Owner's Project Requirements

Texas Facilities Commission

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Glossary of Acronyms

AHJ	authority having jurisdiction
AHRI	Air-conditioning, Heating, and Refrigeration Institute
AHU	air handling unit
APC	angle physical connector
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
AV	audio visual
AWG	American wire gauge
BAS	building automation system
BCN	building control network
BOD	basis of design
C	Celsius
CATV	community access television
Ccf	Unit equivalent to 100 cubic feet of gas
CCTV	closed-circuit television
CE	European Commission
cfm	cubic feet per minute
CHW	chilled water
CHWP	chilled water pump
CPTED	crime prevention through environmental design
CRAH	computer room air handling unit
CRI	color rendering index
CT	current transformer
CW	cold water
Cx	commissioning
DAS	distributed antenna system
DB	dry bulb
dBA	A-weighted decibel
DP	differential pressure
DI	deionized
DIR	Texas Department of Information Resources
DSPR	duct static pressure reset
EAB	Elimination of Architectural Barriers
ECM	electronically commutated motor
EMT	electrical metallic tubing
EQID	equipment identification
EUI	energy use intensity
F	Fahrenheit
FC	footcandle
FEMA	Federal Emergency Management Agency
FLC	field level controllers
FM	Factory Mutual
fpb	fan-powered box
fpm	feet per minute
GAATN	Greater Austin Area Telecommunications Network
GFCI	ground fault circuit interrupter
GMK	grand master key
gpf	gallons per flush
gpm	gallons per minute
H/600	story height / 600
HDMI	high-definition multimedia interface
HMI	human/machine interface

HOA	hand, off, and automatic
hp	horsepower
HW	hot water
Hz/sec	Hertz per second
ICS	International Classification for Standards
IGBT	insulated gate bipolar transistors
IDF	intermediate distribution frame
IESNA	Illuminating Engineering Society of North America
I/O	input/output
IP	internet protocol
IPTV	internet protocol television
ITS	information transport system
IW	inside wiring
JACE	Java application control engine
K	Kelvin
LED	light-emitting diode
LEP	law enforcement personnel
MAU	make-up air unit
MC	metal clad
MCB	main circuit breaker
MDB	maximum dry bulb
MDF	main distribution frame
MEP	mechanical, electrical, and plumbing
MERV	minimum efficiency reporting value
MLO	main lugs only
MUTOA	multi-user telecommunications outlet assembly
NICET	National Institute for Certification in Engineering Technologies
NPW	non-potable water
O&M	operations and maintenance
OM	optical multimode
OSP	outside plant connectivity
PI	proportional and integral
PID	proportional, integral, and derivative
PIV	post indicator valve
PDU	power distribution units
PM	plant manager
psf	pounds per square foot
psi	pounds per square inch
PTZ	pan-tilt-zoom
PVC	polyvinyl chloride
RCDD	registered communications distribution designer
RFID	radio-frequency identification device
RH	relative humidity
RO	reverse osmosis
ROW	right-of-way
rpm	revolutions per minute
RPV	reduced-pressure valve
RPZ	reduced pressure zone
RTU	roof-top unit
SATR	supply air temperature reset
SDT	static dissipative tile
SF	square feet
SFMO	State Fire Marshal’s Office
SOO	sequence of operations
SPD	surge protective device

SWPPP	storm water pollution prevention plan
TAB	test and balance
TCP/IP	transmission control protocol/internet protocol
TDMM	Telecommunications Distribution Methods Manual
THD	total harmonic distortion
TMGB	telecom main grounding bus
TO	telecommunications outlet
TR	telecommunications room (referred to as IDF in this document)
UI	Uptime Institute
UL	Underwriters Laboratories
UPS	uninterruptible power supply
UTP	unshielded twisted pair
UV	ultraviolet
UVGI	ultraviolet germicidal irradiation
VA	volts-amps
VAV	variable air volume
VCS	video camera surveillance
VESDA	very early smoke-detection apparatus
VFC	variable frequency controller
VFD	variable frequency drive
VOC	volatile organic compound
VoIP	voice over internet protocol
VRLA	valve-regulated lead-acid
VWC	vinyl wall covering
W	watts
W/SF	watts per square foot
WB	wet bulb

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OWNER'S PROJECT REQUIREMENTS

These Owner's Project Requirements are the result of a careful and detailed collaboration between multiple Texas Facilities Commission program areas directly responsible for all State-owned and managed facilities under its charge and control. These program areas are required to (1) oversee the design and construction of built facilities and grounds and (2) manage, operate, and maintain all built facilities and grounds. Through this collaborative effort these Owner's Project Requirements embody the shared goals and objectives for new facilities to be built by the agency and provide a guideline for the renovation and rehabilitation of existing facilities.

The Owner's Project Requirements shall be reviewed for accuracy, applicability, and effectiveness and, if necessary, updated no later than every five years. The review is conducted by a committee which is chaired by the Deputy Executive Director of the Facilities Design and Construction division. No changes or amendments shall be made to this document in the interim, unless specifically reviewed and approved in writing. Any such change or amendment shall be duly documented including a reference for the need for the change or amendment and the date such change or amendment was made.

It is agreed that the requirements listed herein adequately identify, describe and document the requirements which form the basis from which all design, construction, acceptance, and operational decisions will be made on behalf of the project. These Owner's Project Requirements are formally approved and adopted as of June 2021.

Deputy Executive Director,
Facilities Design and Construction

John Raff, P.E.

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1 Applicability of Owner's Project Requirements

The Texas Facilities Commission ("TFC") intends these Owner's Project Requirements (the "Requirements") to apply generally to new construction initiated pursuant to the 2016 Capitol Complex Master Plan, to new construction at the State of Texas North Austin Complex ("NAC"), and potentially to other State construction projects. TFC intends these Requirements to be a companion appendix to solicitations for new construction projects and to be a key resource in developing the respective project's basis of design ("BOD").

1.1 Tenant agencies

New construction subject to these Requirements will be owned by the State of Texas (the "Owner") and occupied by State of Texas agencies; those agencies will be tenants within the building(s). Potential tenant agencies include departments, commissions, boards, agencies, or other government instrumentalities. The tenant agencies may or may not be identified when the solicitation issues.

1.2 TFC

TFC will manage the design and construction process and will maintain the building(s) after completion. Pursuant to Texas Government Code Sections 2165.001 and 2165.002, TFC has been assigned charge and control of certain public buildings, grounds, and property and responsibility for its proper care and protection from damage, intrusion, or improper use. In addition, pursuant to Texas Government Code Section 2165.007, TFC provides facility management services to all state-owned properties in Travis County and adjacent counties unless specifically excepted by law. Accordingly, TFC has a right of access to all areas of the properties under its charge and control for the purpose of meeting its statutory duties.

1.3 Texas Capitol Complex Master Plan

Refer to the 2016 Texas Capitol Complex Master Plan and the 2018 and 2020 updates to the Master Plan (collectively, the "Texas CapCom MP") for information regarding phasing, planning and urban design, parking, infrastructure, landscape design, site design, and architectural design guidelines for new construction within the Capitol Complex.

The Texas CapCom MP provides guidance on a wide range of design considerations: general exterior aesthetics, building step-backs and set-backs, pedestrian and vehicular ingress and egress, parking, campus systems infrastructure, and site utilities.

1.4 North Austin Complex Master Plan

For new construction at the NAC, refer to the 2014 Preliminary North Austin Complex Master Plan ("2014 NAC MP") for additional guidance.

1.5 Other locations

These Requirements may apply to other projects in Texas. If applicable, the solicitation will specify that these Requirements shall be followed.

2 Fundamental Design Criteria

The Owner's Project Requirements set forth minimum requirements for all new construction proposed in response to the solicitation. These Requirements summarize minimum expectations relating to the building(s) and related improvements. Refer to the most recently published version of the TFC

Architectural/Engineering Guidelines for guidance related to TFC's preferred procedures, design phase deliverables, and design documentation and BIM/CADD requirements and preferences.

2.1 Exterior Appearance and Finish

For building(s) subject to the requirements of the Texas CapCom MP, refer to Architectural Principles set forth in the Texas CapCom MP. The Architectural Principles provide guidance regarding massing, materiality, relationship to street, relationship to public space, fenestration, climate responsiveness, service areas, parking structures, and other elements. The buildings planned for Phases 1 through 3 of the Texas CapCom MP include both "District Focus" and "Fabric" buildings. The designations of the Texas CapCom MP will significantly affect the exterior appearance and finish of the respective buildings. Refer to the Texas CapCom MP for an explanation of those terms.

Decisions regarding specific building structure, envelope, and building systems shall be made based on life cycle cost analyses to select building systems and elements with the lowest overall total cost of ownership.

2.2 Interior Appearance and Finish

New building(s) subject to these Requirements shall generally be purpose-built office construction; certain buildings may contain specialty program spaces and spaces intended for not-yet-identified, third-party tenants. Refer to the solicitation for descriptions of potential lease and specialty program spaces. If tenant agencies have been identified in the solicitation, new construction will combine core-and-shell and interior finish-out in a single design package for turnkey delivery. If the tenant agencies have not been identified, new design and construction may proceed on the basis of a core-and-shell model with separate tenant finish-out construction.

Ground-level interior spaces, especially those open to the general public, shall be designed to reinforce the design principles outlined in the respective Master Plan. Implementing these principles will require attention to urban design axes, creating engaging public space, reinforcing building porosity, careful finish material selection for durability and aesthetic qualities, use of natural daylighting, among other architectural principles. Public lobbies, public restrooms, staff lobbies and restrooms, waiting areas, elevators, and corridors shall reflect the significance of the important missions fulfilled by the tenant agencies.

Typical office levels (i.e., floors three and above for most buildings subject to these Requirements) shall be designed and finished with an understanding that the occupation by tenant agencies requires frequent reconfiguration of partitions, systems furniture, and demising walls between tenant spaces. Finish selections, lighting design, and space allocation to program requirements shall reflect economic prudence.

2.3 Sustainability

2.3.1 Meeting or exceeding the State Energy Conservation Office ("SECO") regulations is intended to achieve many of the efficiencies for which third-party certifications of sustainable design are typically pursued. Therefore, these Requirements do not require pursuit of any additional specific sustainability benchmarks or targets established by third-party certification organizations.

2.3.2 The building(s) shall be designed to integrate site attributes with building function to create a high performance, resource conserving, flexible and resilient facility to promote and enhance occupant health, productivity and well-being over the life of the building. The building(s) shall create an environment to support effective fulfillment of tenant agencies' missions.

2.3.3 The design of the building(s) and site shall facilitate circulation between indoor and outdoor areas such that outdoor areas shall be easily accessible to building occupants for work-related and informal activities.

2.3.4 The building(s) and site shall be designed to enhance ecosystem function through green infrastructure that integrates landscape design with storm water management, heat island mitigation, and air filtration using native and non-invasive adapted species that also enhance biodiversity.

2.3.5 The building(s) shall contribute to the goal of reducing water use through water-saving fixtures and native, non-invasive adapted species and efficient irrigation equipment. Water reuse opportunities shall be identified to further reduce reliance on potable water use. Species selection shall comply with xeriscaping requirements issued pursuant to Texas Government Code section 2166.404.

2.3.6 The building(s) shall contribute to the goal of reducing energy use through strategic building orientation to take advantage of solar gain, daylight, shade, and breeze, augmented with efficient fixtures and a high level of thermal envelope performance including building insulation and high-performance fenestration. A life cycle cost analysis ("LCCA") shall be used as a basis to determine appropriateness of solar photovoltaic and solar thermal systems. The building shall be designed to be "solar-ready" to facilitate connection to solar photovoltaic energy systems in the future, if not included in the initial building scope.

2.3.7 High indoor air quality shall be achieved by selecting low-toxicity materials including low-emitting VOC paints and coatings, adhesives and sealants, flooring products, composite wood and agri-fiber products, and finishes. Controlling pollutants and outdoor contaminants shall also be achieved to improve indoor environmental quality.

2.3.8 Materials that are locally sourced and manufactured and contain recycled content and rapidly renewable materials shall enhance the life cycle environmental performance of the building(s). Construction waste shall be diverted from landfill through recycling or reuse, to the extent possible. Target amounts of waste diversion shall be determined on a project-by-project basis, relative to the scope of the project.

2.3.9 Occupant health and well-being shall be enhanced by ensuring a minimum 75 percent of regularly occupied areas have access to daylight and views to the outdoors.

2.3.10 Easily accessible, centrally located, dedicated areas for the collection of materials for recycling for the tenant spaces shall be provided for the collection of paper, corrugated cardboard, plastic and metals.

2.3.11 Indoor chemical and pollutants shall be controlled and properly ventilated to prevent hazards to occupants.

2.4 **Functionality**

2.4.1 **Organization of service and common spaces:** Rooms accommodating equipment for building infrastructure, especially if common to each floor, shall be vertically stacked near the building's core for most efficient design for conduit, pipe, ducting, and other distribution pathways. Rooms in this category include but are not limited to mechanical, electrical, telecom, and custodial equipment rooms.

Typical office levels in buildings subject to these requirements shall have at least one each of the following space types: shared break area, shared quiet room, and shared men's and women's restrooms. Because each of these spaces will have plumbing, these common space types shall be vertically stacked.

Shared large conference rooms, training rooms, classrooms, and auditoriums shall be located on the ground level or Level 02, unless specifically indicated otherwise. Refer to the solicitation and other documents related to a specific building(s) for additional detail on program requirements.

2.4.2 Tenant agency spaces: The building(s) shall accommodate tenant agencies' staff, meeting rooms, collaboration areas, training rooms, filing and storage, and other functions required to fulfil tenant agency missions.

2.4.3 Data Center: Buildings shall utilize Co-Located server rooms for tenant servers, to leverage shared infrastructure for supporting critical systems. The room will be on emergency power and protected by a pre-action fire sprinkler system and a redundant NFPA 200 fire suppression system. The data center will be classified as UI Uptime Tier II and shall comply with the requirements of that classification.

2.4.4 Child-care facility: Pursuant to Texas Government Code section 2165.206, TFC must consider provision of a child-care facility as first priority over all other uses in a building except for purposes essential to its tenant agencies' official functions. Refer generally to "Minimum Standards for Child-care Centers" (2015) published by the Texas Department of Family and Protective Services ("DFPS"). The 1601 Congress State Office Building includes a shared Child-Care Facility available to State employees. New construction projects shall evaluate capacity of this facility relative to potential increased demand from any increases in State employees due to the project, to determine if additional child-care program is merited in the new project.

2.4.4.1 Sizing: A child-care facility shall be large enough to accommodate classrooms for children aged zero through five years, with at least one classroom for each developmental group. The facility shall meet or exceed DFPS minimum space standards. The outdoor activity space(s) shall be no less than 25 percent of the total interior square footage licensed for use as a child-care facility.

2.4.4.2 Outdoor activity space: Outdoor activity space(s) shall be separated from common public areas by at least a 6-foot high barrier. Any communicating gate or door to common public areas shall be access-controlled. Refer to the appropriate Complex master plan for guidance on aesthetics for a barrier wall or fence. Provide sunshade for play areas for children aged zero to five years; pea gravel shall not be used as a ground surface for play areas for those age groups. Optimally, the child-care facility outside play shall provide an appropriate mix of permanently installed fixtures: climbing and swinging structures, drinking fountain(s), water play structure, sand areas, storage, a garden, and a tricycle path. Each partitioned outdoor activity space requires at least two exits; one of those exits must direct occupants away from the building.

2.4.4.3 Covered pick-up / drop-off and ground level location: At a minimum, a potential child-care facility tenant shall be accommodated on the ground floor with convenient access to a covered pick-up / drop-off area and to exterior pedestrian paths and shall be located in an access-controlled area. Locating any rooms for child care above the ground level or below grade requires approval by the authority having jurisdiction ("AHJ").

2.4.4.4 Critical program elements: Noise migration both into and out of the child-care center shall be mitigated to the greatest degree possible. Special consideration for young children's lighting sensitivities shall be accommodated in the lighting design. It is recommended that consideration be given to identify a safe refuge area within the facility for use in an emergency. Also refer to 2.4.9 below.

2.4.5 Wellness center facilities: If the building program calls for a wellness center, fitness center, or similar facilities, the preferred location within the building is on or near the ground floor with convenient access to exterior pedestrian paths and located in an access-controlled area. Noise and vibration migration from exercise equipment and/or free weights from the overall facility shall be mitigated to the greatest reasonable degree. Indoor ventilation requirements should follow best practices for this program space. Finishes should be appropriate for the environment and allow easy cleaning. It is not the intent of this section to include clinics or medical facilities.

2.4.6 Food service: Each new building subject to the these Requirements shall accommodate the post-occupancy installation and service of a grease trap appropriate for a food service tenant (e.g., restaurant or cafeteria). Where required by project program, a planned food service space shall be provided with an appropriate sized kitchen hood and dishwasher exhaust pathway leading to a side-wall exhaust at a back-of-house or otherwise non-sensitive exterior area. A make-up air pathway shall lead to a sidewall intake louver with appropriate code-required separation. Grease waste with appropriate heat trace and circuiting should be provided to accommodate the future food service needs. Refer to plumbing design criteria, Section 5.6, for details.

2.4.7 Quiet room: Each typical office level shall have at least one quiet room, minimum 7 feet by 7 feet, with at least two electrical duplex receptacles with space for a small refrigerator, one data terminal, hand sink, occupancy-indication lockset, and a minimum 36-inch wide countertop (inclusive of sink space).

2.4.8 Third party tenants: New buildings subject to these Requirements may house non-State tenants in lease space for retail, food service, and other commercial enterprises serving Capitol Complex visitors and the general public. The anticipated third-party tenant(s) may or may not have been identified when the solicitation issues.

2.4.9 Storm shelter: The Capitol Complex is outside of the 250-mph wind zone per the 2015 IBC, and as such, a Storm Shelter (as defined by IBC) is not specifically required. It is recommended that consideration be given to identify a safe refuge area within the facility, such as a below grade parking structure, for use in an emergency.

2.5 **Building occupancy type**: The buildings subject to these Requirements will generally be classified as Type B - Business occupancy per IBC. Certain building functions as specified in the applicable solicitation may require a different classification for certain spaces, e.g. assembly spaces. Building program elements that increase occupant load above Type B shall be located for most efficient accommodation of concomitant life safety requirements such as increased egress width. Unless specifically noted otherwise in the solicitation, assembly spaces with a maximum occupancy of one hundred or more shall be located on the ground or second floor. Type A – Assembly occupancy shall be applied to break rooms, conference rooms, huddle rooms or areas of congregation per NFPA 101. Stair and door exit width sizing should assume an additional 15 percent reserve capacity beyond applicable code.

2.6 **Floor-to-floor height:** The buildings subject to these Requirements shall be high-rise construction unless specifically noted in the applicable solicitation. Floor-to-floor heights will be thoroughly analyzed in Schematic Design, but the following is guidance for minimum typical, anticipated construction pursuant to these Requirements:

Ground Level to Second Level	20 feet (public lobby, office, training, auditorium, ground-level retail as applicable)

Second Level to Third Level	14 feet (office, training, shared conference)
Third through Roof Levels	14 feet each (office)

2.7 General Project Site

2.7.1 Parking

2.7.1.1 Statutory parking regulations: The Texas Department of Public Safety ("DPS") is generally responsible for enforcing the State Preservation Board's parking rules for state-owned parking facilities within the Capitol Complex, including parking structures and surface parking lots. *See generally*, TEX. GOV'T CODE § 443. 013 *et seq*.; 13 TEX. ADMIN. CODE §§ 111.34 *et seq*.

At the NAC, TFC and the Texas Health and Human Services Commission ("HHSC") are responsible for parking regulation; a third-party security service enforces parking rules for the NAC.

TFC has, pursuant to statute, implemented a program for leasing State-owned parking structures for private commercial use outside regular business hours, including Saturday and Sunday. Parking garages shall be designed to accommodate future access control to provide the ability for TFC or third-party parking contractors to manage the parking structure and collect fees from the general public for parking. In addition, the parking structure must accommodate State employee parking at no charge in designated areas during after-hours events. The parking structure design shall accommodate vertical pedestrian egress directly to exterior ground level outside regular business hours. Final parking structure design shall be coordinated with DPS.

2.7.1.2 Access: Access at garage entries for State employees shall allow for the potential installation of RFID-activated gate arm or a similar technology that provides rapid and efficient garage entry and exit and avoids vehicle stacking and delays. Turn-around spaces shall be provided in front of secure areas controlled by gates or armatures.

2.7.1.3 Safety: Speed hump/bump may be used for slowing cars in the vicinity of pedestrians or entrances to elevator vestibules and stairs. Potential hiding places below should be avoided in design or closed off from public use. If used for storage, such areas shall be secured with doors and locks. Exterior stairway doors and ground-level pedestrian exits may be egress-only; refer to the solicitation and other program documentations for additional information, especially with respect to a Texas CapCom MP building adjacent to a pedestrian plaza. Design best practice will provide for pedestrian entrances to concentrate pedestrians through fewer portals, improving the ability to see and be seen by others. At each parking garage level stairway landing in enclosed garages, designs should consider a fire-rated glazed opening or fire-alarm controlled hold-opens for doors for visibility into the stairwell from the parking level.

Refer to Section 5.13.19 and to IESNA standards regarding illuminance requirements for parking structures. In particular, light fixtures supporting security cameras shall have adequate CRI to ensure highest possible fidelity video recording. Entry ramps shall have graduated light levels to allow for drivers' adjustment from ambient daylight levels to the darker garage.

2.7.1.4 Egress at Plazas: For buildings in the Texas CapCom MP that are adjacent to pedestrian plazas or other prominent pedestrian walkways or spaces, special consideration shall be given to aesthetics of parking garage pedestrian exits. Refer to the Texas CapCom MP for architectural guidelines to inform the appropriate level of finish and the overall appearance appropriate to each such pedestrian exits.

2.7.1.5 Carpool parking: Preferred parking spaces shall be provided for carpool vehicles. The minimum number of such spaces shall be 2 percent of the total number parking spaces. Preferred spaces shall be permanently signed and located in select areas.

2.7.1.6 Bicycle parking: Each underground parking structure shall provide a bicycle parking cage as close as reasonably possible to the vehicular entry to the parking structure or as reasonably located within proximity to a building entrance. The minimum number of such spaces shall be 3 percent of the total number of full-time employees ("FTE") expected to occupy the building(s).

2.7.1.7 Electric vehicle recharge stations: Preferred parking spaces with electric vehicle recharge stations shall be provided for electric vehicles. The minimum number of such spaces shall be 2 percent of the total number of parking spaces.

2.7.1.8 Clear height: Van-accessible ADA spaces shall meet minimum height requirements. Typical parking spaces shall have clear height of 7'-2". To the greatest extent possible, compact spaces shall not be used. All mechanical, electrical, and plumbing infrastructure including fire protection shall be routed in a neat orderly fashion.

2.7.1.9 Loading Dock: Off street loading bays shall be provided with appropriate truck maneuvering, turning radius, approach angle and use. Length, Width and number of loading bays to be determined based on programming.

