air, relief, and exhaust air dampers.
- b. Provide appropriate blade action for the application. Generally, provide opposed blade type for modulating control and parallel blade type dampers for mixing or on-off control.
- c. Provide controls that close the fresh air dampers on fan shutdown or power failure.
- d. Provide steel trunnions mounted in bronze sleeve bearing or ball bearings for damper blades. Do not exceed 48 inches in length between damper bearings.
- e. Provide dampers that close substantially tight and provide substantially the full area of the opening when open.
- f. Provide substantial bar or channel frames for dampers.

- g. For rectangular dampers larger than four square feet in area, provide additional corner bracing.
- (5) Space Temperature Sensors
 - a. If system supports DDC monitoring, provide solid state temperature sensors.
 - b. Temperature sensors in corridors, halls, restrooms and other similar unsupervised areas shall be flush mounted aspirating type with stainless steel cover.
 - c. Temperature sensors in public, but supervised areas shall have locking covers with concealed adjustment.
 - d. Temperature sensors in private offices may have exposed adjustments.
 - e. Avoid locating temperature sensors on outside walls or on partitions between offices.
- (6) Panels
 - a. Provide control devices, relays, piping, wiring and terminals in cabinets, except for switches, pilot lights, and push buttons mounted on the door.
 - b. Provide minimum 14 gauge steel or 12 gauge aluminum.
 - c. Equip doors with hinges, latches, and locks
 - d. Secure panels to walls, columns or floors with clearances required by NEC.
 - e. Provide two (2) keys for each panel.
- (7) Wall Mounted Control Diagrams
 - a. Provide plastic laminated copies of all applicable controls diagrams mounted on the wall in each equipment room.
- (8) Control Wiring
 - a. Provide control wiring in raceway complying with the requirements of Section 3.6 Electrical.
 - b. Label all control wiring on each end of wire termination points and where passing at intermediate locations passing through walls, in junction / pull boxes. Labels shall match wiring diagrams.
 - c. Control wiring shall NOT be spliced.
- G. Chilled Water System
 - (1) If the peak cooling load is 300 tons or more, provide at least two equally sized chillers at 67 percent of the peak capacity.
 - (2) Design chilled water system for a minimum 15°F ΔT , or higher if feasible
 - (3) Provide adequate system volume to minimize potential for chiller short-cycling
 - (4) For water-cooled chillers, design entering condenser water temperature to be 75°F
 - (5) Provide adequate valving to isolate the offline unit without interruption of service.
 - (6) Evaluate primary-only pumping.
 - (7) Analyze a waterside-economizer cycle during the design of the chiller plant and incorporate in the design if it improves the performance.
- H. Boiler Plant
 - (1) If the peak heating load is greater than 500 MBH, provide at least two equally-sized modular boilers sized at 67 percent of peak demand.
 - (2) Evaluate the use of condensing boilers where feasible.
 - (3) Evaluate methods to minimize pumping energy through strategies such as high ΔT , primary only pumping
 - (4) Provide boiler backup by redundancy or modularization.
 - (5) If a power burner is specified, determine the maximum allowable length of positive pressure flue.
- I. Condenser Water System

- (1) Provide each chiller with its own matching cooling tower or cell, and condenser and chilled water pump.
- (2) In the event of multiple cooling towers, provide equalizing lines and automatic control valves to allow individual chiller/cooling tower operation.
- (3) Use plastic pipe where possible

J. Roof-Mounted Equipment

- (1) Mechanical equipment, except for cooling towers, air-cooled chillers, evaporative condensers, exhaust fans, and packaged rooftop equipment, is not permitted on the roof of the building.
- (2) Provide access to roof-mounted equipment by stairs or freight elevator. Do not use ship's ladders.

K. Water Treatment System

- (1) Design the water treatment for closed and open hydronic systems with consideration of the operational and maintenance needs of all system equipment including such components as boilers, chillers, cooling towers, other heat exchangers, pumps, and piping.
- (2) Subject to the specific requirements of the components, the performance of water treatment for closed and open systems must include:
 - a. Closed Systems
 - i. $8.5 < \text{pH} < 10$
 - ii. $100 \text{ ppm} < \text{alkalinity} < 500 \text{ ppm}$
 - iii. $\text{TDS} \leq 500 \text{ ppm}$
 - b. Open Systems
 - i. $7.5 < \text{pH} < 9.5$
 - ii. $100 \text{ ppm} < \text{alkalinity} < 500 \text{ ppm}$
 - iii. Iron content $\leq 3 \text{ ppm}$
 - iv. Soluble copper $\leq 0.2 \text{ ppm}$
 - v. $\text{TDS} \leq 500 \text{ ppm}$
 - c. The methods used to treat the systems' makeup water must follow the guidelines outlined in ASHRAE Applications Handbook.
- (3) Provide BACnet or LonTalk self-contained controls for the chemical feed.
- (4) Provide for one year on-site service by water Treatment Company including supply of chemicals.
- (5) Provide treated water in the heating system until facility is accepted by DFCM.

L. District Steam Heating

- (1) When steam is furnished to the building, convert to hot water with a heat exchanger in the mechanical room near the entrance into the building.
- (2) Steam heating is discouraged inside the building, other than the conversion of steam to hot water in the mechanical room.
- (3) Investigate the use of district steam condensate for preheating domestic hot water.
- (4) Refer to section 5.0 HPBS.

M. Special Area HVAC Systems

- (1) Special areas such as atriums, auditoriums, entrance lobbies and vestibules, cafeterias, mail rooms, loading docks, computer and server rooms, fire pump rooms, BAS control rooms, and fire command centers may require dedicated HVAC systems, separate from

all other HVAC in the building, with individual controls to condition these spaces as required.

- (2) Provide dedicated cooling units to any spaces or processes which require continuous cooling such as telecommunication and main telecommunication rooms, electrical, and server rooms.
- (3) Provide a separate dedicated air-handling system for each mail room. Airflow must maintain negative pressure in the room relative to adjacent spaces.

3.9 Automatic Sprinkler Systems

- A. Provide an automatic sprinkler system in buildings when required by State Fire Marshals Rules R710. The Installation shall conform to State Fire Marshals Rule R710 and NFPA 13.
- B. It is desirable that all buildings constructed by the State of Utah be equipped with an automatic sprinkler system to provide added life safety for the occupants and to protect the building from fire loss.
- C. Fire sprinklers shall be considered as an integral component of building design when the availability of water supply and the cost do not make the installation prohibitive.
- D. Secondary structures and small buildings or buildings with low occupant loads may be excluded from this requirement with the approval of the Director.

3.10 Components

- A. Air Handling Units (AHU)
 - (1) Provide DDC (BACnet or LonTalk) self-contained controls that are capable of being connected to the central BAS. Controller must have a current-sensing device that transmits information to the BAS for calculating the energy consumption of the AHU motor.
 - (2) Additionally, control panel should include:
 - a. fuses,
 - b. high static shut off
 - c. fire shut off
 - d. speed reference control
 - e. fan status
 - f. cfm air flow measurement
 - (3) Provide with mixing boxes on the return side of the AHU.
 - (4) Construction:
 - a. Formed and reinforced, double wall insulated panels, fabricated to allow removal for access to internal parts and components,
 - b. Maximum 1% leakage on the casing.
 - (5) Fans
 - a. It is preferred that fans be direct drive centrifugal with backward inclined, SWSI airfoil wheels
 - b. Be sure wheels are rated for maximum motor speed
 - c. Fans for large, custom, or built up air handler units may be provided with a single, double or fan array type fan system. The fan type should be based on system performance, redundancy, maintenance and efficiency requirements, as well as owner/user preference.

- B. Outdoor Air Intake Locations
- (1) Locate outdoor air intakes as high as possible to minimize potential of outdoor air contamination.
 - (2) On buildings more than 40 feet tall, locate intakes a minimum of 40 feet above grade. On buildings less than 40 feet, the locate intakes as high as practical on the roof or on a wall.
 - (3) Duct outdoor air intakes directly to the AHU cabinet. Do not use the equipment room as an outdoor air intake plenum.
 - (4) Locate outdoor intake locations as far away from contaminate sources as possible, and not less than code required minimum. Sources include but are not limited to; generator exhaust, loading docks, vehicle garages and parking lots, sewer vents, exhaust fans, dumpsters, smoke break enclosures, etc.
- C. Filtration
- (1) For air handlers exceeding 10,000 cfm, provide pressure differential instrumentation across the filter bank to facilitate maintenance.
 - (2) Provide minimum MERV 8 filters upstream of all cooling coils and other devices with wetted surfaces per Standard 62.1- Section 5.8
 - (3) Provide minimum MERV 13 filters on all ventilation outdoor air intakes where the national standard for PM10 is exceeded
 - (4) Provide minimum MERV 13 filters on all ventilation outdoor air intakes where the national standard for PM2.5 is exceeded
 - (5) Specify that the Contractor replace all filters prior to building occupancy and provide one replacement set of filters for the entire facility.
 - (6) Provide pressure differential sensors across each filter bank. Monitor and alarm through the building automation system.
- D. Cooling and Heating Coils
- (1) Locate equipment and other obstructions in the air stream sufficiently downstream of the coil so that they will not come in contact with the water droplet carryover.
 - (2) Cooling coils
 - a. Select cooling coils at or below 500 fpm face velocity.
 - b. Coils with five or fewer rows may have a maximum of 12 fins per inch.
 - c. Coils with six rows or more should not exceed 10 fins per inch.
 - d. Provide stainless steel drain pan, piped to drain
 - (3) Heating coils
 - a. Select heating coils, including reheat coils, at or below 750 fpm face velocity.
 - b. Maintain fluid velocity below 3.5 fps.
- E. Pumps
- (1) Provide pressure gauge with gauge cocks as close to pump suction and discharge as possible and avoid pressure drops across valves, strainer, flexible connectors, etc.
 - (2) Provide suitable throttling valves on discharge side of constant speed pumps, such as globe valves, or balancing cocks. Throttling valve shall have set point position indicator and shall not be used for shutoff valve.
 - (3) Provide pot feeder across pump for each closed hydronic system.
 - (4) Variable Speed Pumps:
 - a. Do not install throttling valves on the discharge of a variable speed pump.
 - b. Utilize a venturi to measure water flow rate.
- F. Boilers
- (1) Use equal-sized modular boilers for hydronic heating applications. Exception: One smaller "Pony" boiler may be used to meet low load conditions.

- (2) Install boilers in a mechanical room with all provisions made for breeching, flue stack, and combustion air.

G. Chillers

- (1) Acceptable Compressor Range (tons)
 - a. scroll \leq 200 ton
 - b. $100 \leq$ screw \leq 500 tons
 - c. $200 \leq$ centrifugal
- (2) Specify appropriate ASHRAE and ARI Standards and certification.

H. Accessories

- (1) Provide air separators and expansion tanks for all closed hydronic systems regardless of piping arrangement.
- (2) Connect air separators and expansion tanks into piping system on suction side of distribution pump.

I. Hot Water Piping and Pumps

- (1) Materials acceptable for piping systems are stainless steel, black steel, cast iron and copper.
 - a. Size fluid velocity at less than 4 fps in Copper piping systems with temperatures above 100°F.
- (2) For copper piping, brazed, soldered and press-seal (test to 300 psig) fittings are acceptable; grooved or mechanically formed T-type fittings are not acceptable.

J. Isolation of Piping at Equipment

- (1) Provide isolation valves, shutoff valves, bypass circuits, drain valves, flanges, and unions for piping at equipment to facilitate equipment repair and replacement.
- (2) Equipment requiring isolation includes boilers, chillers, pumps, coils, terminal units, and heat exchangers.
- (3) Provide valves for zones off vertical risers, including drain valves.

K. Flexible Pipe Connectors

- (1) Fabricate flexible pipe connectors from annular close pitched corrugated and braided stainless steel.
- (2) Grooved pipe solutions are acceptable. Select gasket materials for each fluid type, including temperature and pressure requirements of each system.
- (3) Provide flexible connectors at all pumps, chillers, cooling towers, and other rotating equipment. Exception: In-line pumps, if manufacturer recommends against or prohibits.

L. Meters, Gauges, and Flow Measuring Devices

- (1) Provide each piece of mechanical equipment with instrumentation in addition to test ports to verify critical parameters, such as capacity, pressures, temperatures, and flow rates.
- (2) Calibrate each meter, gauge, and flow measuring device before startup and make provisions for periodic calibration at its location.
- (3) All the metering devices must be capable of transmitting information to the central BAS for monitoring and control.
- (4) Refer to section 5.0 HPBS

M. Unit Heaters

- (1) If a unit heater is higher than 10' AFF, use a centrifugal blower (not a propeller fan).

- (2) Provide all gas or oil unit heater with a 2-stage thermostat. On call for heat, the first stage cycles the fan. The second stage fires the burner.
- (3) For shop applications with heavy duty or corrosive atmospheres, provide sealed combustion units that bring combustion air from outside the space.