2.7.1.10 Trash Removal: Off street loading for trash removal, compaction and collection shall be provided with appropriate truck maneuvering, turning radius, approach angle and use. Length and width shall be determined based on programming and with assistance from designated waste-hauling vendor. At least two bays shall be set aside for this permanent use.

2.7.2 Landscape: Site development and landscape architectural design shall consist of, but not be limited to, the following considerations: grading and drainage; relationships of exterior/interior functions; automatic irrigation system; exterior lighting and landscape illumination; plant material selections and locations; special outdoor amenities such as courtyards, sculpture, plazas, fountains, furnishings, etc.; pedestrian and vehicular circulation including walks, roads, parking, ramps, bicycle cages and racks, service lanes, etc.; and proper utilization of desirable existing features such as water, tree groupings, geological formations, maintenance, etc. Refer generally to TFC Architectural/Engineering Guidelines Appendix F relating to minimum requirements for landscape design and implementation.

2.7.2.1 Settlement: Accommodating settlement is an important consideration for new construction, especially in the Capitol Complex, where extensive excavation and backfill will create conditions making hardscape and landscape areas susceptible to displacement. Minor deflection of parking structure walls may displace a volume of soil at the garage perimeter. The design shall anticipate the likely volume of soil that will need to be added one year following completion of the garage.

2.7.2.2 Irrigation: Site irrigation shall use reclaimed water where practical. Reclaimed water use may include the use of the City of Austin reclaimed system if infrastructure exists to the site. The feasibility of re-using groundwater harvested at the parking structures shall be investigated. Site irrigation design shall use current best practices to the greatest extent to reduce consumption. Zoning and controls for the irrigation system(s) shall be coordinated with TFC landscape staff.

2.7.2.3 Species selection: Consistent with rules adopted pursuant to Texas Government Code section 2166.404, species selection for landscape plantings shall comply with xeriscaping requirements.

2.7.3 Hardscape

2.7.3.1 Settlement mitigation: As noted above, preference shall be accorded designs that proactively anticipate and include measures to mitigate settlement and soil displacement. The preference is for a ground-floor slab that hinges at strategically located flatwork joints rather than at the building perimeter or close to major building entries. The structural slab shall be extended in these critical areas. A perimeter secondary irrigation system may also be deployed to preserve desired soil compaction.

2.7.3.2 Albedo / reflectivity: Mitigation of heat island effect through the use of high-reflectivity and minimization of low-reflectivity materials is preferred.

2.8 Affirmation of meeting OPR and technical review comments

At the conclusion of the construction document design phase, the A/E team shall craft a statement in the form of a letter that affirms compliance with the OPR and the applicable Master Plan as appropriate and the incorporation of technical review comments from TFC and/or its authorized representatives. For those instances of non-compliance, the statement shall detail each instance and provide an explanation of the measure(s) taken by the A/E team to meet the intention of the requirement or of the rationale for non-compliance.

3 Expected Lifespans for Building Elements

The following design life-spans establish the design criteria by which appropriate building equipment and systems can be selected and designed that are fit for the Project's specific purpose.

Level I Major Group Elements	Level 2 Group Elements	Level 3 Individual Elements	Design Lifespan
A Substructure	A10 Foundations	A1010 Standard Foundations	100+ years
		A1020 Special Foundations	100+ years
		A1030 Slab on Grade	100+ years
	A20 Basement Construction	A2010 Basement Excavation	N/A
		A2020 Basement Walls	100+ years, if applicable
B Shell	B10 Superstructure	B1010 Floor Construction	100+ years
		B1020 Roof Construction	100+ years
	B20 Exterior Enclosure	B2010 Exterior Walls	*70-100+ years*
		B2020 Exterior Windows	*40-60 years*
		B2030 Exterior Doors	*40-60 years*
	B30 Roofing	B3010 Roof Coverings	*25-40 years*
		B3020 Roof Openings	*30-50 years*
C Interiors	C10 Interior Construction	C1010 Partitions	30 years
		C1020 Interior Doors	30 years
		C1030 Fittings	30 years
	C20 Stairs	C2010 Stair Construction	100+ years
		C2020 Stair Finishes	25 years
	C30 Interior Finishes	C3010 Wall Finishes	20 years
		C3020 Floor Finishes	20 years
		C3030 Ceiling Finishes	20 years
D Services	D10 Conveying	D1010 Elevators & Lifts	50 years
		D1020 Escalators & Moving Walks	50 years if applicable
		D1090 Other Conveying Systems	50 years
	D20 Plumbing	D2010 Plumbing Fixtures	25 years
		D2020 Domestic Water Distribution	25 years
		D2030 Sanitary Waste	25 years
		D2040 Rain Water Drainage	25 years
		D2090 Other Plumbing Systems	25 years
	D30 HVAC	D3010 Energy Supply	25 years
		D3020 Heat Generating Systems	25 years
		D3030 Cooling Generating Systems	25 years
		D3040 Distribution Systems	25 years
		D3050 Terminal & Package Units	25 years
		D3060 Controls & Instrumentation	10 years

		D3070 Systems Testing & Balancing	25 years
		D3090 Other Systems HVAC Systems & Equipment	25 years
	D40 Fire Protection	D4010 Sprinklers	40 years
		D4020 Standpipes	40 years
		D4030 Fire Protection Specialties	25 years
		D4090 Other Fire Protection Systems	15 years
	D50 Electrical	D5010 Electrical Service & Distribution	25 years
		D5020 Lighting & Branch Wiring	25 years
		D5030 Communications & Security	15 years
		D5090 Other Electrical Systems	30 years
E Equipment & Furnishings	E10 Equipment	E1010 Commercial Equipment	30 years
		E1020 Institutional Equipment	30 years
		E1030 Vehicular Equipment	30 years
		E1090 Other Equipment	30 years
	E20 Furnishings	E2010 Fixed Furnishings	20 years
		E2020 Movable Furnishings	N/A
F Special Construction & Deconstruction	F10 Special Construction	F1010 Special Structures	30 years
		F1020 Integrated Construction	30 years
		F1030 Special Construction Systems	30 years
		F1040 Special Facilities	30 years
		F1050 Special Controls & Instrumentation	20 years
	F20 Selective Building Deconstruction	F2010 Building Elements Deconstruction	N/A
		F2020 Hazardous Components Abatement	N/A

(Based on ASTM Uniformat II Classification for Building Elements and NFPA)

4 Economic Cost Parameters for Life Cycle Cost Analysis (“LCCA”)

4.1 Financial Criteria: At a minimum, the following financial criteria for the new construction service region shall set the basis for performing a Life Cycle Cost Analysis (“LCCA”) and subsequent business-based decisions in the selection of appropriate equipment and systems fit for buildings subject to these Requirements. Values listed are considered default if no other information is known.

Nominal Discount Rate	6 percent
Years of Life Cycle Analysis	30 years
Cost of Electricity	
▪ Winter billing energy rate	
▪ Summer billing energy rate	
▪ Power supply adjustment rate	
Cost of Natural Gas	
▪ First 500 Ccf	
▪ 500-3,000 Ccf	
▪ Amount in excess of 3,000 Ccf	
Cost of Water and Wastewater	
Inflation Rate	3 percent / year
Maintenance Escalation	3 percent / year

4.2 Life Cycle Cost Analyses: The design team shall provide for three complete LCCAs during the schematic design phase. The LCCA is an essential design process for controlling the initial and future cost of building ownership. The Life Cycle Cost (“LCC”) is the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or building system over a period of time. The LCCA is based on the premise that multiple building design options can meet programmatic needs and achieve acceptable performance, and that these options have differing initial costs, operating costs, maintenance costs, and LCCs. By comparing the LCCs across competing proposals, the LCCA can show the trade-offs between low initial first cost and long-term cost savings. Comparing LCCAs can identify the most cost-effective system for a given use and the payback period for the incremental cost.

4.2.1 LCCA comparative analyses: A LCCA relating to any equipment shall include maintenance costs for that equipment. Building system categories include but are not limited to:

4.2.1.1 Energy systems: equipment options (air cooled chillers vs. refrigerant-based direct expansion (“DX”) units); and alternative energy systems

4.2.1.2 Mechanical systems: air distribution systems (variable volume versus constant volume, overhead versus underfloor), and water distribution systems

4.2.1.3 Electrical systems: Indoor lighting sources and controls, outdoor lighting sources and controls, power distribution (transformers, busways, cable trays)

4.2.1.4 Building Envelope systems: skin and insulation options, roofing systems materials and insulation methods, glazing, daylight, and shading options; siting systems; orientation, floor to floor height, and overall building height; and landscape, irrigation, and hardscape options

4.2.1.5 Structural Systems: systems and materials selection (steel versus concrete, cast-in-place versus precast)

4.3 LCCA Process

4.3.1 General: The LCCA process requires clearly identified design approaches and cost information: develop a LCC for each.

4.3.2 Objectives: The LCCA can capture dollar cost variations between alternatives and show which option has the overall lowest cost. An LCCA cannot evaluate the improved comfort or occupant satisfaction with different glazing materials; such non-quantifiable assessments may be addressed in narrative summary.

4.3.3 LCCA metrics: The LCC of each design approach and its payback over the study life are the two LCCA metrics. TFC will consider both total cost and the payback period, including the time value of money.

4.3.4 Cost information: Cost information for each identified design approach shall include but may not be limited to:

Initial costs: construction costs (labor, materials, equipment, etc.); and soft costs (design fees, permit fees, etc.).

Annual future costs: operating costs (utility costs such as electricity, gas, water, steam, chilled water, etc. and service costs such as custodial, etc.); and maintenance Costs (preventative and reactive).

Non-annual future costs: replacement costs (planned maintenance, renovation at a future date, etc.); and demolition costs (if required).

4.3.5 Perform life cycle cost analysis: Calculate the LCC and Payback metrics for proposed design approaches and articulate the rationale for the proposed design using the LCCA and other pertinent information. The narrative required by Texas Government Code section 2166.403 relating to the economic viability of alternative energy sources and energy efficient technologies may be referenced or included in the LCCA for consideration.

4.4 Process for Final Selection and Design Approval: The TFC Project Team will develop an appropriate framework of evaluation for each project. Factors may include aesthetics, land use, energy and water use, programmatic factors, materials and waste, indoor environmental quality and adaptability for future use.

5 Architectural and Engineering Criteria

5.1 Code, Regulations & Guidance

All buildings subject to these Requirements shall be designed and constructed pursuant to current applicable codes and regulations. In case of conflict between these Requirements and governing code or regulations, the relevant code or regulation shall govern. Generally, if any code, regulation, or guidance specifically cited in these Requirements has been superseded by a more recent version, the most recent version shall govern; however, if the authority having jurisdiction ("AHJ") or the regulatory body expressly charged by statute with enforcement of a specific provision has specifically adopted an earlier version, that authority shall govern. In case of conflict between or among statutes, rules, or guidances, the most restrictive requirements of each of the following codes, regulations, and guidances shall govern.

The State Fire Marshal's Office ("SFMO") is the AHJ for enforcement of fire protection and fire alarm requirements.

The SFMO does not provide fire-fighting capabilities, and thus, TFC relies on local fire departments for emergency response and fire suppression. These local fire departments must have confidence that buildings and fire safety systems meet the state standards and are compatible with local equipment so that the fire departments can safely and promptly respond to an emergency. Per a memo issued by the SFMO on April 19, 2016, titled Cooperation with Local Jurisdictions and Fire Departments:

"TFC and state agency staff involved in safety, planning, operation and maintenance must be aware of the responsibilities they have for the compatibility and use of agency equipment by the local emergency responders. All third-party contractors, architects and engineers providing design and construction must ensure TFC and state agencies that the Life Safety Code and local requirements have been taken into consideration and addressed in the planning, design, construction and operation of all facilities.

Water mains, building access, fire lanes and turning radius requirements, compatibility of fire hydrants, fire department connections, fire sprinkler systems, standpipe and hose systems, alarm systems, and other emergency equipment must be designed with the operation by the local department in mind. Local fire departments should be invited to review the plans for and to participate in viewing acceptance tests of water mains and fire suppression systems."

Every effort shall be made to design new buildings in accordance with local development codes and rules related to emergency response. Where utility extension to infrastructure within municipal or other local jurisdiction is necessary, new buildings shall comply with local development codes and rules to the extent required for that extension.

Codes and statutes

Americans with Disabilities Act ("ADA") 1990, 42 U.S.C. §§ 12111 *et seq*.

Energy Policy Act ("EPAct") 2005, Pub. L. 109-58

International Association of Plumbing and Mechanical Officials (IAPMO)

International Code Council (ICC) family of codes (latest published editions)

International Building Code (IBC)

International Fire Code (IFC)

International Fuel Gas Code (IFGC)

International Mechanical Code (IMC)

International Plumbing Code (IPC)

National Fire Protection Association (NFPA) (latest published editions)

NFPA 1 Fire Code (latest adopted edition per SFMO)

NFPA 13: Installation of Sprinkler Systems

NFPA 20: Standard for the Installation for Fire Pumps

NFPA 24: Installation of Private Fire Service Mains and their Appurtenances

NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water Based Fire Protection Systems

NFPA 54: National Fuel Gas Code

NFPA 70: National Electric Code

NFPA 72: National Fire Alarm and Signaling Code

NFPA 88A: Standard for Parking Structures

NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems

NFPA 90B: Standard For the Installation of Warm Air Heating and Air-Conditioning Systems

NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

NFPA 101: Life Safety Code (latest edition adopted by the SFMO)

NFPA 110: Standard for Emergency and Standby Power Systems

NFPA 730: Guide for Premises Security

NFPA 731: Standard for the Installation of Electronic Premises Security

NFPA 780 Standard for the Installation of Lightning Protection Systems

Texas Government Code

Chapter 447 – State Energy Conservation Office

Chapter 469 – Elimination of Architectural Barriers

Chapter 2166 – State Buildings, Grounds, And Property

Chapter 2311 – Energy Security Technologies For Critical Governmental Facilities

Chapter 3151 – Preservation of View of State Capitol

Texas Health and Safety Code

Chapter 372 – Environmental Performance Standards for Plumbing Fixtures

Regulatory requirements and guidance

Code of Federal Regulations

10 CFR Part 436 Federal Energy Management and Planning Programs ("FEMP")

36 CFR Part 1191 Architectural Barriers Act Accessibility Standards

2010 ADA Standards for Accessible Design – 2010 Standards for State and Local Governments Title II

Texas Commission on Environmental Quality (TCEQ)

Regulations regarding water, wastewater and storm water, waste management, and pollution prevention

Edwards Aquifer Protection Program (EAPP)

Texas Department of Family and Protective Services: 40 TEX. ADMIN. CODE §§ 746.101 et seq.; Minimum Standards for Child Care Centers (2015)

Texas Department of Information Resources, *see generally* 1 TEX. ADMIN. CODE Part 10

Texas Facilities Commission

Architectural / Engineering Guidelines (2012)

Uniform General Conditions (2015)

Texas Department of Licensing and Regulations

Texas Accessibility Standards (TAS) 2012

State Energy Conservation Office (SECO)

Water Conservation Design Standards for State Buildings and Institutions of Higher Education Facilities (2020)

Energy Conservation Design Standard for New State Buildings

Energy and Water Conservation Design Standards

Storm Water Management Program

Professional standards and best practices (including but not limited to)

American Architectural Manufacturers Association (AAMA), AAMA TIR A13-13

American Concrete Institute (ACI)

America Council for an Energy Efficient Economy (ACEEE), GreenerCars Rating Guide

American National Standards Institute (ANSI)

ANSI A108 – Tile Council of North America

ANSI B31.1 – Power Piping

ANSI B31.9 – Building Services Piping

ANSI S12.60 – Classroom Acoustics

ANSI 61 – Drinking Water System Components Health Effects

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE 90.1 – Energy Standards for Buildings except Low-Rise Residential Buildings

Fundamental Design Handbook

American Society of Mechanical Engineers (ASME)

ASME A17.1 – Safety Code for Elevators and Escalators

ASME B31 – Code for Pressure Piping

ASME B31.9 – Building Services Piping

American Water Works Association (AWWA)

Applied Technology Council (ATC) Design Guide 1 (ATC-DG-1)

Architectural Woodwork Institute (AWI) Woodwork Standards

ASSE Engineering International Product Standards

BICSI

Electronic Safety and Security Design Reference Manual (ESSDRM)

Telecommunications Distribution Methods Manual

Building Stone Institute (BSI), Recommended Best Practices

Crime Prevention through Environmental Design (CPTED)

Indiana Limestone Institute of America (IILA), *The Indiana Limestone Handbook*, 22dn Edition

Masonry Institute of America (MIA), *Masonry Standards for the Building Industry 7th Edition* (2012)

Master Painters Institute – *Architectural Painting Specification Manual*

National Association of Corrosion Engineers (NACE)

National Fenestration Rating Council Incorporated (NFRC), NFRC-500

National Institute of Building Sciences (NIBS), *NIBS Guideline 3-2012: Building Enclosure Commissioning Process BECx*

National Institute of Standards and Technology (NIST) *Handbook 135*

Plumbing and Drainage Institute (PDI) – WH 201 (water-hammer standard)

Precast Concrete Institute (PCI) - *Design Handbook* (Eighth Edition - 2017)

Sheet Metal & Air Conditioning Contractors' National Association (SMACNA)

Steel Door Institute (SDI)

Telecommunications Industry Association (TIA)

Tile Council of North America (TCNA), *TCNA Handbook for Ceramic, Glass, and Stone Tile Installation* (2020)

Uptime Institute, Tier Standards

Underwriters Laboratory

UL 864 for Fire Alarm and UL 2572 for Mass Notification

5.2 Architectural

5.2.1 Building enclosure attributes

5.2.1.1 Water penetration resistance: For fenestration water penetration resistance, at a minimum the enclosure shall meet the baseline requirements of AAMA/WDMA/CSA 101/1.S.2/A440-17 designation CW30. No water penetration shall be allowed on any interior surface that is not drained to the exterior or otherwise controlled. Water pressure test(s) shall be required as part of the construction sequence. Refer to the American Architectural Manufacturers Association ("AAMA") recommendation regarding static water penetration resistance test pressures for non-hurricane-prone U.S. regions, AAMA TIR A13-13.

Roofing systems shall be highly resistant to physical damage, including impact resistance. The roof assembly shall not permit water entrapment within any layer, including insulation, protection, or drainage layers. Refer to IBC section 1507 regarding minimum drainage slopes.

Roof drainage conductors, leaders, and drains shall be based on 100-year peak hourly rainfall data. To prevent rooftop ponding, redundant roof drainage systems may be used. Flood testing for at least 48 hours shall be provided during the construction sequence.

5.2.1.2 Moisture and condensate control: Fenestration condensation resistance shall be tested consistent with NFRC-500, Procedure for Determining Fenestration Product Condensation Resistance Values. For other exterior wall assemblies, refer generally to ASHRAE 160 regarding the minimum BOD for moisture control design analysis in buildings.

5.2.1.3 Air tightness: Building air tightness shall conform to the maximum air leakage of 0.4 cfm per square foot, including all "six sides" (i.e., four walls, roof, and foundation). The tightness performance may be tested pursuant to ASTM E379. Fenestration shall at a minimum meet AAMA/WDMA/CSA 101/1.S.2/A440-17 rating of CW 30.

5.2.1.4 Building enclosure commissioning: Building commissioning, including enclosure performance shall be performed consistent with ASHRAE Guideline 0 and USGBC LEED Enhanced Commissioning procedures.

5.2.1.5 Acoustic control: The exterior enclosure shall target a minimum rating of STC 35 throughout.

5.2.1.6 Bird-safe and bat-safe building design: Exterior enclosures shall be designed to eliminate areas conducive to bird or bat colonization. Refer generally to the American Bird Conservancy *Bird-Friendly Building Design* guidelines for material and formal strategies to minimize harm to bird and bat populations from collisions and other interactions with buildings. Deep window openings are discouraged, horizontal elements shall be reviewed for conducive habitat early in the design stages.

5.2.2 Enclosure requirements

5.2.2.1 Moisture control: Provide for vector-mapping analysis to confirm consistent waterproofing for fluid-applied products. Prior to cover-up and at stages appropriate for the level of construction, TFC (and its testing representative if applicable) shall be notified for vector mapping analysis. This testing shall be in addition to the field testing performed by the installing contractor.

5.2.2.2 Below-grade systems: "Blind-side" waterproofing for basement walls is recommended. Performance and quality should be addressed through proper specification, substrate preparation, installation procedures and manufacturer's on-site inspections from an experienced contractor. A true drain system that can be maintained with a sump pump system and cleanouts serviceable from the basement interior shall be included in the design. Corrugated PVC drain tile piping shall not be used; stiffer schedule 40 perforated PVC pipe is required. Perimeter drainage shall be a separate system from interior foundation drainage system. All drain tile piping shall be laid onto large, river-washed aggregate stones, which is laid onto a filter fabric, which should be wrapped around and over the drain tile to prevent fine soils from filling the piping. Drain piping shall be installed with minimum 1/8 inch per foot slope to ensure that the water moves toward the sump collector. Penetrations are common sources of leakage and shall be minimized with both primary and secondary seals.

5.2.2.3 Substructure: For a new building without an underground parking structure, the preferred substructure employs a suspended first-floor slab and basement or crawlspace rather than a slab on grade. If pan joists are used, ensure adequate clearance for crawlspace access or at least 4 feet clear at the lowest point. A substructure crawlspace is not necessary for any parking structure. Crawlspaces shall be ventilated appropriately based on applicable code. Provide multiple 3-foot by 5-foot man doors and access points with ladders for maintenance and observation. Crawlspaces shall maintain air barrier continuity for the building enclosure. Any space that qualifies as a confined space under OSHA regulations shall be provided with adequate access and egress pursuant to those rules and guidance; for confined spaces that will require an entry permit under OSHA regulations, all conditions shall be met to ensure that permit may be obtained as needed.

If applicable, refer to the most current version of the Master Plan for guidance regarding provision of utility tunnels. All tunnels shall be sized to provide access, ventilation, and maintenance.

5.2.2.4 Wall systems

5.2.2.4.1 Connections and fasteners: Carbon steel connections and fasteners in exposed conditions are not permitted.

5.2.2.4.2 Air and weather barrier system: A continuous air and weather barrier ("WB") system must be installed both above- and below-grade to separate conditioned air from outdoor spaces. The WB system shall be shown as continuous through all enclosure section drawings. The WB materials and components of each assembly shall be detailed at all penetrations, joints, and transitions. The pressure boundary of the air barrier system(s) and the zone(s) to be tested must also be shown on the drawings. The WB material of each assembly must be joined and sealed to the air barrier material of adjacent assemblies with sufficient flexibility to allow for the relative differential movement and with sufficient strength to resist expected peak air pressure differences. All penetrations of the WB system must be sealed to the air barrier system in an airtight manner. The WB system (and all materials and components comprising it) must last the anticipated service life of the enclosure or allow for easy maintenance, repair, and/or replacement.

5.2.2.4.3 Stone: Installation of granite or marble at exterior walls shall conform to the recommended best practices published by the Building Stone Institute. The installation of limestone shall conform to the Indiana Limestone Handbook, published by the Indiana Limestone Institute of America. The installation shall anticipate water penetration through exterior masonry elements exposed to rain. Lateral tie systems for anchoring veneer to structural back-up or for vertical support of the weight of the veneer shall be stainless steel.

5.2.2.4.4 **Plaster**: For exterior plaster walls, provide expansion joints or control joints, or both, both horizontally and vertically, as recommended by ASTM C1063-Installation of Lath and Furring for Portland Cement Based Plaster. Provide expansion joints or control joints at corners, windows/door openings, or other penetration openings. Finish outside corners with metal casing bead.

5.2.2.4.5 **Masonry and concrete materials:** Concrete formwork shall meet America Concrete Institute ("ACI") class B for office building areas and ACI class C for parking structure areas. Architectural precast design shall follow the recommendations of the Precast Concrete Institute's ("PCI") "Architectural Precast Concrete" publication. Exposed concrete ceilings may be designed for select spaces such as large break rooms, pre-function spaces, or other common areas with atypical finish requirements. Where exposed concrete ceiling occur, formwork shall meet ACI class A.

Masonry construction shall conform generally to the most current version of the Masonry Institute of America's "Masonry Standards for the Building Industry."

Cold-form steel back-up structure is the preferred assembly for masonry walls provided all clips and accessories are stainless steel and back-up framing is a minimum of 16 gage thickness. Masonry back-up structure (cavity-wall construction) may be considered in lieu of cold-form back-up. Relief at each floor for a concrete frame bearing a masonry veneer exterior wall is acceptable.

5.2.2.4.6 **Entrance Doors:** Entrance doors may be aluminum or glass of heavy duty construction. Steel exterior doors and frames must meet the requirements of SDI Grade III with a G-90 galvanic zinc coating. Vestibules are preferred to control air infiltration. Where required, push plates are the preferred actuating devices. Automatic sliding doors shall be considered for primary entrances.

5.2.2.5 **Fenestration systems:** Window assemblies shall at a minimum be thermally improved. Provide at least one LCCA for thermally broken windows to assess value to owner. Aluminum frames must have thermal breaks in a region with more than 3,000 heating degree days ºF. Window mullions, as much as possible, shall be located on the floor-planning grid to permit the abutment of interior partitions.

Skylight design shall follow the guidelines of AAMA Standard 1600. For the design of sloped glazing, refer to the AAMA's Structural Design Guidelines for Aluminum Framed Skylights. Low emissivity ("low-e") glass is preferred for skylights. Skylights shall be located to prevent interior glare and overheating. Condensation gutters and a path for the condensation away from framing shall be provided.

The continuity and uniformity of both primary and secondary seals is critical, and continuous seals shall be maintained. Glass selection should be influenced by reflectivity and low- E coatings. Exterior mirrored glass is not permissible.

5.2.2.6 **Quality assurance:** Refer to TFC's Architectural / Engineering Guidelines for quality assurance requirements during the design phase. Performance testing for building envelope features, including roof, fenestration, and opaque exterior walls, shall be coordinated during the construction sequence.

5.2.2.7 Sun control devices: To minimize maintenance and to simplify interior assemblies, exterior, fixed passive solar control devices are preferred.

5.2.2.8 Window cleaning: Provide davits and roof anchors at the building perimeter for supporting window-cleaning equipment. The design shall provide for cleaning the interior and exterior surfaces of all windows, skylights, and other glazed openings. The ability to clean and maintain all interior glazing surfaces without extraordinary means and methods shall be demonstrated. Roofing materials shall be protected (e.g. additional cap sheet) in the areas of expected window cleaning equipment. Provide power and water source at the roof at appropriate intervals.

5.2.2.9 Access to maintain equipment: Major pieces of mechanical system equipment (e.g., AHUs and RTUs) shall be located such that ease of access for maintenance and a pathway for removal for replacement are preserved. Equipment replacement or relocation shall generally not require demolition. Major equipment replacement may require minor demolition at interior or exterior walls; that eventuality shall be disclosed to and coordinated with TFC during the design phases. Provide at least 1-1/2 times the minimum recommended or code-required clearance around all major equipment.

5.2.3 Interior performance requirements

5.2.3.1 Construction products and materials

5.2.3.1.1 Partitions: Typical partition construction shall consist of light-gauge steel framing with gypsum wallboard sheathing. To achieve required acoustical performance, sound-attenuating insulation, resilient strips, multiple layers of gypsum wallboard, or a combination of these and/or other strategies may be deployed. Use “putty packs” for exposed junction boxes in sound- and fire-rated walls.

Partitions that demise tenant agency spaces shall extend to deck and may include an interlayer of expanded security steel mesh and full height sound attenuation. The fire-resistance rating for demising walls shall be determined by applicable code.

In addition to select offices, all meeting room, training room, or other assembly room partitions shall extend to structural deck and shall have acoustical batt insulation to deck. Refer to Section 5.2.3.3.2 regarding minimum STC ratings. Gypsum wallboard for non-fire rated partitions or non-acoustical partitions shall extend at least 6 inches above ceiling. Partition head tracks may be used to anchor to ceiling grids.

5.2.3.2 Interior finishes and materials

5.2.3.2.1 Floors: In lieu of specifying floor flatness standards in these Requirements, slabs shall be designed to receive a self-leveling cap after formwork and shoring removal to ensure floor levelness and flatness. The floor finish specification should take this into account in selection of finishes and their substrates.

5.2.3.2.1.1 Carpet: Stain-resistant carpet tiles for general office areas are preferred to broadloom for replace-ability. Minimum requirements for carpet construction shall be 1/12 gauge, 10 stitches per inch, tufted, level loop, with appropriate backing to provide moisture barrier, and post-consumer, recycled product/cradle-to-grave certified.

Stain-resistant carpet for areas of heavy traffic, where frequent spills and stains are expected, shall be either 12-foot or 6-foot broadloom or carpet tile. These may also be areas where significant direct sunlight would be experienced and where colorfastness is a primary concern. Static control shall be under 2kV in all areas. Static shall be controlled by permanent means (i.e. antistatic filaments) and without chemical treatment. Provide combined waterproofing and crack isolation membrane at toilet room areas.

5.2.3.2.1.2 **Ceramic tile:** Ceramic floor tile installation shall conform to the current guidelines published by the Tile Council of North America (ANSI A108). Tile finish may be glazed or matte for walls and shall be matte for floors. Grout must be sealed per manufacturer's written recommendations. A dark color grout shall be used on floors and walls. Grout joints at wall and floor shall be aligned where possible. Quarry tile is not allowed in breakrooms or other wet areas.

5.2.3.2.1.3 **Resilient flooring:** For durability and ease of maintenance, luxury vinyl tile ("LVT") is the preferred floor finish for storage rooms, custodial closets, support offices for loading docks, and back-of-house areas generally. Static dissipative tile (SDT) shall be installed in MDFs, IDFs, and Data Centers. Rubber flooring may be installed in wet areas where non-slip flooring is required or recommended.

5.2.3.2.1.4 **Terrazzo flooring:** Terrazzo flooring may be used in entry vestibules, public lobbies or other areas with very high traffic and generally upgraded finishes. Terrazzo must be cut and ground or honed using a machine that captures dust to prevent it from becoming airborne. Cementitious matrix material is preferred; for epoxy matrix, surfaces must be kept wet. Floor must be thoroughly sealed to the point of rejection with a liquid densifier (e.g., lithium silicate) product.

5.2.3.2.1.5 **Stone flooring**: Stone flooring may be used in entry vestibules, public lobbies or other areas with very high traffic and generally upgraded finishes. Follow best practices from TCNA for large format tile placement including subsurface tolerance, grout joint width, warpage, edge treatment, layout and bond pattern to prevent lippage. The potential for lighting and glare shall be carefully coordinated with material selection.

5.2.3.2.2 Walls

5.2.3.2.2.1 **Paint:** The requirements in the "MPI Architectural Painting Specification Manual" for products and paint system indicated shall be followed. Low VOC-content paints are preferred. "Ready mix" type paint is preferred. Paint shall be uniformly dispersed to a homogeneous coating with good flow and brushing properties, capable of drying or curing free of streaks or sags.

5.2.3.2.2.2 **Plaster:** For interior plaster walls, provide expansion joints or control joints at corners, windows/door openings, or other penetration openings.

5.2.3.2.2.3 **Gypsum wallboard:** All assemblies shall have a tolerance of 1/8 inch in 10-foot maximum, non-cumulative. All partitions shall be finished at least to Level Four; finish to Level Five if wall is scheduled to receive application of any roll good e.g., markerboard material or vinyl wall graphic. All outside corners shall be floated with metal cornerbead. Partitions that are part of a perimeter security system, a fire rated assembly, or an acoustical assembly shall extend to structural deck. Blocking shall be provided at all door stop, flat-panel display, or other wall-mounted equipment locations.

5.2.3.2.2.4 **Vinyl wall covering:** The use of vinyl wall coverings ("VWC") is not preferred. If use of VWC is necessary, it shall have a polyolefin coating, type 2, and high permeability ratings. Use of VWC shall be limited to interior partitions and only used in conjunction with proper wall preparation.

5.2.3.2.2.5 **Wood:** Wood is an acceptable wall finish in prominent, publicly accessible areas or rooms with generally upgraded finishes; wood is not preferred as a wall finish for typical office levels. Refer to AWI "premium" and "custom" grade guidelines for appearance and installation requirements. Concealed mechanical fasteners that allow demounting panels are preferred to adhesive attachment methods.

5.2.3.2.2.6 **Tile:** Wall tile substrate shall be a minimum 5/8-inch cement tile backer board. Tile finish may be glazed or matte. Ceramic tile installation shall conform to the current guidelines published by the Tile Council of North America (ANSI A108). A dark color grout shall be used. Grout joints shall be aligned where possible. Quarry tile is not allowed in breakrooms or other wet areas.

5.2.3.2.2.7 **Wall base:** Typical office floors, including corridors and other general circulation areas shall have vinyl or rubber base, with matching pre-molded corners.

5.2.3.2.2.8 **Loading dock and adjacent back-of-house spaces**: Loading dock and other back-of-house spaces including corridors shall be constructed with abuse-resistant gypsum wallboard. Corridors in and adjacent to such spaces shall have continuous crash rails, either wall-mounted or floor-mounted. Floor-mounted crash rails shall be coordinated with specified rolling bins and carts. All outside corners in back-of-house areas shall be finished with full-height, steel corner guards. Consider similar measures in other areas or spaces prone to heavy wear and traffic.

5.2.3.2.2.9 **Chair rail:** Provide chair rail wall protection in small, medium, and large conference rooms and in training rooms.

5.2.3.2.3 Ceilings

5.2.3.2.3.1 **Acoustical tile ceiling:** Ceilings for typical office levels shall be accessible, modular acoustical tile systems. Larger panels and/or higher-grade panels may be considered in higher traffic or higher visibility areas, such as pre-function spaces. Laminated acoustical ceiling tiles may be proposed where acoustical concerns indicate its economical use.

5.2.3.2.3.2 **Gypsum wallboard ceiling:** Gypsum wallboard ceilings shall be used infrequently, e.g. at areas where security, privacy, aesthetics, sound control, or fire ratings require it. Provide access doors in gypsum board ceilings, for servicing equipment, filters, dampers, valves, and other above-ceiling devices.

5.2.3.2.3.3 **Exposed concrete ceiling:** Exposed concrete ceilings may be acceptable in certain areas but is generally not preferred for typical office levels. Slab formwork shall be coordinated to ensure architectural concrete finish. Care shall be taken to minimize exposed conduit, cable trays, and other systems infrastructure. Exposed systems infrastructure shall be routed and organized in neat, tidy, and attractive ways. Exposed mechanical system ducts shall be spiral-wrapped.

5.2.3.2.4 **Millwork:** Architectural Woodwork Institute ("AWI") "premium" grade wood is preferred where the finish is exposed wood. For interior cabinet carcass and typical shelving, particleboard shall not be used. Refer to AWI "custom" grade for preferred guidelines. Refer to AWI "custom" grade regarding plastic laminate. Plastic laminate used for cabinet door and drawer facings shall be applied with contact cement. Provide pre-finished woodwork where possible. Where in-field finish must be performed, coordinate environmental concerns, ventilation requirements, shutdowns, etc. Any area where woodwork is to be installed shall have been satisfactorily conditioned for temperature and humidity control prior to introducing woodwork into the space.

5.2.3.3 **Acoustics:** The building(s) shall be designed to minimize noise transmission between noise-creating equipment and/or spaces (e.g., mechanical rooms, toilet rooms) and adjacent offices or classrooms.

5.2.3.3.1 Spaces shall be planned to minimize acoustic concerns. Executive offices and meeting room partition walls shall extend to deck, with full-height sound-attenuating insulation.

5.2.3.3.2 Provide wall designs to address noise concerns at areas sensitive to noise transmission. For sound transmission class designation, refer to ANSI S12 as the basis for measurement and to ASTM E90 for verification methods.

Sound Transmission Class (STC)

Demising Partitions	
Large Conference and Breakout Rooms	STC60
Medium & Small Conference Rooms, < 1000 sf	STC 55
Break/Lounge, Copy/Work Rooms, Toilets	STC 50
Tenant Agency Demising Walls	STC 50
Executive Office	STC 45

Continuous Background Noise (RC/NC)*

Occupied Spaces	
Conference Rooms without A/V	RC/NC 30
Lobby (Atrium), Pre-Function, Waiting, Public Circulation	RC/NC 40
Break/Lounge, Copy/Work Rooms, Toilets	RC/NC 40

5.2.3.4 **Vertical conveyance**

5.2.3.4.1 **Elevators:** Elevators shall be variable-voltage, variable-frequency drive and micro-processor controlled. At a minimum, signal fixture plates, cab fronts and doors, and hoistway entrances shall be finished with stainless steel. At a maximum, cab speed may vary 3 percent. At a minimum, the safety lower, stop and hold function shall be rated to 125 percent of the cab load. Door thrust shall not exceed 30 pounds. At most, leveling variance shall be 1/8 inch under all loading conditions. Each elevator will have automatic, two-way leveling, regardless of load, rope stretch, or direction of travel. Provide a counterweight for each elevator equal to cab weight plus 40 percent of the rated load. Each elevator cab shall be equipped with an exit hatch operable manually from the exterior for assisted rescue and evacuation. Provide adequate clearances above and below hoist beam for maintenance.

5.2.3.4.1.1 Noise levels: Elevator equipment noise shall not exceed 50 dBA in any adjacent spaces and shall not exceed 60 dBA inside the cab at highest speed, including the exhaust fan operating at highest speed. Elevator machine room noise shall not exceed 80 dBA. All elevator equipment shall be mechanically and electrically isolated from the building to minimize noise and vibration transmission to occupied spaces.

5.2.3.4.1.2 Life Safety: A key switch shall be provided in the car operating service cabinet which, when actuated, shall disconnect the elevator from the hall buttons and permit operation from the car buttons only. Provide for manual override for fire protection professionals. Cab communication devices shall be non-proprietary and easily re-programmable.

5.2.3.4.1.3 Access control: All cabs shall be equipped with infrastructure for card-access control or equivalent security protection at all served floors. Provide at least ten twisted and shielded pairs for card reader use in the traveling cables.

5.2.3.4.1.4 Doors: Door operators shall open at not less than 1.5 fps. Door operation shall be a closed-loop system, with constant feedback regarding position and velocity. The system shall automatically overcome door resistance by increasing power supply to the motor and increasing the torque required to maintain speed.

5.2.3.4.1.5 Passenger elevators: Passenger elevators, included parking structure elevators, shall have a minimum capacity of 3,500 pounds and a minimum speed of 350 fpm. Each passenger elevator cab shall have a minimum door opening of 3’-6” width and 8’-0” height. Each passenger elevator cab shall have a minimum cab height of 8’ under its canopy. Floor-to-floor performance time, from the start of door closing to fully opened door at next, shall be 11 seconds for passenger elevator cabs.

5.2.3.4.1.6 Freight elevators: Freight elevators shall have a minimum capacity of 4,500 pounds and minimum speed of 350 fpm. Each freight elevator cab shall have a minimum door opening of four feet in width and eight feet in height, with two-sided openings. Each freight elevator cab shall have a minimum cab height of ten feet under its canopy. Each freight elevator cab shall be provided with removable wall-protection pads or blankets. Provide one set of riser pushbuttons for all “rear” openings.

5.2.3.4.1.7 Hydraulic elevators: Hydraulic elevator(s) may be evaluated for propriety on a project basis in consideration of the following criteria. Hydraulic elevators may be appropriate where an overhead-slung or bottom-slung traction elevator is not feasible due to clearances and penthouse. A hydraulic elevator shall be considered only for travel heights of no more than 45 feet high. A self-contained, telescoping, hole-less hydraulic elevator may be considered for those limited areas where penthouse or overrun constraints exist or the number of stops is five or fewer. The evaluation of propriety shall include life cycle costs for energy usage and operational costs to minimize environmental impacts: elevators without a machine room may have energy efficiency advantages, but fluid leaks and the costs of containment in accordance with applicable environmental statutes and rules shall be considered.

5.2.3.4.1.8 Maintenance: Access to all equipment, sleeves or motors within the hoistway or penthouse shall at a minimum comply with ANSI A17.3.

5.2.3.5 Doors and hardware

5.2.3.5.1 **Doors:** Typical doors shall be solid-core, flush-panel wood. Typical door heights shall nominally be 7 feet. Door heights of nominally 8 or 9 feet may be proposed for ground floor levels with taller spaces, and for formal, shared, or otherwise upgraded finish areas that are not subject to frequent renovation. Select doors may be fitted with a light, depending on functionality and location.

5.2.3.5.2 **Hardware:** Unless noted otherwise, door hardware on office levels shall include a keyed lockset. Typical finish shall be brush chrome (S3-626 Finish). Provide a closer for each door monitored by an electronic access control device.

Each door that services loading docks, trash bin corrals, and other locations with frequent cart and bin traffic shall be fitted with an aluminum or steel door protection plate at least 34 inches high. Provide geared piano-hinges for doors in these and other areas subject to high traffic and abuse. Doors to equipment rooms, stairwells, and other rooms frequently accessed by service personnel shall be fitted with steel kickplates.

5.2.3.5.3 **Lock:** All doors should install the Best 93K locks, specific function required is a 15 or 14D. Finish shall be brush chrome (SE-626 Finish).

5.2.3.5.4 **Keying**

5.2.3.5.4.1 **Regulatory authority: TFC is the primary agency responsible for locksmith services in the Capitol Complex.** The keying scheme for buildings in the Capitol Complex is subject to special considerations. A primary concern is that "[i]n emergency situations . . ., it is imperative that [TFC and DPS] personnel have immediate access to all buildings and offices within the Capitol Complex" Texas Government Code §2165.001 and 37 Tex. Admin. Code §8.9(b). TFC statue require that "new . . . locking hardware must be compatible to and capable of being placed under the department grand master and control system. Further, "[a]ll construction which involves adding, . . . [or] modifying locking hardware . . . must be compatible to and capable of being placed under the TFC's grand master and control system" DPS will be responsible for the grand master scheme and control system for the following buildings in the Capitol Complex Tex. Admin. Code §8.9(g): Sam Houston Building, Robert E. Johnson, John H. Reagan.

5.2.3.5.4.2 **Capitol Complex keying system:** TFC and DPS must cooperate in protecting the State's economic interest in an efficient and long-lived keying system for its buildings. Therefore, TFC and DPS work in close coordination to manage keyed-access doors for buildings within the Capitol Complex, with the goal of all buildings being on the same interchangeable core format. TFC will be responsible for all buildings in the Capitol Complex except for the Sam Houston Building, Robert E. Johnson, and the John H. Reagan Buildings. The overall system relies on a "single keyed different" (DGMF for Campus-wide exterior doors and a grand master key ("GMK") for interior doors. To maintain a reliable and long-lived system, important constraints are placed on keying for tenant agencies and other occupant groups authorized to access keyed doors. All cores are interchangeable small format 7-pin Best Coremax.

Master keys are limited to one for each tenant agency specific to the agency occupied space. Building Masters are not provided to tenant agencies.

Each tenant agency sub-master shall be limited to two keying levels or as appropriate to facilitate state business – the tenant agency master key and its change keys – to maximize the available change keys throughout the Capitol Complex generally. Card-access controlled doors are not provide to tenant agencies. During emergencies or power failure, card-access key will be place in a TFC Lockbox. Select tenant agency representatives will be granted access approved by TFC Director of Security.

At each building, TFC has installed access to controlled key boxes. Select personnel such as maintenance staff may have access to electrical, mechanical, and janitorial closets using a specific key for those areas. The Department of Information Resources ("DIR") staff, and other authorized personnel may have access to the TFC Key box to enter authorized TFC space. All personnel must use the TFC Key Box to retrieve keys.

Submasters are permitted with the express authorization from the TFC Locksmith Head.

Each building's keybox shall be located in a convenient but non-obvious secure environment with camera surveillance connected to the TFC VRx system. The keybox shall maintain an electronic log of check-in/check-out and programmed with a 24-hour timeclock to alert TFC in case a withdrawn key is not checked in on a timely basis. The keybox shall have a mechanical override function in case of power failure. It is the Owner's preference to have the keybox on emergency power.

5.2.3.5.4.3 North Austin Complex keying system: Each new building at the North Austin Complex shall be accessible via the NAC exterior key, and all interior keyed doors at the NAC shall be on a GMK system. Each building's keybox shall be located in a convenient but non-obvious secure environment with camera surveillance connect to TFC VRx system. The keybox shall maintain an electronic log of check-in/check-out and programmed with a 24-hour timeclock to alert TFC or its agent in case a withdrawn key is not checked in on a timely basis. The keybox shall have a mechanical override function in case of power failure. All cores are interchangeable small format 7-pin Best Coremax (DGMX). It is the Owner's preference to have the keybox on emergency power.

5.2.3.6 Signage and Wayfinding: Default signage shall be a code-minimum room identification plate with Braille. The signage package shall include code-required building egress maps.

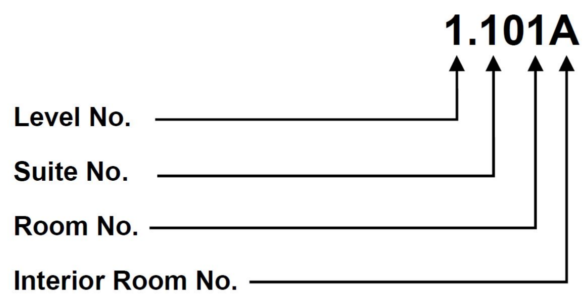
5.2.3.6.1 Exterior signage: Refer to the most current update to the applicable Master Plan for guidance regarding the aesthetics, appearance, preferred location(s), and performance requirements for exterior signage and wayfinding.

5.2.3.6.2 Entry lobby signage: Entry lobby signage shall include a building directory with easily reconfigurable lettering to identify tenant agencies and other building occupant groups.