N. Converters

- (1) Provide side inlets and side outlets for all converters.
- (2) Provide pressure gauges with snubbers on the primary and secondary side of each converter.
- (3) Install thermometers on the inlet and outlet of the secondary side of each converter.

O. Do not provide the following components, unless approved by the Director:

- (1) Electric resistance heat
- (2) Variable Refrigerant Flow (VRF)
- (3) Furnaces

P. Air Delivery Devices

- (1) Ceiling diffusers or booted-plenum slots that are used in variable air volume systems must be specifically designed for VAV air distribution.
- (2) Booted plenum slots must not exceed 4 ft. in length unless more than one source of supply air is provided.
- (3) Select the locations of the air delivery devices and the ranges of their outlet airflow rates to ensure that the air diffusion performance index (ADPI) values remain above 80 percent during all full load and part-load conditions, and below the specified noise level to achieve the background noise criteria, in accordance with the test procedures specified in Appendix A of ASHRAE Standard 113.

Q. Noise Control

- (1) Subject to the restrictions noted elsewhere for duct lining, acoustic duct lining used in supply air systems shall be non-fiberglass material impregnated with an antimicrobial agent and covered by an internal perforated sheet metal liner.
- (2) Sound attenuators should only be used if other methods of noise reduction such as duct velocity reduction, lining, and fan location are inadequate to achieve noise performance requirements.

4.0 LANDSCAPE AND IRRIGATION STANDARDS

Landscape irrigation sprinkler and emitter systems shall comply with the requirements of the ASABE/ICC 802-2014 Landscape Irrigation Sprinkler and Emitter Standard except as modified by this DFCM Design Requirements, Section 4.0

4.1 General

- A. **Applicability.** The provisions of this section shall apply to all projects on state property that involve the development or major modification of landscaping regardless of funding source, and all other projects under the jurisdiction of the DFCM or under state mandates. This section does not apply to:
 - (1) Registered Historical Sites
 - (2) Sites submitted for Design Variance due to unique context. Refer to section 1.4 Changes/Additions to Design Requirements for instructions on the design variance process.
- B. **Site.** The Design Requirements apply to all non-enclosed and non-building landscape areas within project limit lines or natural boundaries including restoration of construction damaged areas to the extent practical. Refer to section 3.2 Civil for site grading, parking requirements, sidewalks, and vehicular and service paths.
- C. **Purpose.** A purpose of this section is to designate site landscape standards for the design of attractive, water efficient landscapes that are sensitive to the geological and historical context of the site. The DFCM envisions landscapes that will endure because they are sensitive to the cultural, social, and aesthetic values of a community; the climate, water resources, and other environmental aspects of a location; and the financial investment of installation and maintenance over the life of the landscape. It is recognized that DFCM projects cover a wide range of community sizes, locations, and climates.
- D. **Definitions**
 - (1) For irrigation related definitions, refer to the following website by the Irrigation Association: <http://www.irrigation.org/>
 - (2) For planting related definitions, refer to the following website provided by Extension: articles.extension.org/landscape_water_conservation
- E. **Designer(s).** Architect or another licensed professional as recognized by the State of Utah to perform Landscape Architectural services and documents submitted to the DFCM including the Site Landscape Plan, Planting Plan and Irrigation Plan. Designers to meet state and local license, insurance and bonding requirements and be able to show proof of such upon demand.
- F. **Contractor Qualifications and Experience.** The Contractor(s), sub-contractors, installers, and others providing materials or services and installing the site landscape shall meet state and local license, insurance and bonding requirements and be able to show proof of such upon demand. Contractors to be directly involved in regular meetings with owner and DFCM and site inspection.
- G. **Submittals**
 - (1) Submit all described documentation in sections 4.3 and 4.4 to the Landscape Architect for review and approval prior to construction or substantial completion as indicated.
 - (2) Contractor to submit all product literature and customer service information for products used/installed on project to Landscape Architect for review and approval prior to installation.

- H. Construction Inspection and Post-Construction Monitoring
- (1) During construction, site inspection of the landscaping may be performed by the DFCM, the local institution or agency.
 - (2) During construction a mainline pressure and leak test will be conducted.
 - (3) Following construction an inspection shall be scheduled with the DFCM to verify compliance with the approved landscape and irrigation plans. A Certificate of Substantial Completion Form shall be completed by the Contractor or Landscape Architect and submitted to the DFCM.
 - (4) Following construction a Water Use Efficiency Review (Audit) will be conducted by a certified Landscape Irrigation Auditor. The auditor shall be independent of the contractor, design firm and owner/developer of the project. The water performance audit will verify that the irrigation system complies with the minimum standards required by this ordinance. The auditor shall furnish a certificate to the DFCM, Landscape Architect, and installer certifying compliance with the minimum distribution requirements and an irrigation schedule.
 - (5) The DFCM reserves the right to perform site inspections at any time before, during or after the irrigation system and landscape installation, and to require corrective measures if requirements of this guideline are not satisfied.

4.2 Water Allowance

- A. The finished installed site landscape shall be designed to be maintained within a designated Water Allowance. Landscape water consumption must be at or below the Water Allowance for the established landscape. In order for site plantings to become established during the first year after planting, watering amounts may exceed the established Water Allowance.
- B. Use the EPA WaterSense tool at the following website to create the water allowance for your site. http://www.epa.gov/WaterSense/water_budget/. It is possible that the site and planting design will need to be adjusted to fit within the Water Allowance designated. Record the water allowance in the irrigation plans with the watering schedule; see section 4.7 B.
- C. For site landscapes with sports fields other justified planting or turf areas that may require more water than is designated by the Water Allowance, refer to section 1.4 Changes/Additions to Design Requirements for instructions on excusal from 4.2 A.

4.3 Landscape Design Standards

- A. Create a Landscape Plan with the following Design Guidelines:
- (1) Using the Water Allowance established for the sight, begin a water conscious design. Refer to the WaterSense website listed in section 4.2 to test percentages of turf and shrub areas to guide the design process.
 - (2) Topsoil Guidelines for Existing and Imported Topsoil
 - a. Imported topsoil installed on site to replace or augment existing soil on site shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. The imported topsoil shall be of uniform quality, free from subsoil stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil borrow shall contain no noxious weeds or noxious weed seeds.

- b. Topsoil testing is required to ensure that all specifications below for either “Ideal” or “Acceptable” categories are met. Soils fall within the “Not-Acceptable” range shall not be used unless sufficient soil amendments are added to reach the approved categories.

Category	pH	Soluble Salts dS/m or	Sodium Absorption Ratio (SAR)	Organic Matter %	Sand %	Silt %	Clay %	Texture Class
Ideal	5.5-7.5	<2	<3	≥2.0	<70	<70	<30	Loam (L), Silt Loam (SiL)
Acceptable	5.0-8.2	<4	3 to 7 SiL, SiCL, CL 3 to 10 SCL, SL, L	≥1.0	<70	<70	<30	Sandy Clay Loam (SCL) Sandy Loam (SL) Clay Loam (CL) Silty Clay Loam (SiCL)
Not-Acceptable	<5.0 >8.2	>4	>10	<1.0	≥70	≥70	≥30	Loamy Sand (LS) Sandy Clay (SC) Silty Clay (SiC) Sand (S), Silt (S), Clay (C)

TOPSOIL QUALITY*

COARSE FRAGMENTS *

Category	%>2 mm (>5.0% exceeds guidelines)	Rocks Present >1.5" (>1.5" exceeds guidelines)
Ideal	≤2.0	—
Acceptable	2.1-5.0	—
Not-Acceptable	>5.0	—

TOPSOIL NUTRIENT SPECIFICATION*

Category	Nitrate Nitrogen ppm	Phosphorus ppm	Potassium ppm	Iron ppm
Ideal / Acceptable	>20	>15	>150	>10

*from “Topsoil Quality Guidelines for Landscaping”, June 2002, AG/SO-02, prepared by Rich Koenig, Utah

State University Cooperative Extension Soil Specialist, and Von Isaman, QA Consulting and Testing, LLC.

- c. Mechanical Analysis shall be performed and shall conform to ANSI/ ASTM D 422.
- (1) Soil Preparation and Amendments (fertilizers). Soil preparation shall be suitable to provide healthy growing conditions for the plants and to encourage water infiltration and penetration. Soil preparation shall include scarifying the soil to a minimum depth of six (6) inches and amending the soil with organic materials and fertilizers based on the Soils Report in order to reach the “Acceptable” or “Ideal” category of soil composition from the tables in 4.3 A. 2.

- (2) Plant Selection. Choose site appropriate plant material. In most cases, this is water-efficient plant material. Refer to 4.1 C. to review the vision of DFCM landscapes.
- (3) Park Strips. Park Strips and other landscaped areas less than 8 feet wide shall be landscaped with water conserving plants and/or grass. Areas less than 5 feet wide shall not be planted in turf.
- (4) Practical Turf Areas. Plant turf only in areas of manageable sizes and shapes. Limit turf to areas where it provides a functional benefit. Selection of appropriate turf varieties should be determined by site location, functionality and climate. Excess turf may be replaced with a variety of other low water-use plants.
 - a. Areas less than 5 feet wide shall not be planted in turf.
 - b. Areas with slopes greater than 33% shall not be planted with turf.
- (5) Screening. Planting material should be used as a screening device for parking areas, service yards, transformers, and other site utilities etc. Trees in parking areas shall be selected based on reducing leaf litter and be “sap-drip” free.
- (6) Mulching. Use bark or rock mulches in tree, shrub and perennial beds to conserve soil moisture and increase soil nutrients. Mulch applied at the right depth will reduce weed growth and slow erosion. Organic mulches such as bark improve soil over time.
- (7) Appropriate Maintenance. Water-wise landscaping will reduce maintenance; however, it will not eliminate it. Low water-use landscapes are simply maintained differently than the average lawn. Maintain the landscape by pruning, fertilizing, watering, weeding mowing and proper deadheading of perennials and flowering plant material.

B. Submit the following to the DFCM for review and approval prior to construction:

- (1) A Landscape Plan with the following indicated graphically and labeled:
 - a. Project name, location, designer contact information, project boundaries, project address, street names, existing and proposed buildings, walls, fences, utilities, paved areas and other site improvements
 - b. Locations of all proposed plant material, landscape materials, mulches, and all other site amenities
 - c. Plant Schedule indicating botanical name, common name, and size for trees, shrubs, perennials, groundcovers, and seed mixes
 - d. Proposed hardscape areas and materials within scope
 - e. Existing and proposed contours and spot elevations
 - f. Existing vegetation
 - g. Necessary details for landscape amenities and installation instructions
- (2) Specifications
- (3) Water Allowance Results Sheets(s) created from Step 3 of EPA WaterSense Tool

C. Submit the following to the DFCM for review and approval prior to substantial completion:

- (1) As-Built Drawings
- (2) Operations and Maintenance Plan including the following:
 - a. A signed and dated written description of the contractor’s one-year landscape warranty period beginning from the date of substantial completion. Include name, address, phone number and license number.
 - b. All product literature and customer service information for products used/installed on project.