5.2.3.6.3 Elevator lobby signage: At each elevator lobby, a floor directory shall with easily reconfigurable lettering shall identify occupant groups for that floor.

5.2.3.6.4 **Level numbering:** The floors in a building shall be referred to as "levels." The lowest ground-entry level shall be Level 1; the next level up is Level 2, and so on. Floors below level one shall have the prefix "B," so the level immediate below Level 1 is Level B1, the floor below that B2, and so on. Level "B" may be used where only one basement level exists.

5.2.3.6.5 **Room numbering:** The room numbering scheme shall use a four-digit number, based on this diagram:



The suite numbers shall begin with "1," and the number "100" suite shall be located as close as possible to due north of the main building elevator bank. Proceed clockwise in numbering the other suites on the floor, so the suite to the east of Suite 100 will be Suite 200; the suite east or southeast of that will be Suite 300; and so on. Within the tenant agency suite, rooms shall be numbered sequentially in a generally clockwise direction to the greatest degree practicable.

For a non-rectangular or other irregularly shaped building floorplate for which the suite-numbering scheme is not easily achieved, zone building floorplates to follow the preferred scheme as closely as possible, in consultation with TFC.

The "interior room" designation is for a room within a room. For example, a closet within a tenant agency's conference room would be designated with a letter suffix, e.g., 2.210A may be a room within a room, in Suite 200 on Level 2. In the rare condition of a further room beyond even that, use an additional letter suffix with a hyphen, e.g. 2.210A-A.

Rooms and numbered spaces in the building core (e.g., equipment rooms, custodial closets, restrooms, etc.) shall be designated with the "suite number" zero, so "2.011" may designate a mechanical room on Level 2. Typical room types that are stacked from level to level, e.g., electrical equipment rooms, shall be consistently numbered to so the suffix identifier for each is identical.

When numbering stairs, the third digit is designated by the letter "S". Elevators are similar to stairs and use the letter "E" in place of the third number. For example, 3.1S1 may designate the landing for Stair 1 on Level 3.

5.2.4 Workplace Performance Attributes

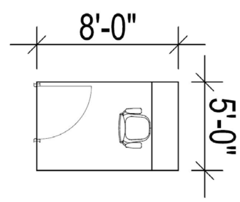
5.2.4.1 Planning strategies

5.2.4.1.1 **Planning module:** Preference shall be accorded plans that anticipate or employ a design module that maximizes efficient use and occupation of space, including standardized modules for systems furniture, meeting and other room types, and corresponding circulation-width hierarchies. Planning for tenant agency spaces shall to the greatest degree possible coordinate workstation and other systems furniture layouts with structural and architectural modules for the most space-efficient layouts.

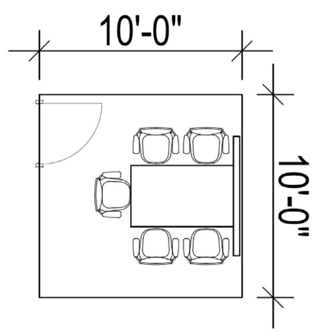
5.2.4.1.2 **Typical room types:** Levels 3 and above for buildings subject to these Requirements will primarily be office space for tenant agencies. The tenant agencies will typically require a range of meeting room spaces. Refer to the solicitation for more specific programming and planning information; in case of conflict, the solicitation language supersedes the following room type descriptions.

5.2.4.1.2.1 **Common break room:** Each typical office level shall be equipped with a common break room. At a minimum, each break room shall be equipped with power outlets for refrigerators, coffee makers, and microwaves, a double-basin sink, a clear space, power and floor drain for a stand-alone icemaker, and lower storage cabinets. Microwaves and refrigerators are recommended to be placed on dedicated, GFCI circuits. Common break rooms shall be sized at a minimum of 2.75 square feet per person served.

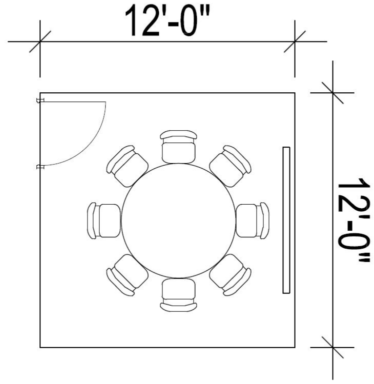
5.2.4.1.2.2 **Telephone Room:** The Telephone Room is a space for a single occupant, typically an employee in an open office environment, to use on a short-term basis for phone calls and other matters for which privacy and acoustical isolation is important. The room shall be provided with power and data, a shelf or small table, and a task chair. The door shall have a light with passage set hardware. This room type is typically not included on a room reservation system. The STC rating for the room shall be equivalent to that of a meeting room.



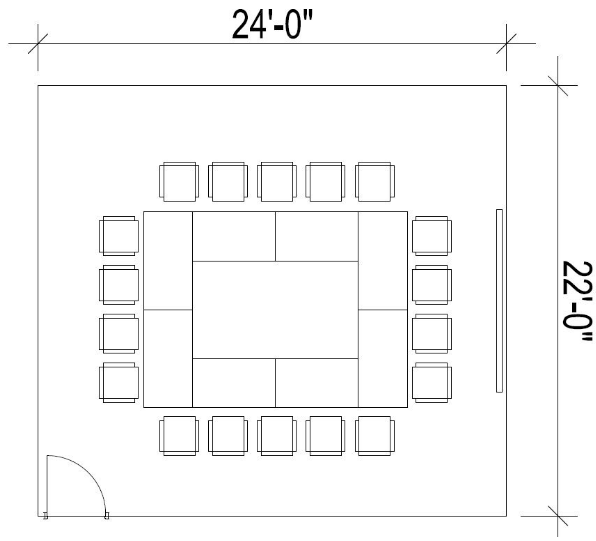
5.2.4.1.2.3 **Huddle 3-5 people:** The Huddle Room is used for short meetings of three to five people at a time. The room shall be provided with wall-mounted power and data, a small table, and chairs. The room may be equipped with a wall-mounted flat panel display for web-conference or content display. This room type is typically not included on a room reservation system. The STC rating for the room shall be equivalent to that of a meeting room.



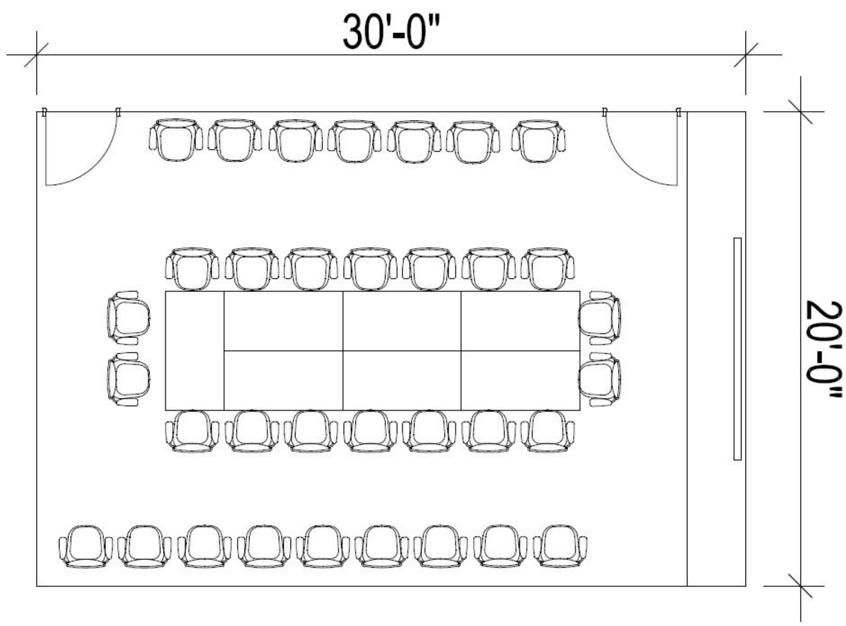
5.2.4.1.2.4 **Small Meeting 6-10 people:** The Small Meeting room can accommodate six to ten people. The room shall be provided with wall-mounted electrical receptacles, a table, and chairs. The room is equipped with a wall-mounted flat panel display for web-conference or content display. The room may be equipped with a poke-through device at the floor, coordinated with the specified table, to provide power and data connections at the tabletop. If a poke-through device is provided, HDMI data connections, at a minimum, shall connect table-top data terminal(s) to the wall-mounted flat-panel display. This room type is typically included on an electronic room reservation system.



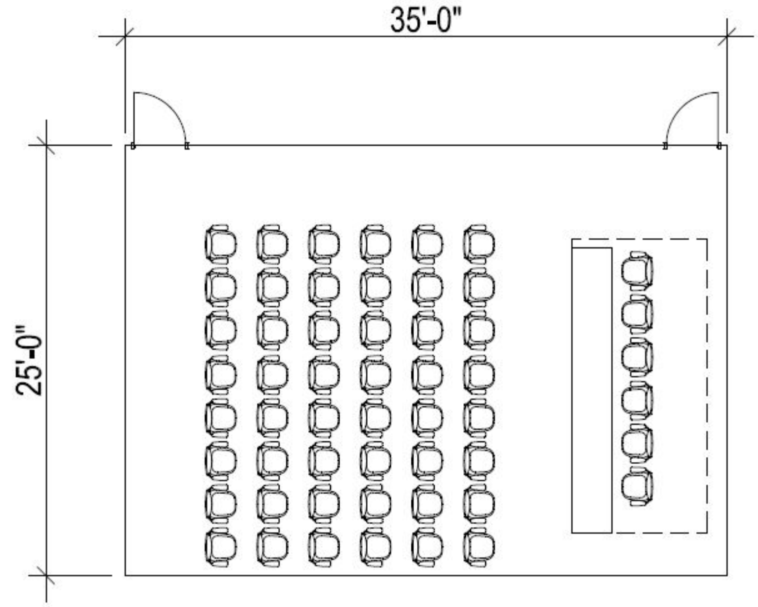
5.2.4.1.2.5 Medium Meeting 1 12-20 people: The Medium Meeting 1 room can accommodate twelve to twenty people. The room shall be provided with wall-mounted electrical receptacles, a table or tables, chairs, and a credenza to accommodate AV equipment. The room is equipped with a wall-mounted flat panel display for web-conference or content display. This room is be equipped with at least one poke-through device at the floor, coordinated with the specified table(s), to provide power and data connections at the tabletop. HDMI data connections, at a minimum, shall connect table-top data terminal(s) to the wall-mounted flat-panel display. If a dedicated video conference system is specified, two wall-mounted flat panel displays shall be provided. This room type is typically included on an electronic room reservation system.



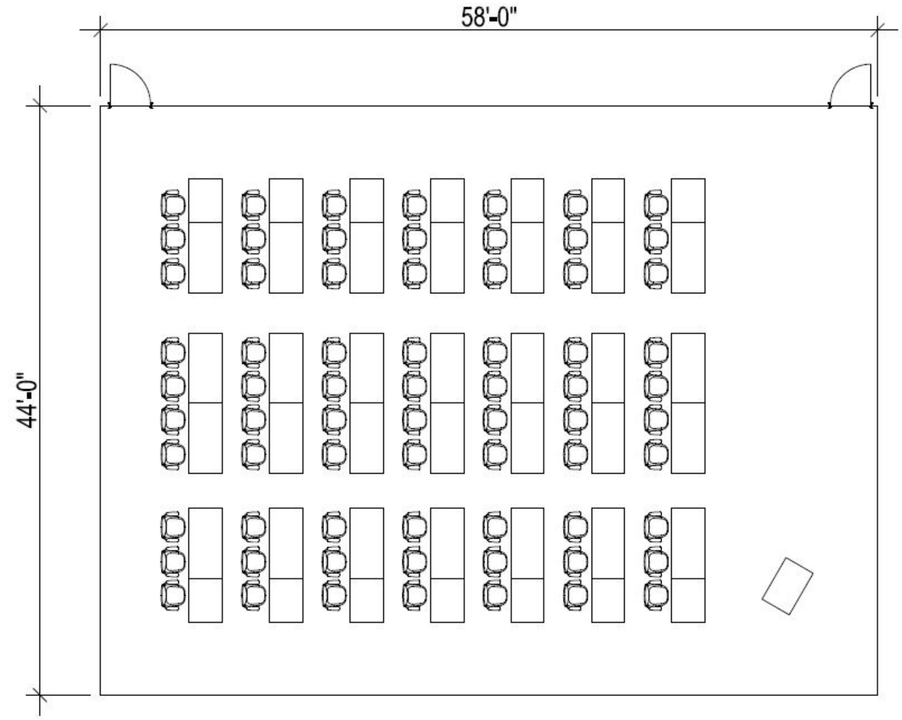
5.2.4.1.2.6 Medium Meeting 2 18-35 people: The Medium Meeting 2 room can accommodate eighteen to thirty-five people. The room shall be provided with wall-mounted electrical receptacles, a table or tables, chairs, and a credenza to accommodate AV equipment. The room shall be equipped with a wall-mounted flat panel display for web-conference or content display, and at least two poke-through devices at the floor, coordinated with the specified table(s), to provide power and data connections at the tabletop. HDMI data connections, at a minimum, shall connect table-top data terminal(s) to the wall-mounted flat-panel display(s). If a dedicated video conference system is specified, two wall-mounted flat panel displays shall be provided. In lieu of flat panel displays, this room may be equipped with a recessed, ceiling-mounted projection screen and ceiling-mounted projector. This room may be equipped with ceiling-mounted speakers and audio in-feed ports at the floor device for table-top speech-reinforcement microphones. This room type is typically included on an electronic room reservation system.



5.2.4.1.2.7 Large Meeting 35-60 people: The Large Meeting room can accommodate thirty-five to sixty people. The room shall be provided with wall-mounted electrical receptacles, a table or tables, chairs, and a credenza to accommodate AV equipment. The room shall be equipped with a wall-mounted flat panel display for web-conference or content display, and at least three poke-through devices at the floor, coordinated with the specified table(s), to provide power and data connections at the tabletop. HDMI data connections, at a minimum, shall connect table-top data terminal(s) to the wall-mounted flat-panel display(s) or ceiling-mounted projection system. If a dedicated video conference system is specified, two wall-mounted flat panel displays shall be provided. In lieu of flat panel displays, this room may be equipped with a recessed, ceiling-mounted projector screen and ceiling-mounted projector. This room may be equipped with ceiling-mounted speakers and audio in-feed ports at the floor device for table-top speech-reinforcement microphones. This room type is typically included on an electronic room reservation system.

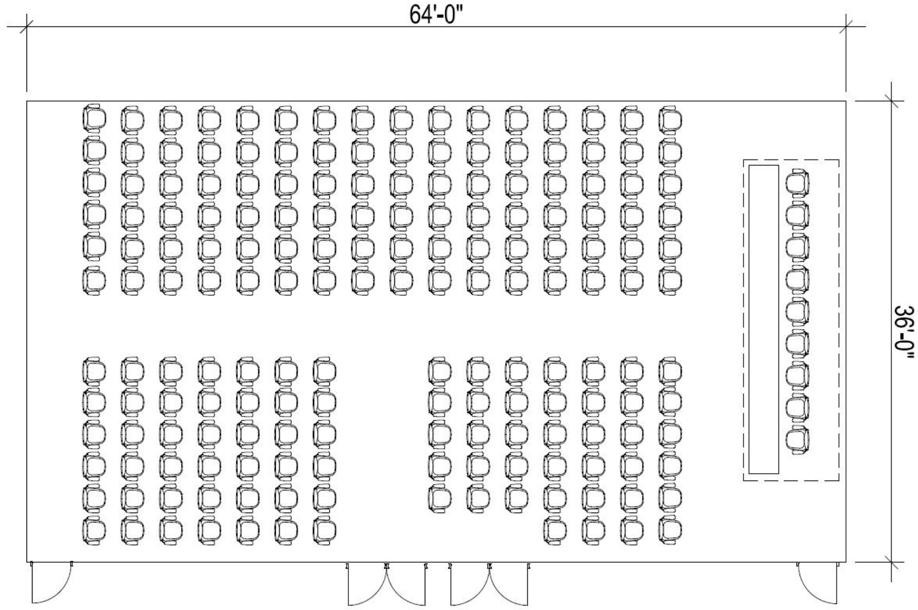


5.2.4.1.2.8 Training room 70+ people: The Training room can accommodate seventy or more people. This room type will typically be located on the ground floor or the next floor above. Refer to the solicitation documents and other program information for specific requirements. The room shall be provided with wall-mounted electrical receptacles, a table or tables, chairs, and a credenza to accommodate AV equipment. The room shall be equipped with at least one ceiling-mounted projector and ceiling-recessed projection screen for content display, and at least twelve poke-through devices at the floor, coordinated with the specified tables, to provide power and data connections at tabletops. HDMI data connections, at a minimum, shall connect table-top data terminal(s) to the ceiling-mounted projection system. If a dedicated video conference system is specified, two wall-mounted flat panel displays shall be provided. This room type is equipped with ceiling-mounted speakers and audio in-feed ports at a minimum of two floor devices for microphones. This room type is typically included on an electronic room reservation system. Storage space convenient to the training room shall be provided for all tables, chairs, and lectern(s).



5.2.4.1.2.9 Conference Center room 100+ people: The Conference Center room can accommodate large gatherings of one hundred or more and a wide range of functions. This room type will typically be located on the ground floor or the next floor above. Refer to the solicitation for detailed information regarding specific program requirements. At a minimum, convenience electrical outlets shall be provided at the walls and via poke-through devices at the floor. The room may be equipped with one or more ceiling-mounted, recessed projector screens and ceiling-mounted projectors. This room type shall be equipped with ceiling-mounted speakers. Select floor devices may include audio in-feed ports for microphones. Lighting design for the dais shall be accommodate the range of uses anticipated for the room, including presentations, classes, and hospitality events. The Conference Center room may require a dedicated closet for AV and lighting controls equipment. Furniture includes, at a minimum, stacking chairs, demountable dais with ramp, and folding tables.

Storage space convenient to the conference center room shall be provided for all tables, chairs, demountable stage components, and lectern(s).



5.2.4.1.2.10 Restrooms: Common men's and women's restrooms shall be located within the building core and shall be stacked vertically for efficient plumbing and mechanical systems integration. Each common restroom shall be equipped with one hose bib under the lavatory. A waste receptacle shall be provided near the restroom ingress/egress door. Single use restrooms may be required elsewhere in the building: refer to the solicitation and related program requirements for additional information.

5.2.4.1.2.11 Custodial closet: Each custodial closet shall be equipped with a floor-mounted mop sink and wall-mounted faucet. The wet wall shall be finished with at least 5/8" cement tile backer board and thin-set ceramic tile to a minimum height of 4 feet above finished floor. Walls scheduled to be finished with paint shall receive a minimum 5/8-inch Type X fiberglass-faced gypsum wallboard.

5.2.4.2 Technology

5.2.4.2.1 Electronic Room Reservation system: Data pathways and backboxes shall be provided near primary entrances to all conference rooms, training rooms, auditoriums, or other assembly spaces that are intended to be shared among tenant agencies. These locations may accommodate installation of terminal electronic room reservation system devices.

5.3 Civil and Site

5.3.1 Design, permitting and construction services: Services for the development of plans for the complete design, permitting and construction of all elements necessary for a complete project shall be provided, including all tasks and deliverables required to provide a complete, functional and usable design using the best industry practices. Management and coordination shall be provided among the architecture and engineering disciplines to ensure that complete system designs are provided. Coordination shall be provided to ensure timely regulatory plan review and permitting.

5.3.2 Neighboring jurisdictional entities: Coordination with the City of Austin or other neighboring jurisdictional entities may be required for the civil engineering of new buildings constructed pursuant to these Requirements, including land development codes, water utility codes, standards for service extension requests, right of way management, and other utility and location coordination standards. Every effort shall be made to coordinate applicable requirements in the design process to minimize costs and schedule impacts.

5.3.3 Landscape planting and irrigation: Planting and irrigation shall be provided. Irrigation water use should be reduced through use of native and indigenous plant materials and efficient irrigation systems. Canopy trees, especially deciduous species, shall be incorporated in order to provide shade and reduce heat islands, both on the building site and within parking lots. All existing trees shall be retained, as feasible. Non-potable water supplies, including rainwater and reverse-osmosis reject water, shall be considered for use in irrigation, which may require storage tanks, sediment filtration, and additional protection for installations of building potable water systems as required by the AHJ. Landscape planting shall provide aesthetic benefits, promote biodiversity including pollinating species, and provide functional performance attributes to enhance on-site storm water management capacity for quantity and quality.

5.3.4 Storm Water Pollution Prevention Plan (“SWPPP”): A SWPPP shall be developed to comply with any TCEQ and other applicable requirements. Drawings that depict project Erosion Sedimentation Controls (ESC) shall be provided.

5.3.5 Pedestrian circulation systems: Pedestrian circulation systems shall be provided to safely and comfortably connect pedestrians from parking lots and structures to buildings and between buildings. Urban sites shall have sidewalks along the back of street curbs and be amenitized with site furniture as appropriate. All pedestrian systems shall be illuminated.

5.3.6 Site Furniture: All building sites shall be furnished with appropriate site furniture to provide a comfortable and clean environment. Furniture shall include trash and recycling receptacles and may include but not be limited to benches, bike racks, and ornamental planters.

5.3.7 Utilities: All utility connection points and available capacities and service as necessary to verify existence of capacity or to upgrade existing systems downstream (offsite as required by any utility) shall be provided and verified and coordinated with all utility stakeholders. This shall include any required service extension requests that will need to be requested and approved by any utility. All utilities’ connections to the building(s) shall be coordinated and verified (to stub-outs provided 5 feet outside the building façade). All review, permitting, and coordination with utility providers shall be included. All incoming utilities shall be metered separately at the building. When tying in to existing site utilities, perform dye testing to confirm no cross-connections between sanitary and storm sewer systems. Consider the impact of any adjacent flood plain on utility design.

5.3.8 Domestic water: All water taps, water services, vaults, backflow preventers or reduced-pressure principal backflow preventers shall be provided, as required, and tap and meter fees shall be included in the base budget. The water taps shall be metered at the property in the ROW or easements. Where distance limitations can be met, backflow preventers shall be mounted to the interior of the building for maintenance. Otherwise, backflow preventers may be located in an accessible vault near the water meter.

5.3.9 Fire protection water: Provide water service connections to the applicable AHJ water utility or fire protection water mains. Provide new taps separate from potable water taps on the existing water mains. The Architect shall determine whether the AHJ water system offsite must be upgraded to obtain Service Extension Request ("SER") approval for the project and shall coordinate efforts for upgrade as needed. All fire protection water taps and services shall be provided, with lines to within 5 feet of the building. Coordinate all utility assignments and connections to the building(s) with all the other disciplines. Reduced pressure zone ("RPZ") backflow preventers are required and, where distance limitations allow, shall be located directly within the main fire pump room for ease of maintenance.

5.3.10 Wastewater: Provide wastewater service connections to the applicable AHJ waste water utility or waste water mains. Provide new connections at existing or proposed new manholes. The Architect shall determine whether the offsite AHJ wastewater system must be upgraded to obtain SER approval and shall coordinate efforts for upgrade as needed. All wastewater connections and services shall be provided as part of the Project, with stub outs provided to within 5 feet of the building.

5.3.11 Electric: Primary electric service shall be provided by an electric utility serving the location. Provide a primary electric duct bank and service that shall be extended to the building site in accordance with all requirements and standards of the electrical service provider. Back-up electric service shall be provided via redundant feed. The Architect shall coordinate provision of offsite connections, any vaults, and all duct bank extensions to within 5 feet of the building. Provide for the design, coordination and installation of all utility assignments, conduit and vault installations, on- and off-site, and connections to building in conjunction with all the other utilities and disciplines.

5.3.12 Communication: Communication services are provided by DIR and by third-party communications service provider(s), e.g., AT&T, unless otherwise specified. Communication services shall be extended to the site from the nearest practicable existing service provider locations. Offsite connections, vaults, and duct-bank extensions shall be provided to within 5 feet of the building. The communication services shall be extended from the termination points. Provide for design, coordination and installation of all utility assignments, conduit and vault installations on- and off-site and connections to building in conjunction with all the other utilities and disciplines.

5.3.13 Natural Gas: Natural gas service shall be provided by the local gas service provider. Verify the connection point and capacity with the gas service and arrange and coordinate the service extension and locations, and provide for any service or installation costs or fees.

5.3.14 Reclaimed Water: The building(s) shall be designed to meet SECO requirements for use of reclaimed water. Life-cycle cost analysis should be performed to determine feasibility of the use of reclaimed water, evaluating sources available to the project and infrastructure costs, and develop a project specific recommendation whether reclaimed water will provide benefit to the State. Sources of reclaimed water may include captured rainwater, condensate, and municipally provided reclaimed water, among others. Reclaimed water may be used for site irrigation, water-closet and urinal flushing, and other appropriate uses. Any reclaimed water taps shall be provided as part of the Project with stub-outs and irrigation plans provided for the Project. The reclaimed water taps shall be metered at the property in the ROW or easements. Reduced pressure zone ("RPZ") back flow preventers shall be required in above-ground enclosures and as required by the AHJ to protect potable water systems for the Project building(s) including hose bibs, etc. Appropriate treatment i.e., filtration, UV light, etc., shall be required for reclaimed water in above-ground enclosures. Piping for potable water shall be separated from reclaimed water piping with appropriate separation per regulatory requirements. Each RPZ shall have a 1-foot clear air gap below it and be placed in an interior riser room with appropriately sized floor drains: in failure mode, all the building water shall discharge at the RPZ.

5.3.15 Reuse water: Cooling-coil condensate inside the building may be collected and reused. If necessary, extend the reuse water return line to a demarcation point 5 feet outside the side the building to be picked up by the Civil/Landscape plans for management and reuse. The same requirements apply for reuse water as for reclaimed water.

5.3.16 Storm water: Provide for storm water runoff conveyance from the developed areas in accordance with the requirements of the AHJ. Storm water shall typically be collected at storm inlets or roof drains that discharge via underground piping to facilities for the water quality treatment and detention of runoff. Water quality treatment and detention shall comply with the AHJ requirements, which may include preference for the use of raingardens/bioswales or other sustainable practices.

Rainwater may be harvested from the building(s) for onsite irrigation, for flushing toilets and urinals, or other appropriate uses. Bioswales may discharge storm water that does not infiltrate through a level spreader or other velocity-reducing mechanism. Permanently planted areas shall be incorporated where storm water discharges are known to occur, such as at fire sprinkler system or bioswale discharge points. Collection of storm water (and condensate re-use water – see above) requires one collection tank per building, or a common tank depending on the configuration of the building(s).

5.3.17 Erosion/Sedimentation Control (“ESC”) plan: An ESC Plan shall be prepared that depicts the temporary best management practices for use at the site during construction. Permanent ESC controls shall be provided for the building(s) and depicted on the drainage plans. Building roof drains and site drainage area inlets shall be collected and discharged into a retention system such as rainwater harvesting or bioswales to mitigate increased runoff from 1- and 2-year storm events.

5.3.18 Storm water runoff treatment for water quality: Where required by the AHJ, the Project shall provide for storm water runoff treatment for water quality in accordance with the requirements of the AHJ. Water quality treatment and detention shall comply with the AHJ requirements. Projects should consider the use of raingardens/bioswales or other sustainable practices. Rainwater may also be harvested from the building(s) for onsite irrigation or reuse.

5.3.19 Storm runoff detention: During construction, the building(s) shall provide for storm water runoff detention in accordance with the requirements of the AHJ. Developed condition peak storm water runoff flows from the site shall typically not exceed the peak storm water runoff flows prior to construction in accordance with the requirements of the AHJ, typically for the two, ten, twenty-five, and one hundred year storm events.

5.3.20 Floodplain: Roadways, buildings, and appurtenant facilities shall all be located above any designated 100-year floodplain and any associated 100-year floodplain modification as established by any Flood Insurance Study, FEMA mapping, Letter of Map Revision, or AHJ. Finished-floor elevations shall be established above any elevation authorized by the standards established by those entities for fully developed conditions in the watershed for the 100-year storm (base flood). Mechanical, electrical, and plumbing equipment shall not be installed below any finished-floor elevation. The building site shall be above the 100-year floodplain and any associated floodplain modification established by FEMA or the AHJ. If the floodplain elevation varies across the project site, the proximity of the buildings to the floodplain shall be addressed to maintain MEP systems beyond the 100-year floodplain and the building(s) a minimum of 1 foot beyond.

5.3.21 Landfill debris, recycling and composting systems: During construction, discarded items shall be segregated between landfill debris and recyclable and compostable materials and be picked up daily. Space shall be provided for the collection and storage of recyclable materials: paper, cardboard, glass, plastic, and metals and compostable organic discards, i.e., food, food contaminated paper, and landscaping debris. Collection of batteries and mercury-containing lamps, i.e., fluorescent bulbs, shall be provided.

5.4 Structural

5.4.1 General Structural Criteria

5.4.1.1 Construction material and structural system: Buildings shall be constructed with cast in place concrete framing with non-post tensioned slabs. One-way systems such as skip joist or slab and beam systems shall be used to allow for future flexibility, allowing future penetrations to be quickly evaluated and safely provided. Post tensioning can be selectively utilized in Primary framing that will not be affected by future renovations.

5.4.1.2 Perimeter Framing: Perimeter members shall be provided to provide rigid support of exterior cladding and to allow for potential recladding in the future.

5.4.1.3 Finish Class: Occupied buildings shall be constructed using minimum ACI Class B formed surfaces. Parking structures shall be constructed using ACI Class C formed surfaces.

5.4.2 Foundations

5.4.2.1 Foundation type: A site-specific geotechnical investigation shall be conducted to determine the appropriate foundation type for the project site.

5.4.2.2 Ground level floor slab: Soil-related slab movements are not acceptable. Structural slabs over ventilated and drained crawlspaces shall be utilized. Crawlspace shall be accessible for maintenance and under floor utility renovation purposes.

5.4.3 Substructures

5.4.3.1 Retaining wall: Walls shall be designed to limit horizontal deflections to a long-term limit of H/600 with consideration of cracked sections and creep. Backfill operations shall be tightly controlled to ensure wall backfill is placed as specified by in the design documents. Walls shall be designed with due consideration of the surcharge loading of the adjacent soils.

5.4.3.2 Waterproofing and drainage: Drainage systems shall provide for maintenance and inspection through the use of readily accessible cleanouts at regular intervals. Wall drains shall be hydraulically isolated from other systems and shall be protected against back-charging of the backfill.

5.4.3.3 Construction phase retention system: The construction phase retention system shall be carefully coordinated with property lines and existing underground construction. All necessary measures shall be taken to protect existing infrastructure.

5.4.4 Superstructures

5.4.4.1 Floor levelness: Elevated slabs shall be designed to receive a self-leveling cap after formwork and shoring removal to ensure floor levelness and flatness. In no event shall the levelness variation exceed 1/4 inch over 10 feet. The weight of the topping material shall be included in the design dead loads for the structure. High areas shall be identified and ground down as required to avoid excessive topping thickness.

5.4.4.2 Vibration criteria: Structure shall be designed to minimize floor vibrations due to human activities based on an office use (refer to ATC Design Guide 1). Fixed equipment shall be supported in a manner that prevents objectionable structural borne vibrations being transmitted through the building. Damping ratio shall be based on an assumption of an open electronic file office.

5.4.4.3 Lateral System: Where feasible, concrete moment frame systems shall be utilized to maintain open and flexible floor spaces. Where required to meet lateral loading requirements, concrete shear walls may be used but shall be located to minimize their impact on the future flexibility of the building use.

5.4.5 Design Loading

5.4.5.1 Gravity Loads: Structures shall be designed for code-minimum loading based on the intended use but in no case shall be less than a uniformly distributed live loading of 80 psf with the additional code-required partition-loading allowance. Dead loads shall include the self-weight of the building construction and shall include a minimum superimposed dead load of 15 psf for ceiling, mechanical, and other suspended systems.

5.4.5.2 Special Loads: Areas that require higher-than-standard load capacity shall be identified on a project-by-project basis with the requirements incorporated into the building design.

5.4.5.3 Lateral Loads: Buildings shall be designed for the code-required loads for essential facilities (Risk Category IV).

5.4.6 Special Structural Considerations

5.4.6.1 Cladding Design: Cladding systems shall be designed with due consideration of the design life of the building. Vertical relief joints shall accommodate differential material movements and shall account for elastic and long-term shortening of the building(s). Use of closer column spacing along the perimeters may be used to reduce potential spandrel deflections. Long-term deflections of the perimeter framing supporting a minimum 50 psf self-weight cladding system shall meet or outperform code required long-term deflection limits, but in no case shall deflections exceed the serviceable movement capability of the vertical relief joint below the supported span, or the cladding system capabilities.

5.5 **Mechanical**

5.5.1 Scope of Work: At a minimum, the following systems shall be included in the mechanical scope of work for the building(s): chilled water pumping systems; heat exchangers; boilers; hot water heating pumping systems; air handling/distribution systems; make-up energy recovery air units; parallel fan-powered variable air volume ("VAV" or "fan power box") terminal units; exhaust systems; and direct digital controls.

5.5.2 Design Criteria

5.5.2.1 Energy Use Intensity (EUI): The Project shall establish a goal to use minimum of 17 percent less energy on an annual basis compared to ASHRAE 90.1 2013, per the HVAC system described in 5.5.4.3. Alternate systems may be considered based on a LCCA analysis factoring initial cost, system efficiency and maintainability, demonstrating benefit to the State.

5.5.2.2 Design Temperatures: Design temperatures shall utilize the ASHRAE Handbook Fundamentals 2013 1% data, as follows, or lower than 1% data.

Sensible Cooling Outside Summer 1%: 97.8°F DB/75.1°F WB

Latent Cooling Outside Summer 1%: 75.4°F DP/80.5 °F MDB

Outside Winter: 25.2°F DB

Inside: 75°F DB/50% RH Cooling; 70°F DB/50% RH Heating

Ventilation shall meet ASHRAE 62.1 requirements.

5.5.2.3 Piping Design Criteria: Hydronic piping systems shall be reverse-return design and sized as follows with a closed loop with C-factor of 120, a maximum pressure drop of 3.0 feet/100 feet or maximum fluid velocity of 7.5 fps (whichever is more restrictive), and a minimum fluid velocity of 1 fps.

5.5.2.4 Ductwork Design Criteria: All ductwork shall be designed in accordance with requirements of the construction specified as stated in the most current SMACNA standards.

5.5.2.5 Chilled Water ("CHW") System: The chilled water ("CHW") system shall consist of centrally located, chilled water plate and frame heat exchangers, sized for N+1 capacity. Heat exchangers shall conform to AHRI guidelines.

5.5.2.6 CHW Distribution: The heat exchangers shall feed into a primary loop system provided to serve the building(s) and with the initial mains sized to also handle future building expansion. The system shall have dedicated pumps. All hydronic piping shall be routed in accessible or easily accessible area such as lay-in ceiling areas and hallways. Provide access panels/doors with labels notifying all shut off valves for above ceiling and in walls.

5.5.2.7 Outdoor Air Intake Locations: On buildings more than 40 feet tall, intakes shall be located a minimum of 40 feet. On buildings less than 40 feet tall, the intakes must be located as high as practical on the roof or on a wall. Intakes shall be a minimum of 25 feet from exhaust/plumbing vents.

5.5.2.8 HVAC Load Calculations: The HVAC load calculations must be performed by a computer-based program capable of providing full-year, hourly analysis. The load calculations must be provided for review at each design phase submission.

5.5.2.9 Isolation of Piping at Equipment: Isolation valves and shutoff valves with bypass circuit shall be provided at all pieces of equipment to allow equipment repair and replacement. Isolation valves shall be provided at each floor level on all piping system to allow isolated shutdown for repair or replacement. Label all valves if hidden from view.

5.5.2.10 Housekeeping Pads: All floor mounted equipment shall be provided with 4-inch-tall chamfered concrete pads which extend at least 4 inches beyond the installed equipment.

5.5.2.11 Meters and Gauges: All equipment requiring flow, temperature, pressure, current or status shall be provided with appropriate measuring devices and such devices must be capable of transmitting the appropriate information to the central BAS.

5.5.2.12 Water Treatment: Proper water treatment for closed loop system must be integrated into the design. The system must address scaling, dissolved solids, biologic growth and corrosion protection.

5.5.2.13 Hydronic Pipe Leak Detection: Provide leak detection system (tape or sensors) in critical and inaccessible areas and have these alarm back to the main BMS.

5.5.3 Equipment

5.5.3.1 Heat Exchangers: Heat exchangers shall be plate-and-frame type. Frames shall be carbon steel with type 304 stainless steel plates. Minimum design operating pressure shall be 150 psi. Heat exchanger shall be designed for N+1 capacity (2 at 100 percent).

5.5.3.2 Air Handling Units: AHU to consist of double wall formed and reinforced, foam insulated panels. Unit shall be of modular construction with L/200 deflection and maximum 1 percent leakage tested at 1.5 times design total static pressure. All air units shall be base-mounted to avoid above-ceiling conflicts.

5.5.3.3 Chilled Water / Hot Water Pumps: CHW/HW pumps shall be centrifugal type with premium-efficiency motors with variable frequency drives (“VFD”) selected to operate at 1750 rpm. It is the Owner’s preference for selection of vertical, in-line centrifugal circulating pumps with VFDs. Pumps for flows above 500 gpm shall be double suction type. Pumps for flows below 500 gpm shall be centrifugal type. Horizontal split case pumps may be considered as an alternative. End-suction pumps shall be considered only for spaces with minimal clearances.

Pump motors shall be premium efficiency; pump motors 2 hp or higher shall be provided with VFDs. Provide packaged hydronic pumping systems if applicable.

5.5.3.4 Hydronic Boilers: Hydronic boilers shall be high efficiency condensing type. Natural gas fired water and conforming to ASME and ANSI Z21.13. Boilers shall be designed to provide 140ºF water with a 40-degree Delta T in order to maximize the efficiency from the condensing boilers. Alternatively, 160ºF water with a summer reset to 140ºF may also be used. Boilers shall be designed for N+1 capacity.

5.5.3.5 Cooling and Heating Coils: Cooling coils must be selected at or below 500 fpm face velocity to reduce potential moisture carryover. Heating coils must be selected at or below 700 fpm face velocity. Cooling coils with 5 rows and fewer shall have a maximum of 12 fins per inch. Cooling coils with 6 rows or greater shall have a maximum of 10 fins per inch.

5.5.3.6 Filtration: Provide minimum MERV 8 pre-filters and MERV 13 secondary filters upstream of all cooling coils on all air handling equipment.

5.5.3.7 CRAC Units: Provide free standing computer room units for all IT/Data areas requiring 24/7 cooling. Wall-mounted DX units may be considered for on-floor IT/Data closets. Units to be primary CHW with backup DX coils. Backup DX coils are not required if primary CHW system has N+1 redundancy. Units to have standalone controls tied into the BMS and operate on emergency backup power.

5.5.3.8 Equipment Egress/Ingress: Pathways and means of egress and ingress shall be provided for all major pieces of equipment. Major equipment replacement may require minor demolition at interior or exterior walls; that eventuality shall be disclosed to and coordinated with TFC during the design phases. Provide double doors or coiling overhead doors in mechanical rooms as appropriate. Provide at least one-and-a-half times the code-required clearance around all major pieces of equipment to facilitate maintenance and access. Equipment replacement or relocation shall generally not require demolition.

5.5.4 Materials

5.5.4.1 Pipe: CHW/HW Piping shall be ASTM A53 black steel schedule 40 with steel fittings for larger pipes and malleable iron fittings for smaller piping. Pipe shall be threaded for piping 2 inches and smaller and welded and flanged for piping over 2 inches. For CHW/HW pipe 2 inches and smaller, brazed Type L copper pipe with brass/bronze socket type fittings is also acceptable. CHW pipe below grade shall be coated and provided with a sacrificial cathode corrosion protection system.

5.5.4.2 Valves: Valves shall be brass with stainless steel ball for 2 inches and smaller and lug type butterfly for larger piping for isolation service and plug type valves for throttling service.

5.5.4.3 Air Handling Systems: All air-handling units ("AHU") for the Project building(s) shall be indoor modular design with components bolted together to allow ease of installation and maintenance. Equipment replacement or relocation shall generally not require demolition. Major equipment replacement may require minor demolition at interior or exterior walls; that eventuality shall be disclosed to and coordinated with TFC during the design phases. All air units shall have integral VFDs with duct static pressure sensors to regulate the airflow. Fans shall be fan-wall (array) modules with individual ECM motors in a common size for redundancy and maintenance. Inverter duty motors on Variable Frequency Drives may also be considered in lieu of ECM motors. Air distribution shall use parallel fan powered VAV ("VAV") boxes. Boxes shall be provided with ECM motors and provided with foil-faced fiberglass or elastomeric insulation. The heating system shall shut off above 65ºF ambient temperature. Label ceiling grids if covered. All air handling units shall have filter configuration and ventilation rates conforming to SECO requirements. AHUs shall be equipped with the following sections:

intake/filtration;
hot water coil;
access section;
CHW coil;
accessible fan-wall module section;
diffuser section; and
discharge plenum section.

5.5.4.4 Make Up Air Unit ("MAU"): At least one distributed outside air system per building shall be provided, conditioning the outside air and providing ventilation per ASHRAE 62.1-2013 separate from the building air handling system, with carbon dioxide sensor monitoring and controls, via the building automation system ("BAS"). The MAU shall be capable of economizer operation during times of acceptable ambient temperature and relative humidity (enthalpy). The unit shall have a supply and exhaust section. A glycol run around coil or heat pipe system for energy recovery should be considered per a LCCA evaluation.

5.5.4.5 Wellness center HVAC: A wellness center may require additional dehumidification or reheat, with exhaust in certain areas. Showers may require 100 percent outside air units for supply. Energy Recovery Ventilation units with energy recovery run around coils to modify the greater quantity of outside air ventilation may be included. If permitted by the Owner, the wellness center may use natural ventilation, separate from the other building areas.

5.5.4.6 Kitchen area HVAC: Provide a pathway for hood exhaust and makeup air. See 5.5.5.8 for equipment.

5.5.5 Basic Materials and Methods

5.5.5.1 Duct systems: All main ductwork shall be G-90 grade, galvanized sheet metal fabricated in accordance with SMACNA standards and shall have pressure classifications suitable for the static pressure of each system. Branch ducts to ceiling registers shall be insulated, flexible ductwork. Ductwork downstream of low velocity air units and all return and exhaust ducts shall be low velocity pressure class 1.

5.5.5.2 Ductwork, low velocity: Low-velocity ductwork shall be hot-dipped galvanized steel, low pressure type construction, air leakage not more than 5 percent of total. Duct-tape all joints and seams.

5.5.5.3 Grilles, register, and diffusers: Grilles, registers, and diffusers shall be prime coated steel and/or extruded aluminum.

5.5.5.4 Fire and smoke dampers: Fire dampers shall be fusible link type and fabricated in accordance with NFPA 90A and UL 555. Smoke and fire/smoke dampers shall be motor-operated at smoke barriers fabricated in accordance with UL 555S Class 2 Leakage Classification. Provide smoke detectors in the supply ducts of all AHUs and in ducts at smoke barriers.

5.5.5.5 Insulation: Insulation shall be rated for a flame spread of 25 or less; smoke developed of 50 or less. All CHW piping shall be insulated with closed-cell phenolic foam or cellular glass insulation with all-purpose scrim foil jacket. Piping insulation shall be 1 inch thick for piping 1 inch and smaller and 2 inches thick for piping larger than 1 inch. Piping exposed in mechanical rooms and inside building shall have PVC jacket. Piping exposed in crawlspace and exterior to building shall have aluminum jacket. Duct insulation shall be minimum 1-1/2” at 1.5 pounds per cubic foot (pcf) density, or 2.2” at 3/4 pcf density, flexible glass fiber with reinforced foil kraft facing, all joints sealed, all external. Duct wrap may be used in lieu of duct board. Provide double-wall, insulated duct in all areas with limited access such as vertical chases and in all areas where duct is exposed.

5.5.5.6 Round or rectangular ductwork and ducts: Round ductwork and ducts shall be 1.0 pound per cubic foot density, 1-1/2 inch thick flexible glass fiber with reinforced foil kraft facing, all joints sealed, all external.

5.5.5.7 Exhaust Systems: All areas requiring exhaust shall be ventilated to the exterior by the energy recovery make-up air unit (“MAU”) exhaust fans, where applicable when a MAU is shown to be of benefit to the Project through LCCA. When a MAU energy recovery unit is installed, all general building exhaust shall be grouped together to main exhaust shafts and routed to the energy recovery make up air unit.

5.5.5.8 Kitchen Exhaust Hoods: Any space that qualifies as a commercial kitchen shall have commercial type grease hood(s) with associated fire extinguishing, lighting, and exhaust and make-up air systems. Dedicated exhaust shall be ducted to a building sidewall and located such that exhaust will not discharge to a space frequented by pedestrians. Make-up air equipment may be located on the roof and ducted to the kitchen through a dedicated shaft in the building. A dishwasher hood will require a dedicated exhaust fan. All main ductwork shall be G-90 grade galvanized sheet metal fabricated in accordance with SMACNA standards and shall have pressure classifications suitable for the static pressure of each system. Branch ducts to ceiling registers shall be insulated flexible ductwork. All grease exhaust ductwork shall be welded black steel ductwork, fire-wrapped for grease duct applications.

5.5.5.9 Stairwell Pressurization: For a building 75 feet high or taller, provide stairwell pressurization in accordance with IBC 2015, NFPA 92, and all applicable local city and state amendments. Ensure that all testing procedures are coordinated with Texas State Fire Marshal's Office and local fire marshal.