4.4 Irrigation Design Standards

A. Create an Irrigation Plan with the following Design Guidelines:

- (1) Recommended Point of Connection (POC) component installation order: 1-connection to source, 2-stop and waste valve/ or shut off, 3-filtration device, 4-pressure regulator, 5-backflow preventer, 6-quick coupler blowout, 7-master valve, and 8-flow meter – (if required).
- (2) In situations of secondary water supply, provide filtration system necessary to clean water supply and protect irrigation system components. Provide accessible pressure gauges immediately upstream and downstream of the filtration device. (Non self-cleaning units)
- (3) Landscape Water Meter. A separate irrigation system water meter and backflow prevention assembly that are in compliance with state code shall be installed for all new landscape irrigation systems. The landscape water meter and backflow prevention assembly shall be separate from the water meter and backflow prevention assembly installed for indoor uses. The size of the meter shall be determined based on irrigation demand.
- (4) Pressure Regulation. A pressure regulating valve shall be installed and maintained by the consumer if the static service pressure exceeds 80 pounds per square inch (psi). The pressure-regulating valve shall be located between the landscape water meter and the first point of water use or first point of division in the pipe and shall be set at the manufacture's recommended pressure for sprinklers and or drip/micro systems. Pressure regulation devices may include one or all of the following: 1-pressure regulation valve at the main line POC, 2-pressure regulation device on individual sprinkler heads, 3-regulation of low volume drip/micro systems.
- (5) Irrigation systems with 1" POC or 10,000 square feet and larger of landscaped area shall have a flow sensor and master valve installed. Systems with irrigated area of 1 acre and larger shall have a normally closed master valve. Where necessary, the master valve shall be capable of manual operation to allow manual use of the irrigation system. A normally open master valve is acceptable if the controller is capable to shut the valve off in event of unscheduled flow.
- (6) Automatic Controller. All irrigation systems shall include an electric automatic controller with multiple programs and multiple repeat cycle capabilities and a flexible calendar program. Controller shall be programmable for multiple start times for repeat and rest periods, and shall be capable of water budget adjustment. Controller shall be able to provide separate programs for turf zones, shrub zones, and drip zones. All controllers shall be capable of temporarily shutting down the system by utilizing internal/external options (such as rain, wind, and freeze devices) and the ability to adjust run times based on a percentage of maximum ET or by use of a soil sensor. Power wire and control wire shall not be contained in the same conduit.
- (7) On slopes exceeding 33%, the irrigation system shall consist of Drip Emitters, Bubblers or sprinklers with a maximum Precipitation Rate of 0.85 inches per hour and adjusted sprinkler cycle to eliminate Runoff. Lateral lines are to run parallel to slope when possible.
- (8) Each valve shall irrigate a landscape with similar site, slope and soil conditions and plant materials with similar watering needs. Turf and non-turf areas shall be irrigated on separate valves. No single zone shall be designed or installed with sprinklers of differing pressure requirements or precipitation rates. (Rotors, spray heads, drip emitters, micro sprays, etc. may not be mixed within a zone.
- (9) Drip Emitters or Bubblers shall be provided for each tree where practicable. Bubblers shall not exceed 1.5 gallons per minute per device. Bubblers for trees shall be placed on a separate valve unless specifically exempted by the DFCM.
- (10) Sprinklers shall have matched Precipitation Rates with each control valve circuit. All sprinkler heads shall be spaced at a maximum of 50% of design performance diameter of the sprinkler. In known windy areas sprinklers are to be designed with reduced head

spacing or low angle nozzles. Spacing shall be reduced below 50% of design performance diameter when conditions demand.

- (11) Check valves shall be required where elevation differences will cause low-head drainage. Pressure compensating valves and sprinklers shall be required where a significant variation in water pressure will occur within the irrigation system due to elevation differences.
- (12) Drip Irrigation lines shall be placed underground or otherwise permanently covered, except for Drip Emitters and where approved as a temporary installation. Filters and end flush valves shall be provided as necessary and as per industry standards.
- (13) Irrigation zones with overhead spray or stream sprinklers shall be designed to operate between 8:00 P.M. and 8:00 A. M. to reduce water loss from wind and evaporation. Drip or bubbler zones are excluded from this requirement.
- (14) Program valves for multiple repeat cycles where necessary to reduce runoff, particularly slopes and soils with slow infiltration rates.

B. Submit the following to the DFCM for review and approval prior to construction:

- (1) An Irrigation Plan with the following indicated graphically and labeled:
 - a. Project name, location, designer contact information, project boundaries, project address, street names, existing and proposed buildings, walls, fences, utilities, paved areas and other site improvements
 - b. Points of Connection present and future with static water pressure
 - c. Water meters
 - d. Pumps and sumps
 - e. Controller location(s), note manufacturer, model, size and number of stations used and central control
 - f. Lines and sizes, i.e. lateral, main, and pressure mains
 - g. Sleeve locations and sizes
 - h. Backflow preventers, quick couplers and hose bibs
 - i. Drip system pressure regulators and filters
 - j. Wire, i.e. control, remote control, and control wire junction boxes; label both ends and in junction box
 - k. Control valves, i.e. master, remote control, flush, pressure reducing, drip, etc., note station assignment, size, flow rate, pressure setting. D.U. and actual flow rates, if available from water audit for applicable valves
 - l. Sensors, i.e. rain, flow, and moisture
 - m. All sprinkler heads, rotary nozzles, bubblers, etc.
 - n. Capped lines and irrigation system removed or abandoned
 - o. Identify locations of existing utility systems encountered during installation, i.e.; gas, phone, sewer, etc.
 - p. Valve Schedule with flow rates in GPM for each valve
 - q. Watering Schedule listing valve station no. plant type, irrigation type, precipitation rate, and water times for initial plant establishment and post plant establishment
 - r. Irrigation Component Schedule
 - s. Necessary details and installation instructions
- (2) Specifications

5.0 HIGH PERFORMANCE BUILDING SYSTEM

The State of Utah Division of Facilities and Construction Management require each project meet a sustainable design standard. All projects must meet the following standards. In the case where a conflict arises between different sections, the more stringent requirement should apply and the Department of Facilities and Construction Management (DFCM) should be notified about the conflict.

5.1 Integrated Design Process

A. General Intent

- (1) The process and expectations outlined in section 5.1 includes certain activities and events that are required to happen during the project. Many of the activities are not required, but their inclusion is based upon the experience of DFCM and professionals that serve DFCM. The intent thereof is to inform the project team of what should happen over the course of a project to not only meet the requirements of the HPBS but also maximize the value of design and construction efforts to DFCM and the State of Utah.
- (2) Adjustments to the process outline below, in order to best suit the needs of each project, are expected and should be discussed with the project team periodically through the project and recorded in the OPR.
 - a. The Owner shall directly hire the Energy Engineer, Building Envelope Commissioning Agent, and Commissioning Agent in the programming phase.
 - i. For Design Build projects the Energy Engineer shall provide the Energy Engineering over the course of the entire project as part of the design build team.
 - ii. Energy modeling and LCCA will be reviewed by the DFCM's third party reviewer.
 - b. The Owner, Energy Engineer, Commissioning Agent, and Building Envelope Commissioning Agent, shall provide timely input to the design team related to the OPR, BOD, and related HPBS documentation.
 - c. An updated BOD and OPR, including narrative of HPBS goals and strategies, shall be included in each design phase submittal to the owner. Changes from one phase to the next shall be documented as to provide a record of the development of the project.
 - d. An updated sustainable site plan shall be included in each design phase submittal to the owner
 - e. A HPBS Workshop must be completed during the first half of each phase of the project. Goals, strategies, and performance metrics must be documented in the OPR, BOD, and project documents accordingly. Additional informal HPBS Workshops shall be held to provide clear direction to the project in regards to the requirements of the HPBS
 - i. As coordinated by the design team and DFCM Energy Program Director, each HPBS Workshop shall include, but not limited to, the following project team members:
 - (a) Design team members
 - (b) Owner
 - (c) Agency Project Manager
 - (d) DFCM Project Manager
 - (e) Agency Energy Manager
 - (f) DFCM Energy Program Director
 - (g) Facilities Operators, if unknown at the time, it must be clearly identified who will be in attendance to represent the interests of facility operations.
 - (h) Energy Engineer

- (i) Commissioning Agent
 - (j) User group representative(s)
 - f. The Owner, design team, Energy Engineer, Commissioning Agent, and Building Envelope Commissioning Agent shall review each design phase submittal for compliance to the HPBS. Appropriate design phase comments shall be provided to the design team within 10 business days.
 - g. The design team shall conduct a building envelop systems meeting, during design development and construction documents phases, to review possible envelope strategies. Topics to review included, but are not limited to, air, thermal and moisture performance, functional performance requirements, constructability, energy efficiency, aesthetics, mock ups, and testing.
- B. Programming
 - (1) The following must be provided during the schematic design phase of the project. The design team shall provide simplified modeling iterations of various conceptual design proposals including, but not limited to, massing, orientation, glazing orientation, and glazing amount for the Energy Engineer to assess.
 - a. On an as needed basis, projects may be permitted an exception to this requirement, if approved by the DFCM Energy Program Director.
- C. Schematic Design
 - (1) The following must be provided during the schematic design phase of the project.
 - a. The design team shall conduct a building systems meeting to review the possible systems applicable to the project. Agenda items to include, but not limited to, performance, LCC, first costs, operations and maintenance, and existing infrastructure integration.
 - i. The design team, appropriate Facilities Operators, Commissioning Agent, Agency Energy Manager and or DFCM Energy Program Director, General Contractor and appropriate subcontractors (if hired), and Energy Engineer must be in attendance.
 - b. DFCM Energy Program Director to sign Rocky Mountain Power's Incentive General Applications as provided by Architect
 - c. The Cost Estimator or General Contractor/Construction Manager must provide relevant supporting construction cost estimates to the Energy Engineer and Design Team in a timely manner.
- D. Design Development
 - (1) The following must be provided during the design development phase of the project
 - a. The design team shall conduct a second building systems meeting to review the possible systems applicable to the project. Agenda items to include, but not limited to, performance, LCC, first costs, operations and maintenance, and existing infrastructure integration.
 - i. The design team, appropriate Facilities Operators, Commissioning Agent, Agency Energy Manager and or DFCM Energy Program Director, General Contractor and appropriate subcontractors (if hired), and Energy Engineer must be in attendance.
- E. Construction Documents
 - (1) The following must be provided during the construction documents phase of the project.
 - a. The design team shall conduct a building controls meeting to review the possible systems applicable to the project. Agenda items to include, but not limited to, metering, controls, points, analytics and operations and maintenance.

- i. The design team engineers, appropriate Facilities Operators, Commissioning Agent, Agency Energy Manager and or DFCM Energy Program Director, General Contractor and appropriate subcontractors (if hired), must be in attendance.
- b. The Design Team shall coordinate all incentives and rebates as outlined in section 5.14.
- c. The Design Team shall submit all required documentation to DFCM as part of the CD submittal. The submittal shall include, but is not limited to the following.
 - i. Sustainable site plan
 - ii. HPBS Spreadsheet
 - iii. Any exceptions and appeals
 - iv. Owner's Project Requirements
 - v. Basis of Design
- d. The Energy Engineer shall submit all required documentation, per section 5.5, to DFCM as part of the CD submittal:
 - i. Energy Model Spreadsheet
 - ii. Life Cycle Cost Worksheet
- e. The CxA shall submit all required documentation, per section 5.12, to DFCM as part of the CD submittal:
 - i. Commissioning Plan
- f. The BECx A shall submit all required documentation, per section 5.13, to DFCM as part of the CD submittal:
 - i. Building Envelope Commissioning Plan

F. Bidding

- (1) Value engineering efforts and substitution request must be evaluated in context of the HPBS, preferred operations and maintenance procedures and performance impacts over the life of the building.
- (2) The General Contractor shall account for HPBS requirements including, but not limited to, functional testing, building envelope function performance testing, and building flush out, in the construction schedule.

G. Construction

- (1) Submittals and shop drawings related to HPBS requirements shall be reviewed by the CxA, BECx A and Energy Engineer in the time period set forth in the construction documents. Their review does not relieve or supersede the responsibility of the design team to review the HPBS related submittals and shop drawings for compliance set forth in the construction documents.
- (2) The Design Team shall provide the required incentive and rebate documentation to the DFCM Energy Program Director as outlined in Section 5.14 and related appendices
- (3) BECx related performance tests shall be tracked in the weekly OAC meeting minutes.
- (4) At a minimum, the BECx A shall attend, in person or via a conference call, OAC meetings monthly. Reasonable effort by other team members shall be made to discuss related issues at the beginning of each meeting
- (5) A building envelope commissioning kick off meeting shall be coordinated by the general contractor and BECx A.
 - a. Required attendees include, but are not limited to the following: Architect, DFCM Energy Program Director. Subcontractors responsible for the following building components shall attend when applicable; masonry, insulation, air barrier, cladding, glazing, roofing and others as dictated by the envelop design.
- (6) Testing of building envelope components, on the building mock up, shall be completed with acceptable results prior to installation of said components.

- a. The general contractor and subcontractors responsible for the installation of the components shall attend the functional testing
 - b. The BECxA shall review deficiencies and possible causes of failed tests with each subcontractor prior to leaving the site on the day of the test(s).
- (7) At a minimum the Commissioning Agent shall attend, in person or via a conference call, OAC meetings on a month basis.
- (8) A building systems commissioning kick off meeting shall be coordinated by the general contractor and CxA.

H. Substantial Completion and Project Closeout

- (1) The CxA shall coordinate with the agency Energy Manager to set up the project for benchmarking in EPA ENERGY STAR Portfolio Manager.
 - a. The agency Energy Manger shall report the ECI, EUI, GHG emissions and water used per EPA ENERGY STAR Portfolio Manager in its annual energy report to DFCM.
- (2) The CxA, Owner, and General Contractor shall conduct a Four Month Walk Through Performance Walk Through meeting.
- (3) The CxA shall finalize the incentive and rebates per section 5.14
- (4) The O&M manuals and As-Built documents must include, but is not limited to, the OPR, BOD, HPBS Worksheet, Energy Modeling Spreadsheet, Life Cycle Cost Worksheet, and Controls As-Built.

5.2 Context Sensitive Design

A. Site Design

- (1) The Design Team shall conduct a review of the local and regional planning documents pertinent to the project. These documents may include, but are not limited to:
 - a. Municipal Master Plan or Land Use Plan
 - b. Applicable Open Space Plans, including trail and recreation plans, municipal open space plans...
 - c. Municipal, Regional or State Transportation Plan
 - d. Local or Regional Stormwater Plans or Guidelines
 - e. Applicable environmental regulations that may apply to the site
- (2) The project design shall reflect the community vision for the site. The building site, open space design and access points shall reflect the goals of the regional and municipal planning documents.