5.5.5.10 Vibration Isolation: Basis of design isolators shall be Amber-Booth, Kinetics, or Vibration Eliminator. Springs shall have minimum K to KY ratio of 1.5.

5.5.5.11 Testing, Adjusting and Balancing: Testing, adjusting, and balancing shall be in accordance with NEBB or AABC standards.

5.5.5.12 Equipment and Piping Identification: Rigid PVC vinyl pipe markers printed with UV resistant ink in compliance with ANSI/ASME A13.1 2015.All equipment to be bar coded. Provide flow direction arrows for all piping systems. Provide the following color-coded tags:

Gas:	Yellow
Hot water tanks:	White
Steam:	Green
Fire protection:	Red
Condensate return:	May Apple (PPG 1225-5)
Domestic water:	Silver
Cold water:	Light grey
Condenser water supply:	Carolina Green (PPG 1229-7)
Chilled water supply:	Cobalt Stone (PPG 1241-7)
Chilled water return:	Windsor Way (PPG 1239-3)
Condensate drains:	Black
Pumps, compressors, chillers, condensers:	Grey
Hot water and boiler feed piping:	Ivory
Reclaimed Water:	Purple

Pipe in the mechanical plants with insulated with ASJ, Glass-Cloth, or other paintable jacket material: Paint jacket with paint system identified above.

Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat of paint. Add fungicidal agent to render fabric mildew resistant.

Finish Coat Material: Interior, flat, latex-emulsion.

5.5.5.13 Direct Digital Controls: Refer to Section 5.12.

5.6 **Plumbing Criteria**

5.6.1 Utility Services: The following shall be provided by the local utilities:

Domestic water supply;

Fire protection water supply;

Sanitary sewer;

Reclaimed water;

Storm sewer drainage; and

Natural gas.

5.6.2 Backflow Prevention: Provide backflow prevention devices at all possible points of cross connection. Coordinate location for ease of testing and maintenance.

5.6.3 Potable Cold Water and Hot Water, and Non-Potable re-use Water (CW, HW, NPW): A potable water system shall be distributed through each floor of the building. For buildings with roofs over 10,000 SF, a rainwater/condensate collection system shall be considered, to distribute re-use of NPW for flushing toilets and urinals and for irrigation, with connection for back-up to reclaim water where available. A LCCA study should be performed and SECO requirements reviewed, to determine applicability of a rainwater/condensate collection system for the Project. See description below.

5.6.4 Building Overview

5.6.4.1 Domestic Systems: Domestic plumbing system shall be designed to service all of the required plumbing fixtures.

5.6.4.2 Acoustic Considerations: Plumbing and gas building systems shall be designed to minimize noise transmission between noise-generating equipment and/or spaces (e.g., mechanical rooms, toilet rooms, and plumbing chases) and adjacent offices, workspaces, meeting rooms, training rooms, or auditoria.

5.6.4.3 Office Space Planning: Plumbing systems shall be designed with sufficient flexibility and space to allow for maximum and efficient tenant floor space. Systems shall remain functional in the building during periods in which other occupied space may be under renovation.

5.6.5 Plumbing System Descriptions

5.6.5.1 Domestic Water

5.6.5.1.1 Water Feed: Preferably, domestic water shall be brought to the building from new utilities by a dual feed serving the building. If conditions preclude a double-feed, a single-feed design may be considered.

5.6.5.1.2 Backflow Prevention: Backflow preventers shall be provided in accordance with AWWA Manual of Cross Connection Control, International Plumbing Code, and other Federal standards criteria for all potential sources of cross contamination of water sources. The following locations shall require installation of reduced-pressure principal backflow preventers: building service entrance (located inside the building); water treatment equipment (such as DI and RO water equipment); ice machines, coffee makers and other food service equipment; humidifiers; sterilizers and decontamination equipment. Provide non-removable vacuum breakers at hose bibs and wall hydrants.

5.6.5.1.3 Distribution

5.6.5.1.3.1 The main water line shall enter the building from underground. The service entrance shall have a main shut-off valve and two parallel branch lines, each with isolation valves, a basket strainer, and a reduced-pressure backflow preventer. The parallel lines shall combine back together. Water shall be connected to a main distribution header. The header shall have separate taps as follows:

tap to serve domestic hot and cold water;

tap complete with RPZ backflow preventer to serve mechanical equipment; and

3/4-inch tap for drawing off water samples for periodic testing.

Each tap shall be provided with a valve and a separate 1/2-inch drain tap with valve. All plumbing distribution piping shall be routed in an accessible or easily accessible area. Provide access panels/doors for access to all valves.

5.6.5.1.3.2 **Distribution Risers**: Domestic cold water, hot water, and hot water return mains shall be routed from the main mechanical room and up the building as distribution risers. There shall be taps from each riser to serve the distribution piping on that floor. Floor mains shall be routed down. Sectional valves shall be provided for potential tenant spaces and to isolate each group of fixtures for maintenance. Fixtures shall be provided with stops.

5.6.5.1.3.3 **Hot Water Distribution**: Hot water distribution shall be from a supply main to each of the floors. Hot water supply shall be distributed to minimize or eliminate recirculation where possible. Each zone shall have isolation valves and a calibrated balancing valve so that the zone and system can be balanced. Remote breakrooms and restrooms will be tied into the domestic water system. “Tankless” demand-gas water heaters may be located and manifold such that recirculation is not required, where approved by Owner. Tankless water heaters shall be set with a leaving temperature range of 115ºF to 120ºF. If tankless water heaters are to be used, confirm that water softening is provided, or is not required, on the domestic cold-water system.

5.6.5.1.3.4 **Domestic Cold Water Booster Pump:** Provide skid mounted domestic water booster pump. Skid shall include a UL listed NEMA 4 solid state (PLC) power and control panel, a through door disconnect, magnetic starters or variable frequency drives, alarm horn, and auxiliary contacts for interface with the BAS. It is the Owner’s preference to implement Tiger Flow brand for portfolio uniformity.

5.6.5.1.4 Accessories and Valves

5.6.5.1.4.1 **Air Vents**: Locate automatic air vents, piped to drain at the top of each water riser.

5.6.5.1.4.2 **Pressure Reducing Valves**: Where required for equipment, pressure-reducing valves shall be automatic-regulating type complete with pilot lines.

5.6.5.1.4.3 Water hammer arrestors: Provide bellows or piston type water hammer arrestors at all supplies to plumbing fixtures and equipment with self-closing or quick-closing valves. Install per latest PDI-WH 201. Provide an access door unless the arrestor is located above an accessible ceiling.

5.6.5.1.4.4 Branch isolation valves: Locate branch isolation valves at all floor distribution mains off the distribution riser, at all branches (with two or more fixtures) off the floor distribution mains, and at the mid-point of each distribution mains and recirculation loops. For each concealed branch isolation valve, provide an access door with valve identification on panel.

5.6.5.1.4.5 Pressure gauges: Locate pressure gauges upstream and downstream of each PRV, at building entrances, at discharge of each pump and at top floor branches from the risers.

5.6.5.1.5 Sizing criteria: Main distribution piping shall be sized per criteria in IPC and 3 psi pressure drop per 100 feet of piping and 6 fps maximum velocity. However, pipe sizes may be increased to reduce overall pressure losses. Also, piping system shall be designed to provide 15 psi at hose bibs at the mechanical penthouse and 35 psi at toilets at Level 7. Minimum pipe sizing shall be 3/4 inch.

5.6.5.1.6 Water Treatment: Water softener may be required, depending on the site chosen, and shall comply with SECO water conservation requirements.

5.6.5.2 Hot Water: Basis of design shall be high efficiency heating and recirculating gas fired water heater, with 140º F HW for sanitation and local mixing valves at fixtures. Provide an LCCA for installation of a solar thermal water heating system to meet part or all of the hot water demand.

5.6.5.3 Storm Water Drainage

5.6.5.3.1 Roof Drainage: The roof drainage design shall be based upon a 100-year storm with 60-minute duration at 5 inches-per-hour intensity.

5.6.5.3.2 Office Roof Drainage: Building roofs with minimum slopes shall have roof drains located at the perimeter of the building roof. Overflow scuppers shall be used where practical instead of piped overflow drains. These leaders shall be routed to rainwater collection system to each building, depending on the site layout.

5.6.5.3.3 Parking structure drainage: If a parking structure is proposed, the top ramp level of the parking structure shall be provided with 6-inch diameter cast iron deck drains. Additional parking deck drains shall be provided at each level of the garage to receive storm water run-off from cars and through openings in the façade. Secondary drainage shall be provided by storm water overflowing the edge of structural members. All storm drainage shall be either piped to bioswales located adjacent to the building or through oil/water separators, depending on the utility requirements for the chosen site.

5.6.5.4 Sanitary Waste

5.6.5.4.1 Sizing: The sanitary waste system shall be sized per IPC using 1/4 inch-per-foot slope for 2 to 3 inch piping and 1/8 inch-per-foot slope for 4 inch piping and larger. One sanitary main shall leave the building and be routed to the site sanitary main. Sanitary inverts indicate that a sewage lift station is not required for this project. Provide at least 2 future taps per floor riser for future connection. Solvent piping is not allowed.

5.6.5.4.2 **Floor drains:** Floor drains shall be provided at public and private restrooms, showers rooms, custodial closets, mechanical rooms, rooms with stand-alone icemakers, and other locations as required by the building design. Floor drains shall be provided at specific equipment locations, e.g., stand-alone icemakers.

5.6.5.4.3 **Floor sinks:** Floor sinks shall be provided at all mechanical equipment with condensate or water connections and at least one floor sink per mechanical room. Coordinate floor sink location to avoid routing drain lines long distances across the mechanical room floor. If rainwater or condensate collection is included in the project, separate hub drains shall be installed to collect condensate and route to a cistern or to tie into the City of Austin reclaimed water line.

5.6.5.4.4 **Trap primers:** Automatic electronic trap primer assemblies, and toilet riser trap primers shall be provided. Provide trap primer lines at all floor sinks, floor drains, and hub drains not receiving regular usage (e.g., floor drains in mechanical rooms and public restrooms, hub drains receiving drainage from drain pans). Floor drains/sinks that do not require trap primers include shower drains, drains receiving condensate from mechanical equipment.

5.6.5.4.5 **Cleanouts:** Provide cleanouts per code requirements. Locate cleanouts in non-sterile locations, in non-public location (where practical), at fixture group "end of run," and outside of building perimeter where possible. Do not locate above ceiling or in crawlspaces. Provide P-traps with cleanouts at lavatories and sinks.

5.6.5.4.6 **Condensate collection**: A condensate collection system shall be considered, as noted in 5.6.3.When provided, the system shall consist of a piping network to collect drainage from the air units, then routed to the rainwater/condensate collection tank or to Complex cooling tower make-up water system via a single common discharge. The system shall not drain to sanitary waste.

5.6.5.4.7 **Elevator pits:** Provide submersible sump pumps with integral float control and oil detector for each elevator pit. Pumps must operate without any human intervention. Provide high-water alarm connected to the Building Automation System ("BAS"). Pump size shall be 50 feet of head and 50 gpm per elevator cab (for example, if there are 3 cabs in one elevator shaft, then the pump is sized for 150 gpm). Sump pump piping shall be routed to storm water connection with check valve.

5.6.5.4.8 **Grease Trap:** A precast concrete grease trap vault with accessible lid shall be provided for the any future commercial kitchen facility. A grease waste line from the building to the grease trap vault shall be provided. The size shall be determined by the selected kitchen equipment and layout, per applicable code. For grease traps located in a loading dock area, vault lids must meet minimum H20/HS20 load rating requirements.

5.6.5.5 Reclaimed, re-used, rainwater, and condensate collection

5.6.5.5.1 **Piping:** All the reclaimed or re-use water is non-potable; it shall be labeled as such on all piping and at all valves, pumps, entrances, etc. All reclaimed or re-use water piping shall be purple in color. All reclaimed or re-use water piping shall be separate from potable piping, including separate risers. The reclaimed piping shall be at least 9 feet from potable piping. All hose bibs shall have RPZ backflow prevention. A separate piping entrance shall be provided if reclaimed water is available as back-up at the selected site. If reclaimed or reuse water is backed up by potable water, the connection shall be through RPZ backflow prevention.

5.6.5.5.2 Reclaimed water storage or contribution to City of Austin: Roof storm drainage for the building(s) may be routed to cistern(s) at one location or routed to a connection with the City of Austin reclaimed water line. Refer to the solicitation for additional detail and requirements. For HVAC condensate routed to a cistern, provide separate hub, drain, and piping with air gap to cistern. Any cistern(s) or water tank(s) shall be capable of handling 1 inch of rain for the roof square footage.

5.6.5.5.3 Distribution: Water distribution of a collected re-use water system (rainwater or HVAC condensate, etc.) shall be through a manufactured complete skid system with pumps, valves, filters, controls, etc. Filtration shall be sufficient to comply with requirements of irrigation system valves, drip emitters, etc., and plumbing flush valves, but is not required to be potable quality.

5.6.5.5.4 Fixture identification: Appropriate building signage at all fixtures shall be provided.

5.6.5.6 Cathodic protection: Cathodic protection shall be provided if required based upon the geotechnical report and per the National Association of Corrosion Engineers ("NACE") standards. PVC piping shall be used wherever possible and as allowed for underground sanitary and storm piping. Cast iron piping, such as grease waste pipe, may also be wrapped with polyethylene encasement (PE) for protection.

5.6.5.7 Natural gas: The building shall be served with medium pressure (5 psi) gas service. Service size shall be coordinated with the natural gas provider. Polyethylene piping shall be used for underground gas pipe. Provide sufficient capacity for two emergency generators, domestic water heaters and a full-size commercial kitchen. Where piping must be routed above hard ceilings or in other inaccessible locations, appropriate fittings and sleeves with vents to the outside shall be provided in accordance with NFPA 54.

5.6.5.8 Plumbing Fixtures

5.6.5.8.1 Fixtures: Fixtures shall exceed EPAct standards for required flow control devices to reduce potable water use by 30 percent. Garbage disposals shall not be installed.

5.6.5.8.2 Fixture selection: Fixture selections shall be coordinated with the owner's standards and attic stock.

5.6.5.8.3 Accessibility: Accessible fixtures shall comply with TAS and ADA. Where requirements conflict between accessibility standards, the stricter requirements will govern.

5.6.5.8.4 Temperature-limiting valves: ASSE-listed temperature-limiting valves shall be provided for showers, public rest room lavatories, and other locations to protect against scalding.

5.6.5.8.5 Toilets: Toilets shall be wall-mounted, vitreous china with hard-wired infrared flush valves. Toilets shall be WaterSense-labeled, high-efficiency (HET), 1.28 gallons per flush (gpf) or down to 1.1 or 0.8 gpf. Wall carrier shall be rated for 500 pounds.

5.6.5.8.6 **Urinals:** Urinals shall be vitreous china with hard-wired infrared flush valves and shall be wall-hung with wall carrier and sized for maximum 0.125 gallons per flush. Waterless urinals are not allowed.

5.6.5.8.7 **Mop service basins:** Mop-service basins shall be floor-mounted cast terrazzo with wall-hung service sink fitting.

5.6.5.8.8 **Sinks:** Sinks shall be stainless steel and self-rimming, with 1.25 gpm aerators, gooseneck spouts and lever handles. Commercial and residential garbage disposals are prohibited.

5.6.5.8.9 **Lavatories:** Lavatories shall be self-rimming, drop-in counter-mount or under-mount vitreous china. Provide maximum 0.5 gpm hard-wired infrared faucets for lavatories. In the alternative, provide 0.35 gpm hard-wired faucets for all lavatories.

5.6.5.8.10 **Hand-washing sinks and lavatories:** Hand-washing sinks and lavatories trim shall be gooseneck spout with integral thermostatic mixing valve. All exposed piping, including drain piping shall be chrome plated, including piping enclosed with ADA-compliant safety shielding. Faucets shall be chrome brass, monel, or stainless steel (plastic is not permitted).

5.6.5.8.11 **Showers:** Showers shall be provided with ceramic tile finish or acrylic, stainless steel grid drain, ASSE-listed thermostatic and pressure-balancing mixing valve (to limit discharge temperature to 105° F), slide bar, 1.125 gpm hand-held shower set, and grab bars per TAS and ADA or wall mounted in non-accessible showers. Faucets shall be chrome brass, monel, or stainless steel (plastic is not permitted). Shower heads shall be mounted at a minimum of 7 feet above finished floor.

5.6.5.8.12 **Electric water coolers:** Electric water coolers shall be bi-level, wheelchair accessible, wall-hung (with carrier), with electronic sensors, with dual lead/lag remote chiller and lead/lag distribution pump with bypass for filter maintenance, served by dedicated chilled and filtered water loop and shall have round bowls, cantilevered support arms, and in-wall refrigeration units; the specified cooler shall have a bottle-fill option. Where possible, use drinking fountains in lieu of refrigerated electric water coolers.

5.6.5.8.13 **Wall and post hydrants:** Freeze-proof wall hydrants shall be provided along the exterior of the building at intervals not exceeding 200 feet along the wall, with at least one hydrant per building side. Wall hydrants shall be encased with locking keyed cover. The building entrance, courtyards, fountains, and each loading dock shall have wall hydrants within 20 feet. Provide at least one freeze-proof hydrant on the roof of the building, and at intervals not exceeding 250 feet along the perimeter of the roof for window washing operations, and one at each mechanical penthouse. Provide post-type hydrants at roof locations greater than 250' away from wall hydrants at penthouses. If reclaimed or re-use non-potable water is used, all hydrants shall include RPZ backflow prevention, per applicable code. Hydrants shall be provided at mechanical rooms for maintenance as required.

5.6.5.8.14 **Hose bibs:** Locate hose bibs at all mechanical rooms, below the lavatories in men's and women's restrooms, and within each mechanical room.

5.6.5.8.15 **Kitchen fixtures:** Commercial kitchen fixtures and equipment will be selected by the Texas Department of Assistive and Rehabilitative Services (DARS), purchased and installed by the Contractor, and operated and maintained by DARS. All kitchen appliances shall be ENERGY STAR-labeled.

5.6.5.9 Legionella control: During commissioning, the hot water system shall have a super-heated or chlorine flush to ensure that Legionella bacteria are eliminated.

5.6.5.10 Piping systems: Dead legs shall be eliminated.

5.6.5.11 Fixtures: Outlet devices (e.g., shower heads, faucets) shall be removable for disinfection. Shower heads shall be self-draining. Piping between shower head and mixing valve shall be as short as practical.

5.6.5.12 Acoustical considerations: Acoustical criteria shall be based on accepted industry standards such as those outlined in 2011 ASHRAE Chapter 48. Cast iron piping shall be used in all sanitary waste and storm piping in lieu of PVC above ground (except in the parking structure).

5.6.5.13 Energy and water conservation: The plumbing system shall reduce aggregate indoor water use by 30 percent over baseline per EPAct 1992. Fixtures and equipment shall meet EPAct 1992, EPA WaterSense Labeled, ENERGY STAR-labeled or FEMP-designated Energy Efficient Product. Where a listing or labeling is not available, the fixture shall conserve water by other means or standards. Eliminate all mercury and lead in fixtures and equipment. Meters shall be provided for incoming domestic water as required by EPAct.

5.6.5.14 Criteria: The plumbing systems shall be designed in accordance with the following codes and appropriate references. Note that applicable codes will depend on the adopted State codes at the time of design and construction.

5.6.5.15 Basic plumbing materials

5.6.5.15.1 Pipe: Interior piping shall be ASTM B88 Type L copper with wrought copper fittings and 95-5TA solder. Piping larger than 2 inches in diameter may be mechanical grooved coupling copper type. Below grade piping and piping installed exterior to the building will be Type K copper with brazed joints for distribution piping. Building feed piping shall be AWWA C900 PVC with ductile iron fittings with appropriate thrust blocks. Ensure dielectrics are provide for all dissimilar piping material connections. Pro-press fittings may be used on interior domestic water piping.

5.6.5.15.2 Valves: Valves shall be brass ball valves with stainless steel ball for 2-inch pipe and smaller and lug type butterfly for larger piping. All valves shall be provided with locking mechanisms to prevent opening or closing of valve as appropriate. Provide ball-and-butterfly valves and handles with valve-position indicators; handwheels are not permitted.

5.6.5.15.3 Insulation: Piping shall be insulated with fiberglass insulation with all-purpose scrim foil jacket. Piping insulation shall be one-half-inch thick for piping one inch in diameter and smaller, and one-inch thick for piping larger than one inch in diameter. Insulation may be eliminated from cold water domestic water piping not subject to freezing. Piping exposed on the exterior or roof shall be insulated with closed-cell phenolic foam with stainless steel or aluminum jacket.

5.6.5.15.4 Heat Trace: Locate pipe to avoid heat tracing when possible**.** Piping exposed to freezing temperatures shall be provided with self-regulating heat trace cable to maintain temperature above 40ºF.

5.6.5.15.5 Sanitary Waste and Vent Piping: Pipe in crawlspace and below slab shall be schedule 40 PVC DWV. Piping above slab and within building shall be hubless cast iron with heavy duty rated stainless steel clamp shields and neoprene gaskets.

5.6.5.15.6 Floor Drains/Floor Sinks: Floor drains and floor sinks shall be cast iron with flashing flange and shall have neoprene hubless outlets with nickel bronze strainer.

5.6.5.15.7 Storm/Roof Drainage: Storm and roof drainage pipe shall be glued joint schedule 40 PVC DWV for below grade use. Piping above slab and within building shall be hubless cast iron with heavy duty rated stainless steel clamp shields and neoprene gaskets.

5.6.5.15.8 Roof Drains: Drains to be galvanized cast iron with flashing flange, clamp, extension flange, polyethylene dome and large sump receiver. Roof drain bodies, horizontal piping, and piping off of the drain where it turns to the horizontal will be insulated with one-inch-thick fiberglass pipe insulation with all-purpose foil scrim jacket.

5.6.5.15.9 Fuel Oil Piping: Where needed, fuel oil pipe shall be schedule 40 steel with cast iron fittings and forged steel valves.

5.7 **Electrical**

This Division covers the furnishing and installation of lighting fixtures, receptacles, 600 volt conductors, conduits, distribution panels, circuit breakers, transformers, lighting and receptacle panels, lighting control panels, motor control centers, switchboards, switchgear, standby generators, and automatic transfer switches, herein called "Electrical", complete and ready for intended service.

5.7.1 Energy conservation: Electrical building systems shall be designed using sustainable energy efficiency goals.

5.7.2 Electrical service: Electrical service to buildings within the Capitol Complex or North Austin Complex shall be provided by Austin Energy; projects in other utility service areas may receive electrical service from the appropriate utility or retail electric provider. Service to the main switchgear located within the main electrical room and the fire pump(s) located in the main plumbing equipment room shall be at 480Y/277 Volts, 3 Phase, 4 Wire. Utility metering shall be installed at service entrance by Austin Energy or other provider as appropriate. The requirements for the proper location of the meter enclosure shall be provided by the service provider. A utility transformer and metering vault shall be provided within the building envelope (wherever possible) that meet Austin Energy building standards, or those of the local service provider. All feeders shall typically be copper. Aluminum may also be considered for busses 3,000 amps or lower.