B. Building Design

- (1) The building shall be sited and oriented to reflect the community development patterns and vision, while responding to the site, solar access, and other climate considerations.
- (2) The building design shall reflect the community vision and vernacular design patterns.

C. The façade design shall reflect the solar access and orientation of the site through the integration of shading devices, window location, and scale. Window to wall ratios that are appropriate based on building energy performance, orientation, and interior programming shall be integrated into the design.

D. Access

- (1) Provide enhanced access from the project entry to the identified pedestrian and transit access points at the perimeter of the site.
 - a. Ensure pedestrian paths are safe, accessible and maintainable by facility staff
- (2) Separate pedestrian paths from vehicular paths with landscaped barriers to the extent feasible.

- (3) Identify key paths on a Sustainable Site Plan drawing submitted at the Schematic, Design Development, and Construction Document phases.

5.3 Transportation Management

- A. Identify transportation management goals for the project to help reduce single rider vehicle impacts. This goal may be an overall percentage reduction in single-vehicle ridership, an increase in transit usage or the implementation of a carpooling program. Record this goal in the OPR.
- B. Incentivize transit use through a reduction in parking stalls provided. This reduction should be based on a 10% reduction in comparison to municipal requirements or a 25% reduction based on the 4th Edition Parking Generation Guide by the Institute of Transportation Engineers.
- C. Define clear, safe paths of access for pedestrians and cyclists from the public right-of-way to the building entry. Locate shower and changing rooms – as applicable – near these locations.
- D. Provide a minimum of 10 secure bicycle storage locations.
 - (1) After the course of one year Facility Operators shall assess the need to for additional bicycle storage racks and provide as necessary.
 - (2) If the project cannot or should not meet the above requirements, provide a written justification in the OPR.
- E. Provide a minimum of two reserved parking stalls for carpool vehicles and fuel-efficient, low emitting vehicles on each project.
- F. Implement three of the following strategies to reduce single vehicle ridership to and from the project.
 - (1) Identify transit and alternative transportation options for the users and site. Identify strategies to encourage transit ridership, such as reduced or free pass offerings.
 - (2) Incentivize transit use through increased parking fees or paid parking lots.
 - (3) Provide telecommuting and / or reduced work week programs to minimize single vehicle ridership to the building.
 - (4) Provide shower and changing room(s) for cyclists and those who exercise mid-day.
 - (5) Designate 5% or more of the total parking provided as parking stalls for low emitting/fuel efficient - locate these stalls in preferred parking locations.
 - (6) Provide alternative fuel stations as applicable for the project.
 - (7) Designate 5% or more of the total parking provided as parking for carpool vehicles- locate these stalls in preferred parking locations.
 - (8) Demonstrate single-vehicle ridership or vehicle impact reductions through an alternative method.
- G. The three strategies shall be identified in the OPR and included in to the Education and Outreach program for the building users and visitors.

5.4 Site Design

- A. Open Space Design
 - (1) Create an open space plan that defines the usable site areas, designates open space, and identifies the landscape and hardscape areas. These specific areas shall be shown on the Sustainable Site Plan drawing, include a brief description of the anticipated level of use of each of the areas, and submit with each design review phase.

- (2) Necessary pedestrian open spaces such as sidewalks, paths, and passive and active recreation areas, shall be designated. Include transportation management areas as indicated in section 5.3
 - a. Define active hardscape areas that will be used for pedestrian traffic or regular pedestrian or visitor use.
 - b. Define active landscape areas that will be used by building users and visitors regularly. Identify intended uses that may occur within this landscaped area.
 - c. Turf shall only be used at active landscape areas that are a minimum of fifteen feet in any direction and a minimum of 200 square feet. Exceptions to this shall be justified by local landscape and/or zoning standards. Any alternate use must be reviewed and approved by the DFCM Energy Program Director.
 - d. Define aesthetic and native or natural open-space areas, as applicable
 - e. Define active pedestrian hardscape areas that are used for emergency or non-active uses
 - (3) The Landscape Architect shall provide an estimated maintenance schedule for the landscaped areas, with an emphasis on the reduced maintenance and reduced water consumption of the native and adapted landscaped areas.
 - a. This maintenance schedule shall be included in the Operation and Maintenance Manuals for the project.
- B. Landscape Water Consumption
- (1) Create a site irrigation water use budget based on your location and site conditions, per the EPA Water Sense criteria.
 - a. Use the EPA WaterSense Tool¹ to identify the water allowance for the site after landscaped areas have been defined. A summary of the water allowance shall be included in the Operations and Maintenance Manuals for the project.
 - (2) Landscape water consumption shall be at or below what is identified as the monthly water allowance for the site by the EPA WaterSense Tool. Justification for exceeding monthly water reviewed and approved by the DFCM Energy Program Director. Design and implement landscape materials and features that respond to the allocated water budget identified in section 5.4.B.1 and meet the native and adapted landscape material requirements.
 - (3) Landscape features shall align with the anticipated use areas defined in the in section 5.4.A Integrate an EPA WaterSense Labeled irrigation controller into the irrigation system.
- C. Storm Water Design
- (1) Design, construct, and maintain storm water BMPs that manage rainfall on site and prevent the off-site discharge of precipitation from the first one inch of rainfall from a 24-hour storm preceded by 48-hours of no measureable precipitation.
 - (2) Implement at least two BMPs from the Best Management Practices for Storm Water²
 - a. Provide two BMP Information Sheets from the Guidance Document and a description of how the specific BMPs are implemented in the project.
 - b. Identify and describe the selected strategies in the OPR, and submit with the Design Development submission.
 - c. Implement one additional site performance standard as identified in items 2 through 5 on page 7-4 of the Storm Water Management Guidance Document.

¹ http://www.epa.gov/WaterSense/water_budget/

² Salt Lake County Engineering and Flood Control – Guidance Document for Storm Water Management – January 2012; Chapter 7. <http://www.pweng.slco.org/stormwater/pdf/longswplan.pdf>

- D. Heat-Island Effect
- (1) Plan exterior hardscape materials to reduce the urban heat island effect. Use materials with an SRI of 35 or greater for all pedestrian oriented paved surfaces and reduce the overall use of asphalt as feasible.
 - a. Reduce the dimensions of 25% of parking stalls to meet compact stall requirements of 8'-6" in width and 16'-0" in length. Provide either signage or striping to indicate the compact vehicles stalls on the site.
 - b. Indicate the compact parking on the Sustainable Site Plan drawing.
 - c. Use concrete at all pedestrian oriented hardscape areas. Colored concrete shall not have an SRI of less than 29.
 - (2) Use reflective roofing to reduce the urban heat-island effect at the building. Install a reflective roof with an SRI of 78 or greater over 75% of the low slope roof areas (slopes below or equal to 2:12) for all buildings in Climate Zones three and five.
 - a. Consider a tan colored, planted or ballasted roof at roofs that are visible from inside the building to reduce glare and increase occupant comfort.
 - b. Darker roofs shall be considered in climate zone 6, where heat absorption may be beneficial to the overall energy use of the building.
 - c. Install roofing with an SRI of 29 or greater at steep-sloped areas (slopes above 2:12)
 - d. SRI values for roofing and hardscape must be included in the Sustainable Site Plan.
- E. Light Pollution Reduction
- (1) Use fixtures that as low in height as feasible, to ensure light is at the appropriate location for pedestrian safety and functionality..
 - (2) All exterior lamps shall be LED.
 - (3) Lighting values greater than 0.01 fc shall not extend beyond twenty feet over the defined site boundary, except as required by the municipality for pedestrian safety.
 - (4) Exterior lighting shall be controlled by a photocell sensor.
 - (5) All interior lighting systems shall be designed and controlled to shield interior light from the exterior of the building, or include a 50% reduction in lighting output between the hours of 11:00 pm and 5:00 am.

5.5 Energy

- A. Energy Performance
- (1) All state agencies and institutions shall design new construction and major renovation, commercial and multi-family high-rise buildings (Proposed design) to achieve, if life-cycle cost-effective, an energy cost performance 20% below the energy cost performance of the corresponding Baseline design as determined by a DFCM hired Energy Engineer.
 - a. For the purpose of calculating the energy cost savings, include all fuel costs incurred for all systems normally specified as part of the Proposed design scope, regardless of specifying entity (interior & exterior), including receptacle and process load energy costs.
 - b. Energy costs for both the Baseline and Proposed designs shall be determined by using the Performance Rating Method as defined by Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings (with errata, without addenda).
 - c. The building/project Performance Rating percentage improvement shall be determined by use of the formula in paragraph G1.2 of *Standard 90.1-2010*, in terms of total energy cost, as follows.
$$\% \text{ Improvement} = 100 \times \frac{(\text{Baseline Utility Cost} - \text{Proposed Utility Cost})}{\text{Baseline Utility Cost}}$$

- d. Buildings or projects with a conditioned floor area less than 30,000 FT², or less than \$5,000,000 total project budget, or a projected EUI of less than 20 kbtu/FT²/yr may, by discretion of the DFCM Energy Program Director, be exempt from section 5.5.A.1.
 - e. Projects exempted from section 5.5.A.1 by the DFCM Energy Program Director are required to incorporate qualitative design assist from a state hired Energy Engineer.
 - f. For Design Build Competitions, each shortlisted team may engage an Energy Engineer, at their own discretion and expense, to provide design assistance during the design competition phase, to demonstrate compliance with the HPBS. The winning team's life cycle cost analysis and subsequent energy efficiency strategies will be subject to review and approval by a DFCM hired third party reviewer and DFCM Energy Program Director. At any time during the competitive proposal phase, design teams may access DFCM's third party reviewer to answer questions concerning the LCCA and adherence to the energy modeling protocol set forth in the HPBS. Contact information will be provided.
- (2) If no life-cycle cost effective package of measures can be found that meets the required energy cost savings, (cost effectiveness shall be measured in aggregate at the project level, rather than each measure individually), and then the life-cycle cost effective package that comes closest to achieving the required energy cost savings may be substituted.
- a. Life-cycle cost-effectiveness shall be determined using the FEMP procedure as described in 10 CFR 436 – *Subpart A – Methodology and Procedures for Life-Cycle Cost Analysis* and NIST Handbook 135 – *Life-Cycle Costing Manual for the Federal Energy Management Program - Dept. of Energy - Energy Life Cycle Cost Model – BLCC 5*.
 - b. Utility incentives must be included in the life-cycle cost analysis where applicable.
 - c. Life-cycle cost-effectiveness may be demonstrated by using one of the following methods consistently throughout the project.
 - i. Life-Cycle Costs
 - ii. Net Savings
 - iii. Savings-to-Investment Ratio
 - d. At the discretion of the DFCM Energy Program Director, the life cycle cost analysis and subsequent Energy Efficiency Measures strategy will be subjected to review and approval by an appropriate third-party reviewer, selected by the DFCM Energy Program Director.
 - e. All life cycle costing estimations must be provided with supporting documentation including but not limited to unit pricing, source of pricing, and labor wages.
- (3) Documentation demonstrating compliance with section 5.5.A.1 must be submitted through the DFCM Energy Program Director for review and acceptance by an appropriate Submittal Reviewer, selected by the DFCM Energy (or Energy Program) Director.
- a. Appeals regarding extenuating circumstances related to demonstrating compliance with section 5.5.A.1 may be submitted to the DFCM Energy Program Director, for consideration on a project/building specific basis. Appeals can only be considered if made prior to the Construction Document design phase.
 - b. Minimum documentation requirements for demonstration of compliance with section 5.5.A.1 are as follows, and must be based upon the drawings and specifications referenced in the final construction document bid set, including the completion of value engineering, bid alternates, and addenda.

- i. All relevant project information as required by *Standard 90.1-2010-G1.4* (Reference Appendix B – Project Energy Performance Statement (link to electronic copies))
- ii. All energy model input values not specified by *Standard 90.1-2010-G1.4*. Examples include, but are not limited to thermostatic settings and occupancy & equipment schedules. Software output reports may be used to demonstrate compliance with this section.
- c. Coordination regarding interpretation of Appendix G methodology and protocol can be discussed between the Energy Engineer and Submittal Reviewer on an as needed basis.
- d. The Submittal Reviewer shall review and discuss the energy modeling submittal with the Energy Engineer. Results of the discussion including clarifications and revisions shall be documented by the Submittal Reviewer with comments. Revisions to the energy model and revised documentation shall be provided in response. A meeting will be held with the Energy Engineer, Submittal Reviewer, and DFCM Energy Program Director, as necessary, to reconcile any outstanding issues. Final acceptance will be granted by the DFCM Energy Program Director.
- e. Projects seeking credit for Energy Efficiency Measures not addressed specifically by Appendix G, at the discretion of the DFCM Energy Program Director, may do so by demonstrating savings relative to a Baseline determined through collaboration between the Energy Engineer and Submittal Reviewer.

B. Appliances and Equipment

- (1) As available, provide appliances, equipment, products, and/or furnishings that meet one of the following criteria³.
 - a. ENERGY STAR Qualified.
 - b. EPEAT Registered
 - c. Products that meet or exceed the US Department of Energy's FEMP Energy Efficiency Recommendations
 - d. Rocky Mountain Power incentive, Questar Gas rebate program, or local utility company incentive/rebate approved equipment.
- (2) Credit for plug & process (unregulated) loads that are associated with products complying with section 5.5.B.1 may be given credit in the Proposed design energy model by following the exceptional calculation method described in *Standard 90.1-2010, G2.5*, or through use of the procedures described in section 6.4.5 of COMNET's *Commercial Buildings Energy Modeling Guidelines and Procedures*⁴.

C. Minimum requirements for new construction

- (1) The building envelope requirements in *Standard 90.1-2010 Tables 5.5.1-8* or code minimum, whichever is more stringent, are mandatory.
- (2) Minimum efficiency requirements of *Standard 90.1-2010 section 6.8 and section 7.8* or code minimum, whichever is more stringent, are mandatory for all new equipment covered under the standard.
- (3) The building envelope requirements of *IECC C402.3.1* are mandatory regardless if the project is complying with *ASHRAE 90.1* or *IECC*.
- (4) During design development the Electrical Engineer will provide a room-by-room count of installed and space-by-space allowed lighting power per *Standard 90.1-2010 Table 9.6.1*, as well as any lighting power exceptions taken per *Standard 90.1-2010 section 9.2.2.3*.

³ www.gsa.gov

⁴ www.ibpsa.us/sites/default/files/publications/COMNET-IBPSA-USA-Response.docx.

5.6 Water Efficiency

- A. Meet the EPA WaterSense⁵ requirements for high efficiency plumbing fixtures and appliances within the building.
- B. Once-through process water systems are not permitted.
- C. Identify water efficiency goals and system expectations into the OPR and BOD submitted at Design Development and Construction Documents phases.

5.7 Materials and Resources

- A. Provide recycling containers and implement a recycling program in all new buildings.
 - (1) Recycling containers shall be collocated with the garbage bins.
 - (2) If co-mingled recycling is not permitted, bins must be clearly marked.
 - (3) At a minimum, mixed papers, cardboard, mixed plastics, and mixed metals shall be recycled.
- B. Integrate water bottle filling stations at a minimum of one drinking fountain in the building.
- C. Implement a construction waste management plan to divert a minimum of 75% of construction waste, by volume, from the landfill.
 - (1) Provide a narrative for exceptions to compliance with section 5.7.C. Narrative shall define the feasible diversion rate, by volume, and is subject to review and approval by DFCM Energy Program Director.
 - (2) Contractor shall track recycled content, per the HBPS Worksheet, and provide a summary of construction waste at project construction meetings to be reviewed for compliance by the Architect.
- D. Sustainable Material Sourcing
 - (1) Identify and specify building materials that are both extracted and manufactured within 500 miles of the project site.
 - a. Only the value associated with the regional content, by percentage, shall contribute to the sustainable value of the product.
 - b. Key materials include concrete, concrete masonry, brick, stone, gypsum board, steel joists, and regionally manufactured misc. metals.
 - (2) Identify and specify building materials that contain recycled materials.
 - a. Recycled content shall be tracked as both pre-consumer and post-consumer recycled content. Only 50% of the value of the pre-consumer recycled content shall contribute toward the sustainable value of the product.
 - b. Only the value associated with the recycled content shall contribute to the sustainable value of the product.
 - c. Key materials containing recycled content include concrete, all metal containing materials, plastic containing materials, carpet, and suspended ceiling systems.
 - (3) 35% of building materials, by value, shall meet one or more of the above sustainable materials strategies.

⁵ http://www.epa.gov/WaterSense/water_budget/

- a. Provide the appropriate specification sections and documentation requirements in the construction document set to ensure the contractor understands the sustainable material requirements and expectations.
 - b. Contractor shall track sustainable material sourcing values and product purchase verification, per the HPBS spreadsheet. The Architect shall review summary values for compliance at the project construction meetings.
- (4) Only use low mercury or LED lamps in new construction projects.

5.8 Indoor Environment Quality

- A. Implement an indoor air quality management plan during construction. This plan shall meet the SMACNA IAQ Guidelines for Occupied Buildings Under Construction, 2nd edition ANSI/SMACNA 008–2008.
 - (1) The Contractor shall submit an Indoor Air Quality Plan to the CxA, outlining the implementation strategies to achieve the SMACNA requirements.
 - (2) Implementation of this plan shall be tracked on the weekly Construction Meeting Minutes.
- B. Implement a pre-occupancy air quality plan.
 - (1) At the end of construction, prior to occupancy, conduct an air quality test per USGBC LEED v4 Construction Indoor Air Quality Assessment requirements.
 - (2) The Test and Balance sub-contractor shall provide documentation to the Commissioning Agent demonstrating the dates and air flows achieved during the building flush.
- C. All interior paints and coatings shall meet the low emitting materials standards set forth by the South Coast Air Quality Management District Rule 1113, as adopted in January 2012.
- D. All interior adhesives and sealants shall meet the low emitting materials standards set forth by the South Coast Air Quality Management District Rule 1168, as adopted in January 2005.
- E. All flooring systems shall be low emitting, and meet the Green Label Plus program, FloorScore, Greenguard, or the Greenguard low emitting requirements.
- F. All janitor's closets, print and copy rooms, and chemical storage spaces shall be directly exhausted and constructed with a hard ceiling or walls constructed and sealed to deck.
- G. Provide permanently installed entryway systems, regularly maintained walk-off mats, or a combination of the two systems. All entry carpets shall be at least 10' in length at primary entryways.
- H. Office environments shall be designed with task lighting at each individual workstation.
- I. 65% of all regularly occupied spaces shall either have direct access to daylight and views or indirect access through shared glazing systems at interior partitions.
 - (1) Complete the HPBS Sustainability Worksheet to demonstrate compliance with Section 5.8.I.
 - (2) Daylighting and view strategies must be included in the OPR.

5.9 Education and Outreach Program

- A. Develop and implement a Building Education and Outreach Program to inform the building users of the sustainable design strategies. This program shall include a minimum of two of the following:

- (1) Digital or fixed signage describing the sustainable goals and strategies as well as behavior modifications to complement the sustainable design and construction efforts.
- (2) A brochure or pamphlet on the sustainable strategies. This shall highlight the location of specific strategies and provide resources for additional information.
- (3) Information on the building or department website highlighting the sustainable goals, strategies, and behavior modifications to compliment the sustainable efforts.
- (4) Enhanced building training to ensure the building operators and users understand the systems and sustainable design strategies. This includes providing enhanced Operation and Maintenance information on the building systems and control strategies.

B. The outreach program shall address the following sustainable strategies:

- (1) Context Sensitive Design
- (2) Transportation Demand Management Plan and Programs
- (3) Sustainable Site Design
- (4) Energy Efficiency
- (5) Water Efficiency
- (6) Indoor Environment Quality
- (7) Recycling and Material Management

C. Energy Star Tracking

- (1) The Facilities Operator or Commissioning Authority shall register the building under the Energy Star Portfolio program and input and monitor energy and water consumption of the building.

5.10 Metering

A. Metering System Scope

- (1) All state agencies and institutions shall incorporate the utility metering requirements of this section into new construction and major renovation projects. The scope of metering shall include at minimum:
 - a. Meters on each utility connected to the building, including but not limited to power, natural gas/propane, domestic water, irrigation water, chilled water, steam or condensate, and heating water, shall be provided as part of the construction project and shall be connected to an energy metering monitor network. If meters provided by utility companies can be connected to this network, these meters can serve to meet this requirement. Otherwise, separate meters will be required as part of the construction project that can connect to the meter monitoring network.
 - i. Irrigation metering is only required on projects where irrigation system feeds from a building or is a standalone system as part of the project.
 - b. Monitoring network for utility meters shall be connected to each meter and submeter in the building. This network shall connect to the building controls network via a dedicated automation engine device such as a JACE, NAE, or equivalent as approved by DFCM. Communication protocol on the monitoring network shall be BACnet, LON, and/or Modbus RTU and shall be coordinated with the building automation network. All devices connecting to this network shall use the selected communication protocol as their standard means of communication and shall make all data points readily available for monitoring through the network. A schematic of the monitoring network shall be included in the construction drawings.
 - c. Meter the entire building electrical load at the main service entrance switchboard. For projects with budgets exceeding \$5,000,000, or as directed by DFCM, provide submetering of electrical loads to HVAC systems, lighting, and plug loads. For Medium Voltage switchboards at 4160 volt or higher, provide

metering at each branch circuit. Multi-relays that gather metering data may be used in place of a standalone meter on branch circuits of large switchboards. Provide additional submeters for large renewable energy projects that interconnect to the building electrical panels.

- i. Submeters shall connect to the monitoring network. Connection to the monitoring network shall be through one connection point through a dedicated Building Automation node. Do not mix HVAC monitoring and Electrical metering on the same BAS node. Allow the HVAC monitoring and control to continue during maintenance on the metering side
- d. Provide additional submetering for any equipment or systems exceeding the following thresholds:
 - i. Electrical load exceeding 100 kW
 - ii. Natural gas/propane load exceeding 1,500,000 Btu/h
 - iii. Cooling tower fill and drain for cooling towers on systems with over 150 tons cooling capacity. If this information is available from chemical treatment or other systems, these systems can be included in the metering network in lieu of separate meters.
 - iv. Evaporative cooling system fill and drain for evaporative cooling systems sized for 50,000 CFM or more.
 - v. If individual pieces of equipment do not cross these thresholds, but they are part of systems (e.g. chiller or boiler plant) that have demands above the threshold level, provide submetering for the entire system.
 - vi. Verify with agency whether any additional submetering requirements exist (billable tenants, etc.)
- e. If individual pieces of equipment have internal metering capabilities that meet the requirements of this section, these points can be mapped into the meter monitoring network in lieu of external submeters.
- f. Where the project is part of a campus of other buildings, coordinate with campus personnel and design standard supplements for additional metering requirements. This may include matching existing head end equipment protocol, particular standards related to specifications of equipment, and requirements for programming on the head-end system to receive the new metering signals.
- g. The meter monitoring network shall be provided with graphics pages available over the web and through the building controls head end system (if provided). The graphics page shall provide a summary of the instantaneous readings of each meter, provide hourly and daily peak kW trend graphics, as well as the monthly and annual peak kW and total kW-hr readings of each meter. Provide data to allow comparisons of each month and year of the building's operation. Trends shall collect data at 15 minute intervals coincident for each meter on the network.
- h. The meter monitoring network shall be provided with export capabilities of a minimum of one year of data at hourly intervals, for all metered points, with trend data required, to either CSV or SQL format.
- i. Construction documents shall include schedules and locations of meters, and require submittals of meters for review by the design team, DFCM, and commissioning agent. Commissioning agent will review installation, calibration, and operation of meter system.

B. Utility Meter Requirements

(1) Electric Power Meters

- a. Provide digital power meters on all buildings. If there is more than one building on the project, provide separate metering for each structure.
- b. Provide power meter output in the communication protocol selected for the meter monitoring network.