5.7.3 Emergency power system: The building design shall accommodate at least two back-up power generator systems; one system shall be dedicated to life-safety-related emergency power needs, and the other system shall be dedicated to the building data center and any other back-up power requirements. To avoid flooding, the generators shall not be located in a below-grade parking garage; verify the location with TFC. Generators shall be diesel generators.

5.7.3.1 Generator service: Emergency generator power shall provide capacity to serve but not necessarily be limited to the following: stair lighting; fire command station; service elevator and one passenger elevator in each bank (fire service access elevators); fire pump; egress lighting (assumed maximum of 3000 watts per floor, depending on floor area); sump pumps in elevator pits; sump pumps in basement garage (if applicable); smoke control dampers; smoke evacuation fans; stairwell pressurization fans; and communications and security systems.

5.7.3.2 Life-safety emergency power: Life-safety system emergency power shall be supplied from a dedicated natural gas standby generator. The capacity of this emergency power system shall be sized to accommodate all life safety loads, including 25 percent spare capacity, at 480Y/277 Volts, 3 Phase, 4 Wire. This emergency power system shall be automatically started upon loss of normal power source to any of the Life Safety emergency power distribution system automatic transfer switches. An automatic timer shall be provided to "exercise" the standby generator on a weekly basis.

5.7.3.3 Data Center back-up generator: A dedicated generator system shall be used as a means of back-up for the building data center. It shall be sized to handle all computer, IDF, and MDF room loads, plus 25 percent spare capacity, at 480Y/277 Volts, 3 Phase, 4 Wire. Generator shall not be located inside parking garage; verify location with Owner.

5.7.3.4 Generators: The generators shall be complete, including but not limited to: prime mover, alternator, controls, unit mounted radiator, starting system, charging system, vibration isolators, coolant heater, condensation trap, flexible exhaust connections, diesel fuel belly tank, and other standard and required accessories. Generator shall be supplied with a critical grade exhaust silencer and sound attenuation enclosure to meet or exceed local noise ordinance due to proximity to property line. Coordinate with local fire codes for safety requirements for fuel storage and refill for generator fuel tanks.

5.7.3.5 Generator docking station: A plug-in generator docking station shall be provided for connection to a portable temporary generator for each emergency generator system. A portable temporary generator can then be safely and quickly deployed should there be a failure of a permanent emergency generator. Each docking station ampacity rating shall match or exceed the full load rating of the respective generator.

5.7.3.6 Capacity: All horizontal and vertical emergency power feeders shall be 2-hour fire-rated cable assemblies, or shall be installed in a 2-hour rated enclosure. A 480Y/277 Volt, 3 Phase, 4 Wire emergency distribution panel, sized to accommodate all necessary loads at worst case power density plus 25 percent spare capacity, and shall house over-current devices for the emergency feeders.

5.7.3.7 Automatic transfer switches: All automatic transfer switches shall be of the mechanically-held, electrical transferred, enclosed type with maintenance bypass isolation transfer option and all required accessories for starting and stopping of the standby generator including timers, relays, etc. A transfer switch, provided by Division 21 and integral to the fire pump controller, shall be designated for use of the fire pump only. A transfer switch shall serve elevator, receptacles and associated mechanical equipment serving the MDF and the IDFs. A transfer switch shall serve emergency equipment loads, lighting loads, the fire alarm system, and security systems. Transfer switches for generators shall transmit an “on generator” signal to the BAS for notification and alarm.

5.7.3.8 Coordination: All emergency power feeder and branch circuit overcurrent protective devices, downstream of automatic transfer switches, shall selectively coordinate 0.01 seconds over the entire range of available fault current. This may require the use of fused distribution equipment, fused panel boards, and/or fused elevator disconnects to serve emergency feeder and branch circuit loads.

5.7.3.9 Remote annunciator: Location for the generator remote annunciator shall be coordinated with owner.

5.7.3.10 Load bank provisions: Each generator shall be provided with provisions for connection of temporary a load bank for testing of the generator.

5.7.4 Normal Power Distribution

5.7.4.1 Main switchgear: The Main Switchgear, sized to include all loads at worst case power density plus 25 percent spare capacity, shall be 480Y/277 Volts, 3 Phase, 4 Wire, and mounted on a housekeeping pad. The main switchgear shall have silver-plated copper bus and shall be UL labeled for service entrance. Aluminum may be considered for busses 3,000 amps or lower. Switchgear shall have an electronic circuit monitor system with a communication output compatible with the specified Building Automation System, external SPD, and ground fault protection on devices as required. Switchgear shall not be located below street level. Main service entrance switchgear shall be UL 1558 switchgear with draw-out type breakers. Breakers shall be injection-tested.

5.7.4.2 Power factor correction: Provisions shall be made for the addition of capacitors for power factor correction and harmonic mitigation. Provisions shall include physical space in main electrical room as well as spare breaker in the Main Switchgear. Addition of capacitors shall be determined on a case by case basis.

5.7.4.3 Distribution: Normal power distribution shall be fed from one main switchgear through vertical busway to typical floor electrical rooms. Tenant power requirements shall be served from main switchgear through a 480Y/277 Volt, 3 Phase, 4 Wire distribution panel. Provide distribution panel with provisions for tenant feeder breakers, CTs and power meters. Sub meter shall be provided by third party tenants at distribution panels in order to read power usage and allow a laptop to download the information for printing tenant bills. Mechanical and elevator loads shall be fed from one 480Y/277 Volt, 3 Phase, 4 Wire switchboard, sized to all loads at worst case power density plus 25 percent spare capacity through copper feeder busway. Mechanical bus shall extend from ground floor main electrical room into penthouse to serve mechanical and elevator loads. Busway construction shall be equal to IP54 (splash resistant). Busway plug switches shall utilize current limiting fuses or properly coordinated circuit breakers.

5.7.4.4 **Power Monitoring**: Electrical loads shall be grouped according to load type in order to facilitate monitoring of power usage through an energy dashboard application or Building Automation System.

5.7.4.5 **Capacity:** Typically, a 3-section 208Y/120 Volt panel, one 480Y/277 Volt panel and one transformer shall be required in each electrical equipment room. Additional distribution equipment may be required based on building square footage and anticipated loads. Each panel shall be sized to include all loads at worst case power densities plus 25 percent spare capacity.

5.7.4.6 **Tenant power capacity:** The third party tenant power provision shall be five watts per square foot (5 w/sf) tenant power capacity: 4 w/sf for plug loads, and 1 w/sf of spare, exclusive of lighting loads.

5.7.4.7 **Panel boards:** Power and distribution panel boards shall be floor mounted or wall mounted, bolt-on circuit breaker type with tin-plated copper bus, commercial grade with at least 42 circuits, double-hinged doors (door-in-door construction), and NEMA 1 type construction, mounted on housekeeping pads as required. They shall be sized to handle all anticipated loads at worst case power densities including 25 percent spare capacity.

5.7.4.8 **Lighting panel boards:** Lighting panel boards shall be commercial grade 84 circuit, 480Y/277 Volt, 3 phase, 4 Wire, sized to handle all loads at worst case density including 25 percent -spare capacity. They shall have bolt -on breakers, tin-plated copper bus, main compression type lugs only (MLO) or main circuit breakers (MCB) as required, feed through lugs where required, and NEMA 1 type construction.

5.7.4.9 **Receptacle panel boards:** Receptacle panel boards shall be commercial grade 3-section, two (2) 84 circuit and one (1) 42 circuit, sized to handle all anticipated loads at worst case power densities plus 25 percent spare capacity, 208Y/120 Volt, 3 phase, 4 wire, and shall have bolt-on breakers, tin-plated copper bus, main compression type lugs only (MLO) or main circuit breakers (MCB) as required, feed through lugs where required, and NEMA 1 type construction.

5.7.4.10 **Garage panel boards:** The garage/parking area shall be served from dedicated 480Y/277 volt, 3-phase, 4 wire commercial grade electrical distribution panel boards fed from the main building switchgear. They shall have bolt -on breakers, tin-plated copper bus, main compression type lugs only (MLO) or main circuit breakers (MCB) as required. Each panel board shall be sized to include all anticipated loads at worst case power densities plus 25 percent spare capacity.

5.7.5 **Surge protective device (“SPD”):** SPD shall be provided external to the service entrance switchgear.

5.7.6 **Data Center:** The design for the data center component of the building shall be according to NFPA 75 and NFPA 70 Article 645. It shall utilize a ‘2N’ approach where there is an “A” and a “B” UPS system. A power distribution unit (PDU) per UPS will then distribute 208/120V power to the racks. Plug-in busway shall be provided as a means of power connections. Each rack shall be dual corded, providing an “A” and “B” side connection.

5.7.6.1 Back-up generator: A single natural gas generator shall be used as means of back-up for the Data Center critical infrastructure. It shall be sized to handle all computer room loads plus 25 percent spare capacity. Refer to Section 5.7.3 for a description of features.

5.7.6.2 Uninterruptible power supply (“UPS”) system: The design for the UPS system has a “2N” approach, with external bypass. The UPS shall consist of two static-type, single-module system with VRLA batteries, a maintenance bypass static switch, and a critical distribution bus (UPS distribution) if applicable.

The equipment/modules shall be static-system type. Each UPS shall be sized to accommodate full data center build-out plus 10 percent spare capacity. Provide a continuous-duty static switch. The UPS input and output voltage harmonic distortion (THD) shall not exceed 5 percent total or 3 percent of any single harmonic frequency. UPS modules shall have front and rear access clearances. Use of motor operators on the input breakers is not allowed. Provide external maintenance bypass with isolation. Size UPS based on assumed load of 100W/SF of footprint of rack space (not gross room area). Provisions shall be made for future addition of UPS with a total assumed load of 200W/SF of rack space.

UPS input tolerance shall be coordinated with output tolerance of the back-up generator such that additional power conditioning is not required between the generator and UPS.

5.7.6.3 UPS distribution: The equipment/modules shall be static-system type. Each module shall include an integrated input isolation transformer. Each UPS shall be sized to accommodate full data center build-out plus 10 percent spare capacity. Provide a continuous-duty static switch. The UPS input and output voltage harmonic distortion (THD) shall not exceed 5 percent total or 3 percent of any single harmonic frequency. UPS modules shall have front and rear access clearances. Use of motor operators on the input breakers is not allowed. Provide external maintenance bypass with isolation. The UPS Slew setting of 0.5 Hz/sec is typical. Size UPS based on assumed load of 100W/SF of computer room space.

5.7.6.4 Battery requirements: VRLA batteries shall be provided. A minimum of 15 minutes of ride-through time shall be provided at full UPS load.

5.7.6.5 Battery monitoring: A stand-alone battery monitoring system shall be considered on a per project basis.

5.7.6.6 Power distribution units (“PDU”): Rack power system is anticipated to utilize 208/120 VAC. The system shall use separate PDUs (step-down transformer, distribution bus, and feeder breakers integrated into a single enclosure) to achieve these voltages. The UPS power to racks and other designated critical equipment shall be distributed from the UPS output through PDUs located in the UPS Room.

5.7.6.7 Plug-in busway: Plug in busway shall be located in the Computer Room(s) and Telecom Room(s), near the IT equipment.

5.7.6.8 Leak detection: Leak detection shall be not be provided unless specifically requested by the owner.

5.7.6.9 Load bank provisions: Install provisions for connection of temporary load banks for testing of UPS batteries.

5.7.6.10 Hydrogen detection: If required by IFC, hydrogen detection shall be installed in all lead-acid battery rooms.

5.7.7 Variable frequency drive ("VFD"): VFDs should be utilized for all motor loads larger than 5HP (excluding the Fire Pump). Provide a complete solid state variable frequency controller, with Pulse Width Modulation (PWM) output waveform, including a full wave rectifier to prevent input line notching, AC line reactor, input fuses, capacitors, and insulated bipolar gate transistors (IBGT) as the output switching device. SCR, GTO and Darlington transistors are not acceptable. Six step and current source are not acceptable. All standard and optional features shall be included within the VFD enclosure. VFD shall be approved by the equipment manufacturer for the particular product and application involved. All of the variable speed controllers shall be supplied by one manufacturer for this project. All variable speed controllers shall have communication ports compatible with the Building Automation system.

5.7.8 Transformers: Transformers serving tenant loads (one per Electric Room) shall be dry-type, high efficiency type. Transformers 25 KVA and larger shall be 130°C temperature rise over a 40°C ambient and shall have six 2.5 percent full capacity taps. Transformer windings shall be copper or aluminum. Impedance shall be 3-5 percent. Transformers shall be provided in accordance with NEMA ST20. Transformers shall have a K4 rating (150 percent neutral) unless specific loads require a K13 rating. Transformer shall comply with the latest efficiency standards as adopted by the AHJ.

Transformers shall be properly bonded and shall be grounded back to the building steel as required by NEC.

5.7.9 Busway: Busway shall be totally enclosed feeder or plug-in busway and shall have tin-plated copper bus bars.

5.7.10 Conductors

5.7.10.1 Conductors: Conductors shall be copper with solid conductors for power wiring in sizes No. 12 AWG through No. 10 AWG; copper stranded conductors for control wiring in sizes No. 18 AWG through No. 10 AWG; and copper stranded conductors for power wiring in sizes No. 8 AWG and larger. Conductors shall be Type TW, THW or THHN/THWN for sizes No. 18 AWG through No. 10 AWG, and Type THW, THHN/THWN, XHHW-2 for sizes No. 8 AWG and larger. Underground feeders shall be Type XHHW-2. Aluminum conductors may be considered for normal power feeders #1 and larger if approved by the Engineer of Record and the Owner.

5.7.10.2 Insulated conductors: Insulated conductors shall have XHHW-2 insulation for exterior work and other wet locations, regardless of conductor size. All wiring and bus bars shall be made of copper. Aluminum conductors may be considered for normal power feeders #1 and larger if approved by the Engineer of Record. The power feeder lug connections to mains or buses shall be made with hydraulically applied high compression-type lugs or connectors, except for panel boards 400A and smaller.

5.7.10.3 Feeder Conductors: All feeder conductors within switchgear, switchboards, and distribution boards shall be properly supported/secured to prevent strain on point of termination.

5.7.11 Raceways

5.7.11.1 Rigid steel or intermediate metal conduit (IMC) shall be used where cast in concrete walls or floor slabs which have waterproof membranes; where cast in masonry walls; in damp or other wet locations; where exposed outdoors; or indoors where exposed to physical damage.

5.7.11.2 MC cable shall only be used for lighting whips 6 feet or less in length. MC cable shall not be used for any other purpose.

5.7.11.3 PVC schedule 40 conduit shall be used for underground primary feeders shall be concrete encased Type "EB" UL labeled utility duct rated at 90ºC, and shall be constructed to electrical utility company standards.

5.7.11.4 PVC schedule 40 conduit shall be used for underground raceways, in ground bearing floor slabs, except where specifically indicated or specified to be galvanized rigid steel conduit. Provide insulated ground wires as required. Elbows used with PVC conduit shall be rigid galvanized, standard radius or long sweep. All stub-ups above finished grade or finished floor shall be PVC-coated rigid steel or PVC wrapped IMC conduit.

5.7.11.5 Flexible steel conduit or liquid-tight flexible steel conduit shall be used for raceway connection to rotating or vibrating equipment in lengths not to exceed 48 inches. Provide bonding jumpers across flexible conduit lengths.

5.7.11.6 Flexible metal conduit shall be used for power poles, switches and receptacles or where flexibility is otherwise required. Only the use of steel compression fittings on EMT raceway is permitted. All other raceways shall have fittings that are listed for their specific purpose and use.

5.7.11.7 All power and fire alarm main risers shall be installed in conduit. All conduit for branch circuits shall be ¾-inch or larger except when feeding a single receptacle or switch. Conduit/Raceway exiting interior panel boards shall be ¾-inch EMT conduit or larger, and in no case shall MC cable or other flexible wiring be exiting a panel board. Plastic coated rigid steel or PVC wrapped IMC conduit shall be used at all "wet" locations. Seal-Tight Flex Conduit (Blue, low smoke) shall be used under any raised computer room floors.

5.7.11.8 Do not use Re-Lock wiring system or under-floor electrical systems in any new facility.

5.7.11.9 New buildings shall follow the Austin Utility Criteria Manual for color coding phases.

5.7.12 **Safety switches:** All safety switches shall be of the heavy-duty type, with a NEMA 1, 3R or 4X enclosure, and fused or non-fused as required. NEMA 3R enclosures shall be used at "wet" locations, NEMA 4X (304 SS) at corrosive locations.

5.7.13 **Grounding**: The electrical distribution system and all equipment shall be grounded in accordance with the NEC. An insulated ground wire shall be included with all distribution feeders and with all branch circuits. The building grounding system shall consist of a minimum 4/0 bare stranded copper ground loop with 7/8-inch X 10-foot copper clad steel ground rods encircling the building, a concrete encased grounding electrode, connections to reinforcing steel, and the main incoming water line to the building. Ground rods shall be on 50-foot centers or every other column footing, whichever is closer. The building grounding system shall provide a resistance to ground of not more than five ohms. Installing contractor shall submit a signed test document certifying grounding system resistance to ground. Provide at least two ground test wells along the ground loop at locations dictated for each specific structure. Grounding bushings shall be used on electrical systems of 277/480 volt or higher. The grounding system shall include separate dedicated ground risers: one for the grounding of dry-type transformers, and one for each telephone/ data riser closet. There shall be at least one ground copper bus bar on each side of the building. Each ground bus bar shall have two stranded copper whips connected between the ground bus bar and the building ground loop. Grounding whips shall be exothermically welded at each end.

5.7.14 Wiring Devices

5.7.14.1 All 20 ampere, 125- or 277-volt wiring devices shall be decorator style where recessed, and standard where surface mounted. Normal power receptacles shall be white in color and emergency power receptacles shall be red in color. Receptacles shall be side-wired specification grade. Receptacles shall be mounted vertically. Switched receptacles shall have a marking, as per NFPA 70 Article 406.3(E), and shall be gray in color unless explicitly stated in existing standard/code. Switches shall be white with white cover plates.

5.7.14.2 All cover plates for 15 and 20 ampere single and multi-gang wiring recessed devices shall be white thermoplastic specification grade, except for surface mounted devices and floor box cover plates which shall be determined by architect.

5.7.14.3 Wiring device mounting heights shall be in accordance with applicable accessibility codes. Conduit and boxes installed in rated partitions shall comply with UL requirements.

5.7.14.4 For office space, preferred method for data/power routing: down mullion of window walls. Power poles shall be provided only as needed. They shall have data and power capabilities. Floor and furniture mounted data/power boxes on an as needed basis per space. In-carpet power, voice and data floor raceway is not permitted.

5.7.14.5 All circuits shall be labeled using a labeling machine on junction box covers. Circuit labels on face plates for receptacles, switches and other devices shall be engraved or attached via a similarly durable method approved by the owner. The labels shall contain the designated panel from which the circuit originates and the corresponding circuit number.

5.7.14.6 No in-floor branch circuiting will be allowed, except final stub-ups to powered conference room furniture and other locations approved by the Owner.

5.7.15 Lightning protection: Lightning protection system design shall be in accordance with NFPA 780. It shall be provided for each building and shall meet minimum UL standard. If possible, conceal lightning protection from exterior view. A UL Master Label certificate of inspection shall be provided for the lightning protection system.

5.8 Lighting Design

5.8.1 General: The lighting system shall be designed for enhanced visual quality while minimizing connected lighting power density and lighting energy use. Illumination quality and quantity shall enhance the visual experience of visitors and staff by providing orientation cues and addressing visual comfort needs. Vertical surfaces shall be illuminated where appropriate to enhance the sense of brightness and openness. The lighting system shall be designed to provide average illuminance levels in keeping with IESNA recommendations. Advanced lighting controls shall be used to minimize electric lighting energy utilizing daylight sensors, occupancy and vacancy sensors, and programmable dimming. Luminaires shall use primarily high efficacy, long life, and high color rendering lamping. Provide a life cycle cost analysis for lighting design.

5.8.2 Luminaires: The vocabulary of lighting techniques shall include ambient, task, and accent lighting using leading-edge technologies. Luminaire construction quality, especially regarding reflectors, shielding, and lenses, is critical to the successful design of this low energy, high quality visual environment. All luminaires shall be high quality specification grade equipment by reputable manufacturers and CE/UL/IP- listed for the application, unless otherwise noted. Luminaires shall be specified and located for ease of future maintenance. Fixtures from reputable manufacturers shall be specified, ensuring future support.

5.8.3 Lamps: Lamps shall have a high-quality color rendering index (CRI) of 80 or greater with a standard color temperature. Color temperature shall be 3000K for exterior spaces and 3500K for office spaces. Long life versions of lamps shall be specified when available to reduce long term maintenance costs. The design shall endeavor to minimize the variety of lamp types to simplify long-term maintainability. The most current, adopted version of ASHRAE/IESNA 90.1 should be met for lighting power allowances per space. The target luminous efficacy shall be 60 lumens/watt or greater.

5.8.4 Ballasts and drivers: Typical ballasts shall be high-efficiency, electronic program start with normal ballast factor. High and reduced light output ballasts shall be used as necessary to provide appropriate lighting with minimal load. Dimming ballasts or drivers shall be specified in spaces with daylight-responsive controls, and in multi-function spaces. Dimming ballasts and drivers shall be specified to dim to 5 percent light output or less and shall be fully compatible with dimming control equipment. Remote drivers may be required for some LED luminaires.

5.8.5 Controls: All lighting equipment shall be automatic, controlled through a combination of manual switching, occupancy sensors, and daylight sensors. Each space that will be equipped with dimming may require a local dimming panel. All spaces with dimming, or AV integration, will require advanced commissioning and programming after installation and before occupancy. Occupancy sensors shall be installed in restrooms in locations that sense movement inside toilet cubicles.

5.8.6 Public lobby: Lighting for the lobby shall be integrated with the architecture to provide satisfactory illuminance levels with an emphasis on visual comfort and glare control. Architectural elements shall also be highlighted. Decorative fixtures may be used to highlight key areas. Lighting controls shall enable the electric lighting to respond to daylight availability and occupancy patterns**.**

5.8.7 Public circulation: The lighting for corridors shall be integrated with the architecture to provide satisfactory illuminance levels with an emphasis on visual comfort and glare control. It is anticipated that this lighting will be by recessed LED fixtures. Vertical surfaces can be highlighted to increase visual interest and highlight displays. Lighting controls shall enable the electric lighting to respond to occupancy patterns.

5.8.8 Restrooms: The lighting for the restrooms shall be ceiling-recessed downlights coupled with perimeter luminaire at the stalls. Vertically mounted fixtures shall highlight the sink area. Dual technology type occupancy sensors shall enable the electric lighting to be automatically turned off when vacant. Sensors shall be located to monitor occupancy of restroom stalls.