- c. For monitoring the submeters, connect all back to a central location for interface with the Building Automation system node. Provide riser, plans, and details of wiring and conduit connections. Carefully consider how meter wiring can be routed and connected through switchboards. Consider how meters and wiring can be serviced in live switchboards. An acceptable alternate to switchboard mounting is a separate bank of meters adjacent to the switchboard.
 - d. Meters shall meet the ANSI standard for billable type meters. Provide meters to monitor with true RMS metering, with 0.2% accuracy.
 - e. Power meters shall have on board clock with date and time, and be able to record the day and time of any maximum demands or other events.
 - f. Monitor shall include instantaneous demand for kW, kWh, power factor PF, and shall also include maximum demand kW and total kWh.
 - g. Power meters shall have an on board digital display that reports measured voltage, amperage, kW, kWh, and power factor. The digital display shall be programmed and calibrated against a portable meter. Verification and commissioning is required for the monitoring network and the on unit digital display.
 - h. For large switchboards exceeding 2000 amp, or for medium voltage exceeding 4160 volt, provide test blocks on the face of the switchboard for testing the CT's and PT's. For medium voltage application, provide three PT's, 3 phase 4 wire system, and multiple tap CT's.
 - i. For main service meters, additional meter functions may be considered at the main service such as Total Harmonic Distortion, waveform capture, high speed event capture, and power analysis data. Do not provide these features for submetering unless requested by the agency or user group.
 - j. Where application calls for net metering, provide this function.
 - k. Metering and submetering data shall be coincident, with trending available independently for each individual metering point.
- (2) Natural Gas/Propane Meters
- a. Provide diaphragm type flow meters for sizes up to 1,000,000 Btu/h. Provide rotary type flow meters for sizes above 1,000,000 Btu/h. Accuracy on diaphragm meters shall be +/- 3% over the published flow range of the meter. Accuracy of the rotary meter shall be +/- 2% over the published flow range of the meter. Verify that maximum and minimum flow requirements for the project are suitable for the meter selected. Include requirement in the contract documents to correct meter multiplier for project gas pressure.
 - b. Provide a strainer upstream of all meters. Provide a bypass around meters. If meter is installed outside, route output wiring to local display inside building mechanical room. Orient pipe horizontally where meter is installed. Meter installation shall be in accordance with manufacturer's specifications. Show straight pipe requirements on contract drawings (12 pipe diameters upstream and 7 pipe diameters downstream, unless more is required by manufacturer). Strainers and bypass fittings are not to be included in the straight pipe length.
 - c. If the meter is provided with a dry-contact pulse output, a 4-20 mA output, or a proprietary protocol, require a controller/convertor be provided to convert the signal to the communication protocol used in the meter monitoring network.
 - d. Meter output to the monitoring network shall provide instantaneous flow rate as well as totalized flow rate. A local display shall be provided that shows these flow rates at the meter. Units shall be in CFH for instantaneous flow rate and 100's of cubic feet (CF) for the totalized flow rate.
- (3) Domestic/Irrigation Water Meters
- a. Provide positive displacement type flow meters for sizes up to 2" and direct coupled turbine type flow meters for sizes up to 20". Insertion turbine type flow

- meters are acceptable in sizes from 2 1/2" to 8". Accuracy on all meters shall be +/- 2% over the published flow range of the meter. Verify that maximum and minimum flow requirements for the project are suitable for the meter selected.
- b. Provide a strainer upstream of all meters. Provide a bypass around meters that are installed inline. Bypasses are not required for insertion turbine meters that can be removed from the pipeline for maintenance without interrupting flow. Provide a test port downstream of meters.
 - c. Install meter in well-lit and easily accessible area (irrigation meters may be installed in underground meter boxes, but display shall be located inside adjacent buildings). Orient pipe horizontally where meter is installed. Meter installation shall be in accordance with manufacturer's specifications. Show straight pipe requirements on contract drawings (12 pipe diameters upstream and 7 pipe diameters downstream, unless more is required by manufacturer). Strainers and bypass fittings are not to be included in the straight pipe length.
 - d. If the meter is provided with a dry-contact pulse output, a 4-20 mA output, or a proprietary protocol, require a controller/convertor be provided to convert the signal to the communication protocol used in the meter monitoring network.
 - e. Meter output to the monitoring network shall provide instantaneous flow rate as well as totalized flow rate. A local display shall be provided that shows these flow rates at the meter. Units shall be in GPM for instantaneous flow rate and Gallons, or 10's of Gallons, or 100's of gallons for the totalized flow rate as applicable to the project size.

(4) Steam Meters

- a. Provide a vortex type mass flow meter with integral density compensation. Accuracy to be +/-2% over the published range of the meter. Verify that maximum and minimum flow requirements for the project are suitable for the meter selected.
- b. Provide a strainer and drip leg upstream of all meters. Provide a bypass around meters.
- c. Install meter in well-lit and easily accessible area. Orient pipe horizontally where meter is installed. Meter installation shall be in accordance with manufacturer's specifications. Show straight pipe requirements on contract drawings (12 pipe diameters upstream and 7 pipe diameters downstream, unless more is required by manufacturer). Strainers and bypass fittings are not to be included in the straight pipe length.
- d. If the meter is provided with a dry-contact pulse output, a 4-20 mA output, or a proprietary protocol, require a controller/convertor be provided to convert the signal to the communication protocol used in the meter monitoring network.
- e. Meter output to the monitoring network shall provide instantaneous flow rate as well as totalized flow rate. A local display shall be provided that shows these flow rates at the meter. Units shall be in lb/hr for instantaneous flow rate and 1000's of lb for the totalized flow rate.

(5) Condensate Meters

- a. Provide positive displacement type flow meters for sizes up to 2" and direct coupled turbine type flow meters for sizes up to 20". All condensate meters shall be rated for operation with fluids up to 230°F. Accuracy on all meters shall be +/- 2% over the published flow range of the meter. Verify that maximum and minimum flow requirements for the project are suitable for the meter selected.
- b. Provide a strainer upstream of all meters. Provide a bypass around meters that are installed inline. Require that meter be installed in a low point in the piping system to ensure the pipe remains full of water. Provide a test port downstream of meters.

- c. Install meter in well-lit and easily accessible area. Orient pipe horizontally where meter is installed. Meter installation shall be in accordance with manufacturer's specifications. Show straight pipe requirements on contract drawings (12 pipe diameters upstream and 7 pipe diameters downstream, unless more is required by manufacturer). Strainers and bypass fittings are not to be included in the straight pipe length.
 - d. If the meter is provided with a dry-contact pulse output, a 4-20 mA output, or a proprietary protocol, require a controller/convertor be provided to convert the signal to the communication protocol used in the meter monitoring network.
 - e. Meter output to the monitoring network shall provide instantaneous flow rate as well as totalized flow rate. A local display shall be provided that shows these flow rates at the meter. Units shall be in GPM for instantaneous flow rate and Gallons, or 10's of Gallons, or 100's of gallons for the totalized flow rate as applicable to the project size.
- (6) Chilled Water or Heating Water (Below 200°F)
- a. On buildings that receive chilled water or heating water from a remote plant, provide a BTU meter that consists of flow meter, supply and return temperature sensors (matched pair of RTDs), and local display that calculates GPM, Btu/h, and totalizes Btu readings. The flow meter shall be an insertion turbine meter for pipe sizes from 2 1/2" to 8". For sizes larger than 8", the flow meter shall be an electromagnetic or ultrasonic flow meter. Accuracy to be +/-2% over the published range of the meter. Verify that maximum and minimum flow requirements for the project are suitable for the meter selected.
 - b. Provide a strainer upstream of all meters. Provide a bypass around meters that are installed inline. Bypasses are not required for insertion turbine meters or ultrasonic flow meters that can be removed from the pipeline for maintenance without interrupting flow. Provide a test port downstream of meters.
 - c. Install meter in well-lit and easily accessible area. Orient pipe horizontally where meter is installed. Meter installation shall be in accordance with manufacturer's specifications. Show straight pipe requirements on contract drawings (12 pipe diameters upstream and 7 pipe diameters downstream, unless more is required by manufacturer). Strainers and bypass fittings are not to be included in the straight pipe length.
 - d. Meter output to the monitoring network shall provide instantaneous flow rate, supply and return temperatures, instantaneous energy transfer rate as well as totalized flow and totalized energy transfer. A local display shall be provided that shows these values at the meter. Units shall be in GPM for instantaneous flow rate, Btu/h for instantaneous energy transfer rate, and 1,000,000's of Btu for the totalized energy transfer. If room temperature will exceed 85°F, move display to adjacent cooler room.
- (7) High Temperature Heating Water (Above 200°F)
- a. On buildings that receive high temperature heating water from a remote plant, provide a BTU meter that consists of flow meter, supply and return temperature sensors (matched pair of RTDs), and local display that calculates GPM, Btu/h, and totalizes Btu readings. The flow meter shall be an ultrasonic or flange to flange insertion type flow meter. Verify with DFCM or agency for each project. All components in this system shall be rated for temperatures up to 750°F. Accuracy to be +/-2% over the published range of the meter. Verify that maximum and minimum flow requirements for the project are suitable for the meter selected.
 - b. Provide a bypass around meters that are installed inline. Bypasses are not required for ultrasonic flow meters that can be removed from the pipeline for maintenance without interrupting flow.

- c. Install meter in well-lit and easily accessible area. Orient pipe horizontally where meter is installed. Locate flow meter on return line. Meter installation shall be in accordance with manufacturer's specifications. Show straight pipe requirements on contract drawings (12 pipe diameters upstream and 7 pipe diameters downstream, unless more is required by manufacturer). Strainers and bypass fittings are not to be included in the straight pipe length.
- d. Meter output to the monitoring network shall provide instantaneous flow rate, supply and return temperatures, instantaneous energy transfer rate as well as totalized flow and totalized energy transfer. A local display shall be provided that shows these values at the meter. Units shall be in GPM for instantaneous flow rate, Btu/h for instantaneous energy transfer rate, and 1,000,000's of Btu for the totalized energy transfer. If room temperature will exceed 85°F, move display to adjacent cooler room.

5.11 Data Points

A. Definitions

- (1) The input/outputs points list as defined in Appendix A have the following definitions:
 - a. Digital Input: This term is defined as binary data flow into a controller or control function. These values are "on/off", alarm or normal, 0 or 1, etc.
 - b. Digital Output: This term is defined as binary data flow out of a controller or control function. These values are on/off, start/stop, open/close, etc. These values are typically shown as 0 or 1, True or False, On and Off, etc.
 - c. Analog Input: This term is defined as analog data flow into a controller or control function. These values are associated with thermostats, thermo wells, transducers, CO2 sensors, humidity sensors, flow sensors etc. These values are typically shown in incremental values.
 - d. Analog Output: This term is defined as analog data flow out of a controller or control function. These values are associated with speed, position, damper actuators, valve actuators, etc. These values are typically shown as 0-100%.
 - e. Hardwire Interlock: This term refers to physical wiring between two devices which prevents one device from operating until the other device confirms ability to operate. These types of interlock are typically associated with a damper confirming open before a fan may start, a valve confirming open until a pump may start, etc. This does not refer to any software interlock but an actual physical connection.
 - f. BAS Communication: This term refers to values sent from or sent to devices which communicate over a software communication protocol such as LonWorks, BACnet, Modbus, or other software communications. These are not physical points directly wired to controllers but are typically sent over a communications protocol.
- (2) The graphics points list as defined in Appendix A have the following definitions:
 - a. Dynamic Flow Diagrams: This refers to graphics which have animation showing digital inputs operation. These are animations are typically fan status as shown as a moving fan, pump status as shown as a moving impeller on a pump graphic, a coil status as shown as a color change in the coil color, etc.
 - b. Start/Stop: This refers to a digital output value as shown in textual format. These values show open/close, start/stop, as physically shown on the graphic.
 - c. Display Status: This refers to a digital input value as shown in textual format. These values show on/off, open close, as physically shown on the graphic.
 - d. Display Value: This refers to both analog inputs and outputs as shown in textual format. These values show percentage open, speed, gpm, cfm, etc.

- e. Adjust Value: This refers to any value that can be manipulated through the BMS system. These values can be adjusted as an override from the BMS or an adjusted set point. All controlling set points will be shown on the graphic.
- (3) The other points list as defined in Appendix A have the following definitions:
- a. Alarm Local: This refers to an alarm that is shown only locally on the BMS and an alarm that does not require immediate attention by staff or an alarm that is generally not detrimental to the system if it does not function correctly. Different priorities will be defined in the project requirements.
 - b. Alarm Email: This alarm is reserved for failures in the system which could create a great monetary expenditure to resolve if not addressed immediately. The intent is to alarm offsite personnel during unstaffed time periods to immediately come to the site to resolve the issue before further damage could be done.
 - c. Trend 15 Minutes: This refers to trending that needs to be setup in the system to trend every 15 minutes. The cache for these trends needs to be at least 8 weeks in storage for review by the DFCM or user groups. Trend charts shall be setup by the contractor in direction of the Cx, Engineer, or User group. It is not the intent that all points listed in the “trend 15 min” be all shown on a single chart but be separated in relation to the control of the system and the command of the system. An example is an pumping system where the lead/lag or duty/standby is shown compared to the differential pressure in the system.

B. Implementation

- (1) The points list shall only be implemented in buildings that require a BMS. If a BMS system is not required or requested by DFCM then the points list will not apply in its entirety.
 - a. This requirement is not to alleviate Design/Build applications from providing a BMS unless it is specifically stated in the program documents that it is not required.
 - b. If the program documents do not address a BMS then it will be inferred that a BMS is required in compliance with this section.
- (2) Trending will be implemented for all pieces of equipment as defined in the points list. Individual charts shall be created at direction of the Cx, Engineer, or DFCM representative. These trend charts shall be able to be accessed through a web interface and a single point click. The intent is not to have these charts created each time an individual logs into the system. The intent is to have these charts accessed through a single click.
- (3) Implementation of this section is not to be applied wholly to each individual building. The intent is only individual systems as applied to the project only be followed per the stated section.
- (4) Any system that is not listed in the points list shall not alleviate the design or construction team from implementing a defined points list. In the event that a system is not defined a list shall be provided to DFCM to show which points shall be implemented. The points list shall be delivered to the DFCM, user groups, and Cx by the design team before 50% CDs are created in a Design-Bid-Build or CM/GC delivery system. The points list shall be delivered to the DFCM, user groups, and Cx by the design team before DDs are created in a Design/Build delivery system. A narrative shall be submitted to DFCM in the event compliance with section 5.11 is too stringent or costly for a given project that requires a BMS. Any waiver shall be approved by the DFCM and the user group. The waiver shall be accompanied by a descriptive reason on why the standards are too stringent or costly for the project.
 - a. The waiver shall not be approved when finances are not in place, only when the implementation does not prove to have a reasonable use.

- A. The following industry standards provide a minimum level commissioning in to determine the scope for capital development projects.
- (1) American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) ASHRAE Standard 202, Commissioning Process for Building and Systems
 - (2) National Environmental Balancing Bureau (NEBB) - Procedural Standards for Whole Building Systems Technical Commissioning
 - (3) Building Commissioning Association (BCxA) - New Construction Building Commissioning Best Practice
 - (4) AABC Commissioning Group Guidelines (ACG) – ACG Commissioning Guideline
- B. DFCM shall determine the systems and assemblies to be commissioned, per the OPR, in the project's team's scope. The following systems must be commissioned as a minimum.
- (1) Cooling systems
 - (2) Heating systems
 - (3) Steam systems
 - (4) Air handling systems
 - (5) Smoke controls systems including fans ductwork and interconnected air handling/supply systems
 - (6) Plumbing systems
 - (7) Emergency power systems
 - (8) On-site renewable energy systems
 - (9) Electrical systems
 - (10) Building Automation Systems (BAS), including verification of correctly installed data points and meters
- C. The below following duties only pertain to mandatory systems to be commissioned. Other systems that may be commissioned shall be defined per individual project. The following duties shall be performed by the commissioning project manager and not any other individual commissioning team member:
- (1) Review OPR at each design phase
 - (2) Review BOD at each design phase
 - (3) Review each design phase (Programming, SD, DD, CD) submittal for compliance to HBPS Sections
 - (4) Attend Design Meetings as necessary, including design phase review meetings, systems meetings and HPBS Workshops
 - (5) Conduct Commissioning Kick-off Meeting, attendees per Section 5.1
 - (6) Review the Commissioning Plan (prepared by other commissioning team members)
 - (7) Review submittals for main pieces of equipment and issue a report written by the project manager (main pieces of equipment include Boilers, Chillers, Cooling Towers, Heat Pumps, Air Handling Units (larger than 5,00 CFM), Pumps, VFDs, Lighting Controls, Building Management System, Roof Top Units, VRF, Chilled Beams, VAV, FCU)
 - (8) Attend Construction Meetings (at least monthly at first install of MEP rough in)
 - (9) Review first installed or mock-up items
 - (10) Review Final Sequence of Operations as installed to ensure compliance with documentation.
 - (11) Review Functional Acceptance Test final test records(as performed by other commissioning team members)
 - (12) Review Test and Balance Report
 - (13) Review Commissioning Report
 - (14) Review Systems Manual
 - (15) Review Trending data (at least four weeks) for major pieces of equipment and lighting controls

- (16) Follow up on the project at 3,6,9,11 months to ensure the system is performing as intended.
- D. The following duties shall be performed by the commissioning agent or may be performed by the commissioning project manager and not any other individual commissioning team member:
- (1) Review SD drawings
 - (2) Prepare the commissioning plan
 - (3) Review minor submittals (minor submittals include piping, valves, plumbing equipment, other electrical equipment not defined in project managers duties, and other pieces of equipment not defined in the project manager duties)
 - (4) Conduct construction meetings
 - (5) Verify Equipment on site matches items submitted
 - (6) Prepare and execute PFAT checklist
 - (7) Prepare and execute FAT checklist
 - (8) Execute PT-PT checks on 100% of all of the points on the building management system
 - (9) Calibrate all (100%) points on PT-PT checks on the building management system, occupancy sensors, and day lighting controls.
 - (10) Attend Startup of major pieces of equipment and review startup reports from contractors.
 - (11) Review issues logs.
 - (12) Review Training Agendas
 - (13) Prepare the Commissioning Report
 - (14) Prepare the Systems Manual
- E. The following duties shall be performed by the commissioning technicians or may be performed by the commissioning agents or may be performed by the commissioning project manager and not any other individual commissioning team member:
- (1) Review all installed pieces of equipment, piping, insulation, conductors, receptacles, switches, transformers, switchgear, panel boards, switchboards, MCC, VAV, VRF, Chilled beams, FCU, Exhaust Fans, Relief Fans, etc. that they meet OPR, CD, and Manufacturer recommended instructions
 - (2) Assist in execution of PFAT checklist
 - (3) Assist in execution of FAT checklist
 - (4) Perform all other duties not defined in the commissioning project manager and commissioning agents responsibilities but defined in the Standards and Guidelines as defined in the Standards and Guidelines section.
 - (5) Prepare issues logs.

5.13 Envelope Commissioning

- A. High performance building shall be commissioned in general compliance with ASTM E2813-12 *Standard Practice for Building Enclosure Commissioning*. Where conflicts arise between ASTM E2813 and this Standard, this Standard shall supersede.
- B. Standard performance buildings shall be commissioned through the design phase in general compliance with ASTM E2813-12,
 - (1) Project budget will dictate commissioning activities beyond the design phase.
- C. Building Components Included in Building Envelope Commissioning
 - (1) Below-grade construction including foundations, basements, and slab-on-grade that functions as part of the exterior enclosure system with utilization of waterproofing and drainage systems, but excluding structural and fireproofing systems and components
 - (2) Superstructure floor and roof construction that functions as part of the exterior enclosure system.

- (3) Exterior enclosure construction, above grade, including exterior opaque walls and claddings, fenestration, sheathing, framing, insulation, air barriers, vapor barriers, drainage control layers (or Water Resistive Barriers –WRB’s), RF shielding materials, and additional components of the assembly that may impact the long term performance of the enclosure.
 - (4) Roofing, including roofing system, roofing insulation, air barriers, vapor barriers, roofing membranes, skylights, hatches, and other roof openings/penetrations.
- D. Building Envelope Commissioning – Phases and Tasks – Design-Bid-Build
- E. The overall BECx process and scope of services shall be in general accordance with the following industry standards, but with emphasis placed on ASTM E2813:
- (1) NIBS Guideline 3-2012 Building Enclosure Commissioning Process
 - (2) ASTM E2813 Standard Practice for Building Enclosure Commissioning
 - (3) CSA Z320-11 – Building Commissioning Standard & Check Sheets
- F. The following tasks shall be included in the BECx scope of work
- (1) Pre-Design Phase
 - a. The Building envelope commissioning agent (BECxA) must be engaged during or prior to the pre-design phase for all High Performance projects and during the design phase for all Standard Performance Projects.
 - b. The OPR, relative to the building envelope components selected for commissioning, is documented in order to establish a baseline of performance expectations to which the actual installed performance is compared. The BECxA, with the assistance of the Owner, discusses the BOD Summary that documents the OPR for those building systems selected for commissioning. The BOD Summary reflects the underlying assumptions and requirements that become represented in the construction documents. The OPR is developed by the Owner and documented by the BECxA. Project schedule, design life, and project delivery method should all be included in the OPR. For Standard Performance projects, this task is complete in the design phase.
 - c. Review of the design narratives to attain an understanding of the BOD. The Basis of Design (BOD) Document records the concepts, calculations, decisions, and product selections used in the design to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document generally includes both narrative descriptions and lists of individual items that support the design process. The BOD Document is developed by the Architect/Engineer of Record (A/E) through a series of design narratives. The BECxA reviews the BOD statement and design narrative documentation and provides written commentary to the A/E and other members of the Commissioning Team as required.
 - d. Identify the scope of the BECx process. A BECx Scope Meeting will be conducted. Topics to be covered during the BECx Scope meeting include, but are not limited to, the BECx process, communication protocols, and development of OPR and BOD. The step is often accomplished with a conference call.
 - e. Development of the initial BECx plan. The BECxA will develop the initial BECx plan, which can either be its own entity (common) or a part of the Master Commissioning Plan (uncommon). The plan shall include key elements including, but not limited to, project schedule inclusive of BECx tasks and milestones, systems to be commissioned, roles and responsibilities of commissioning team members, means of communication and reporting of conditions and progress throughout the BECx process, and the level of documentation expected throughout the BECx process. The plan is updated

periodically throughout the BECx process to reflect changing project conditions or requirements until the end of the project, when it then becomes the Project Commissioning Record.

(2) Design Phase

- a. The BECx shall review the relevant project documents to assist with the development of a building envelope that provides environmental separation. The design concepts will be evaluated against the OPR and BOD. The review will include verification that all systems to be commissioned are addressed in the BOD and fulfill the OPR such that the systems are coordinated with each other. The review shall occur a minimum of two times, including a back-check of subsequent issuances. Deliverables typically consist of written mark-ups of the architectural drawings and project specifications to be shared and discussed with the project team. The A/E provides a written response to the BECA and Owner as to how the comments will be reflected in the final bid documents. On a typical high performance project, there will be at least three in person meetings between the A/E and the BECx.
- b. The BECx requirements are incorporated into the construction documents via a BECx specification sections provided by the BECx and submitted to the A/E for review and approval. The functional performance testing requirements (including both mock-up and field testing) will be incorporated into the construction documents via a functional performance testing specification section. Both specification sections are created by the BECx based on the requirements outlined in the OPR and BOD and submitted to the A/E for review and approval.

(3) Pre-Construction Phase

- a. The A/E or Contractor shall provide all sub-contractor submittals, including material submittals, shop drawings, applicable substitution requests, and quality control documentation to the BECx prior to commencement of building envelope construction. The BECx will review all contractor exterior envelope submittals for compliance to the BOD, design documents, performance, and constructability, with concentration on transition details, sequencing concerns, and quality control contractual requirements. All concerns shall be forwarded, in writing, to the A/E for their review and formal response to the Contractor. All submittal and shop drawing reviews by the BECx will occur prior to review by the A/E, when possible. When applicable, the BECx will provide written mark-ups of the shop drawings to the A/E. Air barrier shop drawings are required on all projects.
- b. In general, the Contractor will complete CCs for all assemblies and systems prior to formal performance testing of equipment or subsystems of the given system. These checklists will be reviewed by and as needed commented on by the BECx.
- c. The Contractor will arrange and schedule a Pre-Construction Trade Orientation Meeting, prior to the commencement of the building envelope mock-up or building envelope construction, to be chaired by the BECx. Topics covered during the meeting would include, but not necessarily be limited to, inspection and testing procedures, review of plans and specifications, review of shop drawings, construction schedule and sequencing, material selection and compatibility, and other installation concerns. This meeting may also serve as the building envelope commissioning kick-off meeting or they may be separate meetings.
- d. Mock-ups of the critical envelope components shall be constructed and tested prior to the commencement of building envelope construction in order to verify the performance of the systems and to set construction standards and material

selection for the duration of the project. Components required in the mock-ups will be as identified in the relevant sections of the Project Specifications and Architectural Drawings. Construction of the mock-up is to be observed and documented by the BECxA. Once completed, the Contractor will provide confirmation of completion to the BECxA and A/E. The completed mock-up will then be reviewed by the BECxA and A/E for compliance to the Contract Documents. Once the mock-up has been visually observed for compliance to the Contract Documents, the mock-up will be tested to ensure adherence to the performance requirements set forth in the Contract Documents. The testing protocol will be as identified in the Contract Documents in the Functional Performance Test Specification developed by the BECxA and approved by the A/E during the Design Phase. Should failures occur during mock-up testing, the Contractor shall investigate the source of the failure and propose a remediation strategy for review and comment by the BECxA and A/E, and install the approved repair work. The mock-up shall be retested until passing results are achieved, prior to full scale construction at the project site. Any repairs or remedial work performed on the mock-up must be documented by the BECxA.

(4) Construction Phase

- a. The BECxA will participate in pertinent envelope performance/installation meetings and commissioning meetings as required.
- b. The BECxA will participate, in person or via conference call, at least one OAC meeting per month.
- c. Upon commencement of building envelope construction and continuing throughout the construction process, on-site inspections will be conducted by the BECxA to review the Work for compliance to Contract Documents and industry standards. Deficiency logs will be generated by the BECxA and repairs tracked with the goal of having a zero punch list project.
- d. The BECxA will observe or perform functional performance testing of the building envelope. The field testing protocol will be as identified in the Contract Documents in the Functional Performance Test Specification developed by the BECxA and approved by the A/E during the Design Phase. Failed tests should be retested until satisfactory results are achieved. Additional testing may be performed as determined by the Owner, BECxA, and A/E as outlined in the functional performance test specification. Envelope components and systems shall not be installed on the building or beyond the in situ mock location until testing has demonstrated satisfactory results.
- e. The BECx plan will be updated as needed, as this is a living document and may reflect new and/or reduced requirements as directed by the Owner.
- f. The BECxA may participate in dispute resolution regarding exterior envelope components/systems and associated performance. The BECxA and the A/E may be relied upon during construction to evaluate compliance with the OPR; to provide and vet out alternative solutions; and to evaluate the associated risks.

(5) Post-Occupancy Phase

- a. The BECxA will finalize the BECx plan and the final commissioning report with respect to the building envelope.
- b. The BECxA provides appropriate training to the building maintenance personnel with respect to building envelope maintenance.
- c. The BECxA will provide a site review and follow-up meeting 10 months post-occupancy. A written post-occupancy site visit report will be incorporated into the Building Envelope Commissioning Record.

G. Guidelines for performance criteria and associated functional performance testing commissioned systems/assemblies are as follows below. The BECxA may deviate from the general

recommendations below to suit project needs. Section 5.16 lists Referenced Standards and Codes which can be applied to the building envelope functional performance testing plan.

- (1) Water
 - a. In general, water testing on a façade surface shall be in accordance with ASTM E 1105 or AAMA 501.1. Project test pressures will be based on the wind load calculations per ASCE 7 in conjunction with the rated performance of specified products per AAMA 101 with a minimum 6.24 psf differential pressure. Water leakage shall be defined as any water that is interior to the primary plane of air tightness (whether visible or not from the interior) that is not positively drained to the exterior. Detailed water penetration resistance requirements are outlined in Appendix G.
- (2) Vapor
 - a. A continuous vapor barrier (or vapor retarder) must be provided to all exterior opaque walls, roofing, below grade foundation walls and slabs, and slab-on-grade conditions as determined by appropriate hydrothermal analysis. This vapor barrier shall be sealed at all interfaces, fenestrations, penetrations, etc. A vapor barrier (or vapor retarder) is defined as materials with vapor permeability below 1.0 perm per ASTM E96 desiccant or dry cup method (Class I or Class II per 2012 IBC).
 - b. Testing is not required, but visual inspections of installed work are required. High Performance structures require vapor barriers to be included in the performance mock-up.
- (3) Air
 - a. In general, air testing is performed in accordance with ASTM E 1186, ASTM E 783, and ASTM E 779. Detailed performance criteria are identified in Appendix G

5.14 Incentives and Rebates

- A. Utility sponsored incentive and rebate programs when properly leveraged offer project additional cause to implement energy efficient strategies into the State's facilities. It is the intent of DFCM to obtain, in a timely manner, all possible gas and electric utility incentives and rebates for the *prescriptive or typical* measures included in their new building projects.
 - (1) *Prescriptive* energy efficiency measures are defined as those that propose equipment/systems that exceed existing building energy code and have incentives or rebates paid based on the type, size, and quantities of high efficiency equipment installed.
- B. This section of the HPBS and its supporting appendices provide information about the incentive and rebate process as well as guidance to project teams on how to best navigate both Rocky Mountain Power (RMP) and Questar Gas Company's (QG) programs.
 - (1) As of July 1st, 2014 only RMP and QG are the only utility providers in Utah who offer whole building program incentives and rebates. Therefore this section is oriented towards the programs that they currently offer. If, at a later time, local municipal utility companies offer incentive and rebate programs, the DFCM will utilize those programs, when possible, to further energy efficiency in State's facilities.
- C. Incentive and rebate opportunities shall be properly identified in the design phase of each project.
- D. Possible incentive and rebate values for specific energy efficiency strategies shall be incorporated as a separate line item in the LCCA required in section 5.5.

- E. In the case where the incentive and rebate program conflicts with the sections within the HPBS that conflict shall be made know to the DFCM Energy Program Director, who will then discuss the conflict with the project team.
- F. The architect is ultimately responsible for the design team performing their assigned tasks and obtaining all utility incentives and rebates.
- G. Custom energy efficiency measures (EEMs), are to be identified and handled by the design team by reporting them, as soon as they are identified, to the DFCM Energy Program Director who will coordinate with the proper utility.
- H. Appendix H, and Appendix I provides a road map for how the project's prescriptive measure incentives are to be obtained. Deviations from the process outlined in this appendix must be approved by DFCMs Energy Program Director.

5.15 Owner's Project Requirements

- A. A concise OPR must be developed by the design team and owner during the project programming phase, or by the midpoint of schematic design, for projects without a programming phase.
 - (1) For projects with a programming phase, the OPR is required to be complete and included in the project program.
 - (2) For projects without a programming phase the, the OPR is required to be complete and included in the schematic design review set.
- B. Once the initial OPR and BOD are developed by the design team and the Commissioning Agent (CxA) has been integrated into the project, it is to be reviewed by the CxA at the SD, DD and CD submittal.
- C. Changes to the OPR and BOD, from one design phase to the next, must be documented by the design team.
- D. Sections that must be included in the OPR are detailed in Appendix F. Coordination with DFCM's Design Requirements⁶ is required.

5.16 Referenced Standards

- A. American Architectural Manufacturers Association
 - (1) AAMA 101-2011 North American Fenestration Standard/Specification for Windows, Doors, and Skylights
 - (2) AAMA 511-08 Voluntary Guideline for Forensic Water Penetration Testing of Fenestration Products
 - (3) AAMA 501.1-05 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
- B. American Society of Civil Engineers
 - (1) ASCE 7 Minimum Design Loads for. Buildings and Other Structures
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers
 - (1) ASHRAE Standard 90.1-2010 -- Energy Standard for Buildings Except Low-Rise Residential Buildings

⁶ dfcm.utah.gov/wp-content/uploads/design_requirements.pdf

- D. ASTM International
- (1) ASTM C90-14 Standard Specification for Loadbearing Concrete Masonry Units
 - (2) ASTM C91/C91M-12 Standard Specification for Masonry Cement
 - (3) ASTM C144-11 Standard Specification for Aggregate for Masonry Mortar
 - (4) ASTM C150/C150M-12 Standard Specification for Portland Cement
 - (5) ASTM C207-06(2011) Standard Specification for Hydrated Lime for Masonry Purposes
 - (6) ASTM C270-12a Standard Specification for Mortar for Unit Masonry
 - (7) ASTM C370-12 Standard Test Method for Moisture Expansion of Fired Whiteware Products
 - (8) ASTM C595/C595M-13 Standard Specification for Blended Hydraulic Cements
 - (9) ASTM C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
 - (10) ASTM C1060 Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
 - (11) ASTM C1153 Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
 - (12) ASTM C1157/C1157M-11 Standard Performance Specification for Hydraulic Cement
 - (13) ASTM C1193 Guide for Use of Joint Sealants
 - (14) ASTM C1258 Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation
 - (15) ASTM C1329/C1329M-12 Standard Specification for Mortar Cement
 - (16) ASTM C1384-12a Standard Specification for Admixtures for Masonry Mortars
 - (17) ASTM C1400-11 Standard Guide for Reduction of Efflorescence Potential in New Masonry Walls
 - (18) ASTM C1498-04a(2010)e1 Standard Test Method for Hygroscopic Sorption Isotherms of Building Materials
 - (19) ASTM C1715 Standard Test Method for Evaluation of Water Leakage Performance of Masonry Wall Drainage System
 - (20) ASTM D5957-98(2013) Standard Guide for Flood Testing Horizontal Waterproofing Installations
 - (21) ASTM E783-02(2010) Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
 - (22) ASTM E1105-00(2008) Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
 - (23) ASTM E1186-03(2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
 - (24) ASTM E2357-11 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
 - (25) ASTM E2112-07 Standard Practice for Installation of Exterior Windows, Doors and Skylights
 - (26) ASTM E2178-13 Standard Test Method for Air Permeance of Building Materials
 - (27) ASTM E779-10 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
 - (28) ASTM E2813 Standard Practice for Building Enclosure Commissioning
- E. Canadian Standards Association
- (1) CSA Z320-11 – Building Commissioning Standard & Check Sheets
- F. Institute of Transportation Engineers
- (1) 4th Edition Parking Generation Guide
- G. International Code Council
- (1) AC38-2013 Acceptance Criteria for Water-Resistive Barriers

- (2) 2012 International Building Code
- (3) 2012 International Energy Conservation Code

- H. National Institute for Building Sciences
 - (1) NIBS Guideline 3-2012 Building Enclosure Commissioning Process

5.17 Definitions

Baseline – The performance level used for comparison to the above standard design.

Basis of Design – Formal documentation of the primary decision-making process and assumptions behind design decisions made to meet the OPR.

Building Analytics – Software programs that utilize data provided by building management systems (BMS) to deliver automated fault detection, diagnosis and real-time performance monitoring. Applications include building commissioning, equipment fault detection, energy analysis, load profiling, facility benchmarking, asset performance tracking, and carbon and greenhouse gas reporting.

Building Commissioning - A systematic and documented process of ensuring that the owner's operational needs and performance requirements are met. Additionally the process ensures that building systems perform efficiently and building operators are properly trained. The intent of the process is to set the stage for facility operators to operate the building as intended in the building design. A Commissioning Agent (CxA) is generally responsible for implementing the building commissioning process.

Building Envelop Commissioning - Building Envelop Commissioning (BECx) is a process involving evaluation, verification, and documentation that a building's design and construction meet defined performance expectations. BECx begins at the project inception and continues through the start of the Operations and Maintenance Phase. A Building Envelop Commissioning Agent (BECxA) is generally responsible for implementing the building commissioning process.

Cost Estimator – Consultant responsible for providing a forecast of construction cost prepared on the basis of a detailed analysis of materials and labor for all items of work. Note that this is different from preliminary estimates of construction costs based on area, volume or other conceptual estimating techniques often provided by the owner or architect.

Design Build – Design build is defined as the selection of the qualified design build entity through a competitive process which may require evaluation of the concept design and project cost, along with other criteria. The procurement of architect-engineer services and construction services by the use of a single contract with the design build provider.

Design Team – Consultants providing design services to the project, including but not limited to, Architects, Mechanical Engineers, Electrical Engineers, Civil Engineers, Landscape Architects, Acoustical Engineers, Kitchen Designers.

Direct/Site Emissions - Emissions from fuel that is directly burned at the building for heating, electricity generation or other facility operations.

General Contractor – Contractor providing construction management, cost estimating and general contracting services, including and not limited to supporting subcontractors.

High Performance Building Standard (HPBS) – The requirements and process outlined within DFCM’s Design Requirements, section 5.0, that require State buildings to be designed and built in such a manner to optimize energy efficiency, durability, life-cycle performance, water efficiency, material resources, occupant comfort and productivity.

High Performance Building Standard Workshop – Formal collaboration and coordination meetings in which various goals and strategies related to the HPBS are identified and evaluated in the context of the project. See Appendix? – HPBS Workshop Suggested Agenda.

Indirect/Source Emissions - Emissions associated with energy purchased from a utility, such as emissions generated from the generation of electricity at a coal fueled power plant.

Life Cycle Cost Analysis - Life-cycle cost analysis (LCCA) is a method for assessing the total cost of facility ownership. It takes into account all costs of acquiring, owning, and disposing of a building or building system. LCCA is useful when project alternatives that fulfill the same functional requirements, but differ with respect to initial costs, operating costs and performance, have to be compared in order to select the one that maximizes net savings.

Owner – One or more of the following, DFCM Project Manager, Facility Operator, Facility Manager, DFCM Energy Program Director, Agency Energy Manager, DFCM, State Institution, State Agency, or other governmental entity for which DFCM is providing project management services.

Owner’s Project Requirements (OPR) – A formal document created in the programming phase that provides a basis for the project’s functional and performance requirements. This document is intended to provide an explanation of ideas, concepts and requirements that are important to the owner. It is to be initially completed by the Architect with input from the owner and other parties as necessary. See Section 5.15 – Owner’s Project Requirements.

State Agency - Any state agency, board, commission, department, or division

State Institution –Institutions referring to the University of Utah, Utah State University, Southern Utah University, Weber State University, Snow College, Dixie State University, College of Eastern Utah, Utah Valley University, Salt Lake Community College, Utah College of Applied Technology, and any other university or college which may be established and maintained by the state.

5.18 Appendices

- A. Data Points List – Section 5.11
- B. Energy Modeling Spreadsheet – Section 5.5
- C. Life Cycle Cost Worksheet – Section 5.5
- D. HPBS Sustainability Worksheet – Section 5.6, 5.7, 5.8, 5.
- E. HPBS Workshop Suggested Agenda – Section 5.1
- F. OPR Required Sections – Section 5.15
- G. Envelope Commissioning Matrix – Section 5.13
- H. Incentives and Rebates Process Guidelines – Section 5.14

I. Incentives and Rebates Responsibility Matrix – Section 5.14