5.8.9 Stairs: The lighting for the stairs shall be ceiling-recessed downlights coupled with surface mounted wall fixtures. Fixture-integrated occupancy sensors (100 percent on during occupancy to 50 percent automatic off) controls shall reduce lighting output to half when stairs are unoccupied.

5.8.10 Mechanical, electrical, telecom spaces: General lighting shall be provided by suspended industrial luminaires. Provide non-automatic switched lighting controls for safety of maintenance personnel.

5.8.11 Exterior lighting: Exterior areas adjacent to the building shall be illuminated with recessed or surface mount exterior- rated fixtures. All exterior pedestrian areas shall be illuminated with pedestrian-scaled pole mounted fixtures and/or bollards. Lighting shall be Dark-Sky compliant and minimize general light pollution. Photo sensors and programmable astronomical time clocks shall control the lights in response to available daylight and seasonal changes. A suitable bypass or override switching system shall be included to enable temporary manual energizing of lighting covered by this section in case of controller failure.

5.8.12 Parking: Garage areas shall be illuminated with surface mount exterior-rated fixtures and shall incorporate daylight harvesting for automatic control. Provide daylight sensors for parking garage levels that can take advantage of daylight harvesting to reduce lighting load. Supplemental lighting shall be used at building entrances per the recommendations of IESNA. A suitable bypass or override switching system shall be included to enable temporary manual energizing of lighting covered by this section in case of controller failure.

5.9 Fire Alarm

5.9.1 Fire alarm system: The fire alarm system shall be a networked, addressable system supporting up to 2,500 intelligent analog/addressable points per panel. The fire alarm control panel shall have an 80-character display. A Fire Alarm Remote Annunciator panel shall be provided at the building entrance within plain sight for ease of access by fire department personnel, or as required by the AHJ. The fire alarm system shall be designed to maintain a 20 percent spare capacity of all circuits.

5.9.2 Networked system: The fire alarm system shall be able to communicate to a head unit via TCP/IP Ethernet network. Networked Fire Alarm communications and Fire Alarm Addressable loop circuits shall be class "X." Fire Alarm Notification circuits and Fire Alarm auxiliary circuits shall be class "B" style "B." Addressable devices shall be capable of replacement without the need of an additional programmer.

The Building Control Network (BCN) infrastructure shall provide these communications. Coordinate all requirements with the Division 27 Telecom designer.

5.9.3 Mass notification: The Fire Alarm/Mass Notification shall meet the following minimum requirements:

Audio devices shall meet intelligibility requirements;
Audio and visual devices shall be white and not say "FIRE";
The System shall have 8-channel digital-audio capabilities;
The Audio system shall have an extended digital memory to hold up to 32 minutes of specific recorded messages; and
The System shall have an auxiliary input for third-party audio.

5.9.4 Smoke control: Provide separate panel(s) for smoke control. Use the same model and manufacturer as fire alarm manufacturer if required. Smoke detectors shall be multi-sensor (Photo/Thermal) analog addressable. Very Early Smoke Detection Apparatus (VESDA) shall be installed at return air grilles of data center computer room.

5.9.5 Accessibility: ADA typical-configuration guidelines shall be accommodated in the fire alarm specifications.

5.9.6 Warranty: The fire alarm system shall have a minimum one-year warranty on equipment from the supplier. The system supplier shall maintain a service organization with adequate spare parts stocked within 30 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor. Contractor shall provide spare parts for the system and field devices.

5.9.7 Licenses: Bidding contractor shall provide copies of all state licenses for work being performed to the owner for acceptance.

5.10 **Fire Protection**

5.10.1 Complete fire protection system: Provide all design, materials and installation required to provide a complete fire protection system to protect the specified building in accordance with design requirements. All fire protection system equipment shall be new and listed by Underwriters Laboratories (UL) or approved by FM Global. Provide documentation of all approved code deviations or alternate means of compliance.

5.10.2 Fire department connections: Provide Fire Department connections adjacent to and visible from fire access lanes. Fire department connection access to sprinkler standpipes must meet code and all AHJ requirements. Coordinate water sources available for fire sprinkler system and confirm capacity of system.

5.10.3 Fire department access: At all times provide Fire Department access to Project building(s) and Knox-Box rapid entry system devices. Each building shall be provided with a Knox-Box-type rapid entry system for emergency personnel.

5.10.4 Installation: System design and installation shall be supervised by a licensed NICET Level III sprinkler system technician or fire protection engineer with not less than 5 years' experience with sprinkler systems.

5.10.5 Pumps and valves: Provide dedicated private fire service mains with double-check backflow prevention to the building(s), and an AHJ-approved backflow prevention on a separate fire line. Provide a post indicator valve ("PIV") on the main fire supply to building. Provide an isolation valve at each level of the building. Provide fire pump(s) and jockey pump(s) for the building(s) as required. Conduct new fire hydrant flow tests to verify available water supply. All systems shall be hydraulically calculated. Provide a 10 psi or 10 percent safety factor, whichever is greater, in all hydraulic calculations.

All sprinkler systems connected to the new fire pump system shall be provided with a pressure reducing valve. Pressure reducing valve discharge pressure settings shall not exceed 155 psi. All system valves requiring monitoring shall be lockable and equipped with a tamper switch and sight window. Isolation valves shall be located at each floor.

Identification tags shall be porcelain enamel 18 gauges and shall be affixed securely by brass chain to all valves. All signs shall be red.

5.10.6 Standpipes: Provide Class I standpipes in the building where required. All express drains shall be piped to a sanitary sewer. Provide a floor sink (2-foot by 2-foot x 2-foot concrete receiver) for the express drain.

5.10.7 Controls: Provide secondary power supply for controls where required.

5.10.8 Wet pipe / dry pipe / inert gas suppression: Provide a wet pipe automatic sprinkler system using quick response sprinklers throughout the building. Extended coverage sprinklers may be utilized if proven in the hydraulic calculations. Provide dry pipe systems in areas being protected that cannot be maintained above 40° F. Antifreeze systems are not permitted. In the building data center: provide a double-interlocked, cross-zoned pre-action sprinkler system, with a Novec1230 clean agent system.

5.10.9 Variable frequency drive ("VFD"): VFD controllers for fire pumps are not allowed.

5.10.10 Vertical openings: Comply with the more stringent vertical opening requirements contained in NFPA 1 and IBC. Patch holes between floors to maintain fire resistance rating and to prevent dirt and debris from collecting in non-rated assemblies. Minimize the use of smoke management systems though alternative code compliance.

5.11 **Information Technology Systems**

5.11.1 ITS infrastructure: The Information Transport Systems technology infrastructure for the Project shall include consulting, design, and architectural and engineering coordination for the following systems. All current versions of the TIA and building codes shall be followed.

5.11.1.1 Two autonomous network types shall be designed and provided as follows:

The IT Data Network ("DATA"), including voice over internet protocol ("VoIP"); data; Wi-Fi; cable television ("CATV") or internet protocol television ("IPTV"); audio-visual ("AV") systems; and distributed antenna systems ("DAS"); and

The Building Control Network ("BCN"), administered by the TFC's BCN staff. The BCN shall include the building automation system ("BAS"); security (access control and intrusion detection); closed circuit television ("CCTV"); fire alarm; and energy-related monitoring systems.

5.11.1.2 TFC related active equipment for BCN, BAS and Security such as servers, switches, cabling and cabinet UPS devices in Co-Located Server rooms, Office IDF rooms and Garage IDF rooms to be purchased by TFC outside of the GMP contract. TFC to procure and purchase related extended warranties for those items. CMR to provide cabinets and install PDU's and cabinet patch panels and install TFC provided active equipment, with the exception of network and security switches, which TFC IT will install.

5.11.2 Standards: All design shall be performed per latest BICSI and TIA standards and the current building codes within the jurisdiction. SFMO guidance shall be incorporated as required for fire alarm systems.

All Telecommunications and Network design shall be performed under the supervision of a Registered Communications Distribution Designer ("RCDD") with a current certification.

All copper categorized cabling 8P8C connectors shall be per standard TIA-568-B.

5.11.3 Outside plant connectivity ("OSP"): Redundant OSP infrastructure with separate paths and entry points into the entrance facility ("EF") shall be designed for each network type (BCN and DATA). OSP connectivity shall be from the Capitol Complex Telecommunications/Data network infrastructure. Trench 1 may have both the DATA1 and BCN1 conduit; Trench 2 may have both DATA2 and BCN2 conduits.

OSP fiber optic cable shall be Single Mode OS1 or OS2 loose tube cable. Strand counts shall conform to building design requirements plus 100 percent spare capacity. Provide at least one spare 4-inch conduit for each network. All fiber optic cabling shall be installed in MaxCell-type innerduct. Provide raceway quantities and sizes per latest ANSI/EIA/TIA standards.

5.11.4 General Telecom Requirements

5.11.4.1 Passive racks shall have fiber optic shelving located at the top with copper patch panels below. Provide space for future expansion of 50 percent.

5.11.4.2 Fiber optic connections shall be the LC type with APC ferrules.

5.11.4.3 Copper solid 24 AWG CAT 6 cable shall be used for DATA network permalink connections. Copper solid 24 AWG CAT 6 shall be used for all BCN permalink connections. Jacket colors for network cabling shall be:

DATA Network – Blue

BCN Network – see BCN-specific color code guide below.

5.11.4.4 Equipment jumpers, work area jumpers and patch cables shall be 24 AWG cabling with the same jacket color and cable categories. These cables shall be stranded copper for flexibility.

5.11.4.5 Copper patch panels shall be of the same category as the copper cable plant.

5.11.4.6 The MDF shall be environmentally conditioned per BICSI/TIA standards.

5.11.4.7 Access to the space shall be controlled by the electronic security access control system using suitable identification and authentication technology.

5.11.4.8 At least two dedicated, non-switched electrical receptacles shall be provided for each active rack plus provisioning for future active racks. Plan for overhead distribution unless specific project requirements dictate otherwise.

5.11.4.9 A Telecom Grounding Busbar ("TGM") must be provided to ground all telecom metal components in the room per BICSI/TIA standards.

5.11.4.10 DATA and BCN equipment and racks (both passive and active) is required to be segregated in separate locked cabinets. BCN equipment cannot be located in a DATA rack and vice versa. DATA and BCN Networks are to be housed in their respective equipment cabinets provided with Electronic Security Access Control placed on both front and rear cabinet doors. The separately locked cabinets may be located in a common room.

5.11.4.11 Piping, HVAC duct systems and electrical distribution may not enter the space unless specifically serving the space.

5.11.4.12 The DATA network shall be segregated from non-IT staff who may have access to the room. If security, fire alarm, BAS or any other low-voltage, IP-based systems are located in the space, then the DATA racks shall be lockable four post racks; otherwise, an open, four-post rack is acceptable. Low voltage and high voltage wiring shall not be permitted to share conduit.

5.11.4.13 Provide a minimum one-hour rated enclosure for all IDFs. Mechanical fire-stop systems such as cable transit and pathway systems and factory-assembled sleeve systems are preferred.

5.11.4.14 Telecom administration is required. In addition, all low-voltage building systems using the IT/Telecom infrastructure shall have fiber optic strands located in the shelf assigned to each system by the telecom designer.

5.11.4.15 Unless otherwise indicated in the solicitation or related documents, raised floors are not provided in the MDF.

5.11.4.16 Refer to current BICSI Chapter 3 TDMM revision for space requirements.

5.11.4.17 Tie wraps and cable ties are not allowed; use only textile hook-and-loop wraps (commonly known as Velcro).

5.11.5 Entrance facility: An integral or separate EF shall be sized per standards; the minimum size shall be at least 4 feet by 6 feet. The EF shall terminate outside plant cabling onto fiber optic shelving and establish the grounding for the Telecom system throughout the building using the telecom main grounding bus (TMGB). The Entrance Facility may be within a shared use CoLo space, where approved by the TFC project manager.

5.11.5.1 Passive Racks shall have fiber optic shelving located at the top with copper patch panels below. Provide for 50 percent future expansion.

5.11.5.2 Fiber-optic connections shall be the LC type with APC ferrules.

5.11.5.3 The EF shall be environmentally conditioned only if it is contained within the MDF per BICSI/TIA standards.

5.11.5.4 Access to the space shall be controlled by the security access control system using suitable identification and authentication technology.

5.11.5.5 Refer to chapter 3 of the latest BICSI TDMM revision for space requirements.

5.11.5.6 Tie wraps and cable ties are not allowed; use only textile hook-and-loop wraps (commonly known as Velcro).

5.11.6 Telecommunications room ("IDF"): The IDF houses the horizontal cross connect. Provide at least one IDF per floor, and locate it so that passage through intervening space(s) is not required for access. The IDF should be sized per BICSI/TIA standards at a minimum. The room contains active equipment located in the active racks and is interconnected or cross connected with patch panels located in the passive racks. DATA and BCN racks must be in separately locked cabinets. Space should be provisioned for at least one DATA cabinet and one BCN cabinet, and is recommended to include space for two active racks and two passive racks each for the DATA and BCN.

5.11.7 Main distribution frame room ("MDF"): The MDF is the main telecommunication space within the building and should be located on the first floor. The MDF may contain both the EF and may serve as the IDF for the first floor. The MDF shall at a minimum be sized pursuant to BICSI/TIA standards. The room contains active equipment located in the active racks and is interconnected or cross-connected with patch panels located in the passive racks. The MDF shall house the main cross-connect systems for the building. Intermediate cross-connects are acceptable. Space should be provisioned for at least eight racks: four active racks and four passive racks for the DATA and BCN each.

5.11.8 Requirements for MDF and IDFs

5.11.8.1 Rooms shall be sized in conformance with Chapter 3 of the latest BICSI TDMM revision for space requirements.

5.11.8.2 Passive racks shall have fiber optic shelving located at the top with copper patch panels below. Copper patch panels shall be of the same category as the copper cable plant. Provide future expansion space of 50 percent spare.

Fiber Optic connections shall be the LC type with APC ferrules. Copper solid 24 AWG CAT 6 cable shall be used for DATA network permalink connections. Copper solid 24 AWG CAT 6 shall be used for all BCN permalink connections. Jacket colors for the respective network cabling shall be:

DATA Network

Data – Blue

VoIP – White

BCN Network – see color-code guide in section 5.11.12

5.11.8.3 Equipment jumpers, work area jumpers and patch cables shall be 24 AWG cabling with the same jacket color and cable categories. These cables shall be stranded copper for flexibility. Patch cables shall match the same category (e.g., Cat 5e or 6) as the cable for which they are being used.

5.11.8.4 The room shall be environmentally conditioned per BICSI/TIA standards. No piping, HVAC duct systems or electrical distribution may enter the space unless it specifically serves the space.

5.11.8.5 A minimum of two non-switched electrical receptacles shall be provided for each active rack plus provisioning for future active racks. Provide overhead distribution unless otherwise specified. Provide a TGM to ground all telecom metal components in the room per BICSI/TIA standards.

5.11.8.6 Access to the space shall be controlled by the electronic security access control system using suitable identification and authentication technology. Physical segregation of DATA and BCN equipment and racks (both passive and active) is required. BCN equipment cannot be located in a DATA rack and vice versa. DATA and BCN network equipment shall be housed in separately locked cabinets with Electronic Security Access Control placed on the front and rear cabinet doors. If security, fire alarm, BAS or any other low voltage IP based systems are located in the space, then each discipline's individual equipment, racks, and conduit sleeves shall be physically segregated from one another. The racks and equipment may be located in a common room if separately locked cabinets are provided to isolate access to each different system.

5.11.8.7 In addition to segregation of the DATA and BCN networks, the following systems shall also be segregated within the passive and active racks in an IDF and MDF space: AV systems, CCTV, security access control and perimeter detection (if applicable), BAS, CATV, VoIP, Wifi, DATA, and others should be segregated in separate racks where possible or within separate areas of a rack. Provisions for expansion shall be included for each system.

5.11.8.8 Provide minimum one-hour fire-resistive rated walls for all IDFs. Mechanical fire stop systems such as cable transit and pathway systems and factory assembled sleeve systems are preferred means of fire stop.

5.11.8.9 Telecom administration shall be required. All low-voltage building systems using the IT/Telecom infrastructure shall have fiber optic strands located in the shelf assigned to each system by the telecom designer.

5.11.8.10 Unless specifically required by the project, raised floor systems are not permitted.

5.11.9 Backbone Cabling: The building(s) shall have separate vertical pathways for DATA and BCN fiber backbone distribution.

5.11.9.1 All fiber optic cable shall be multimode OM4, 50/125/900 type. All fiber optic cables shall be home run from the IDF to the MDF.

5.11.9.2 Vertical pathways at stacked telecom rooms shall be sleeved and supported structurally. All fiber optic cabling shall be physically protected from mechanical damage.

5.11.10 Horizontal Distribution: The horizontal distribution shall consist of minimum Category 6 unshielded Twisted Pair ("UTP") cabling capable of supporting 1000BASE-T Ethernet for connections in the IDF. Cabling special needs such as fiber optic to the desktop shall be addressed during design. Two telecommunication outlets ("TO") per workstation shall be provided. Network engineering shall provide active equipment for contractor installation and deployment.

5.11.10.1 All channel and permalink installations shall be tested per BICSI/TIA standards.

5.11.10.2 Raised floor systems in the office spaces are not preferred. Distribution shall typically be overhead.

5.11.10.3 If permalink lengths exceed 90 meters on a floor, the preferred resolution is relocation of the room during the design phase in coordination with the design team. If relocation is not possible, telecom enclosures may be considered. Shallow room IDFs are discouraged.

5.11.10.4 Wi-Fi access point layout shall be initially designed in open spaces for one access point per 10 meter by 10 meter area.

5.11.11 BCN requirements

5.11.11.1 The BCN cabling shall be color-coded fiber optic, CAT 6, and CAT 6 copper cable jacket colors shall be

Green	Energy
Orange	Security
Red	Fire
Blue	HVAC
Yellow	Input/ Pass Through
Grey	Crossover
Black	Automation
Purple	Voice over IP (VoIP)
White	Wireless

5.11.11.2 Each System shall have a separate and distinct patch panel, color designated per section 5.11.12.1 at the patch panel jack. For example, cabling dedicated solely to BAS shall be black, and the patch panel shall also be black to indicate that it is reserved for the BAS.

5.11.11.3 BCN team at the TFC maintains an asset management system. This system and its telecom administration should be included with specifications to any division 27 contractor.

5.11.11.4 Telecom administration shall use the BCN cable-labeling format:

[*Building Code*] – [*Level*] – [*IDF*] – [*Individual number*]

Refer to Appendix A for the BCN building codes.

5.11.12 DIR requirements

5.11.12.1 CAT6 network jacks shall be blue. CAT6 shall be orange. Voice jacks (cat6) shall be white. Provide Panduit or equal mini-com UTP jack modules. Face plates for offices shall be Panduit 4-port mini-com sloped executive series or equal. Provide matching blank module inserts. Furniture faceplates shall be mini-com snap-on for modular furniture or mini-com surface-mount 2-port or 4-port boxes.

5.11.12.2 Patch panels shall be 24-port or 48-port Panduit mini-com, flush-mount, modular panels rated for gigabit Ethernet service. 10/100 base-T patch panels shall not be used. On top, bottom and between each patch panel on a rack shall be a NetManager horizontal cable manager with both front and rear-hinged covers.

5.11.12.3 Unless noted otherwise, Network specific cabinets are to be used and are to be grounded and bonded with electronic security access on cabinet doors, to segregate all DATA network equipment from other equipment in the room. If open racks are utilized, racks shall be two-post, 19 inches by 84 inches, grounded and bonded.

5.11.12.4 Vertical wire management shall be incorporated within the network specific cabinets. Where open racks are used in lieu of cabinets, vertical wire management shall be Patch Runner dual-sided, 84 inches by 6 inches, on each side of the rack with slack spools attached. Provide Patch Runner vertical cable management doors on the front and back of the wire management.

5.11.12.5 TV cabling shall be RG-6 for analog distribution and CAT6 for IPTV.

5.11.12.6 Install wire-type 4 inch by 18 cable tray for above-ceiling IW routing. Cable trays shall be installed “trapeze-style” with all-thread and anchors into the slab above. Cable trays shall be grounded and bonded. Provide J-Pro cable support systems for supporting above-ceiling IW cables and for maintaining bend radius. J-hooks shall be supported by their own grid-type wire anchored into the slab above.

5.11.12.7 Provide Pan-Punch 110 CAT5e system kits or GP6 Plus CAT6 high-density kits for voice consolidation and cross-connect point applications.

5.11.12.8 Fiber boxes shall be rack-mounted or wall-mounted lockable enclosures.

5.11.12.9 Horizontal IW cabling shall be labeled behind each termination point behind the jack, on the sloped faceplates, behind the termination points on the patch panel, and on the face of the patch panel. All cabling shall be in numerical order starting with #1. Cabling shall not be labeled with reference to room or modular furniture numbers. All riser, copper, and fiber backbone shall be labeled at each termination point and between each floor it passes through.

5.11.13 Conferencing and collaboration spaces: Audio-visual systems for conferencing and collaboration spaces shall be provided per InfoComm International standards. If the scope for the project does not include tenant finish-out, the following subsections provide guidance for provision of infrastructure to support tenant spaces.

5.11.13.1 In general, pathways and infrastructure shall only be provided in tenant spaces. Each tenant shall provide their specific AV systems during the finish out phase. Infrastructure includes:

A recessed flat panel back box with power and HDMI set back box shall be located on the wall planned for all flat panel locations;

A floor box with power and HDMI connector(s) shall be provided that is in the approximate center of the room; and

Refer to section 5.2.4.1.2 for a description of room types shown in the following sections.

5.11.13.2 Common Break Room and other common spaces: CATV using IP technology capable of supporting digital signage functions shall be provided in each break room. A back box mounted a minimum of 52” above the floor shall be included with separate EMT conduit for power and communications back to the nearest IDF.

5.11.13.3 Telephone Room: Assume one telecom data port, with a set-top VoIP provided by the tenant. Assume no electronic room scheduling system function.

5.11.13.4 Small conference room: Provide telecom data and VoIP TOs cabled to the nearest IDF room. Install at least one back box for power and wired or wireless collaboration. Provide at least one floor box with two 20-amp circuits and one HDMI cable minimum. Flat panel monitor size shall not exceed 65”, unless otherwise required by room dimensions and aspect ratio. Provide for room scheduling system cabled to the nearest IDF room.

5.11.13.5 Medium conference room: Provide telecom data and VoIP TOs cabled to the nearest IDF room. Install at least one back box for power and wired or wireless collaboration. Provide at least one floor box with two 20-amp circuits and one HDMI cable minimum. Assume at least one flat panel monitor, including up to a 4x4 matrix video wall system, and at least two back boxes. A credenza may be necessary for local mounting of AV equipment. Overhead speakers for teleconferencing and goose neck microphone provisions should be considered when selecting the floor box. Provide for a room scheduling system cabled to the nearest IDF room**.**

5.11.13.6 Large conference room: Provide telecom data and VoIP TOs cabled to the nearest IDF room. Install at least one back box for power and wired or wireless collaboration. Provide at least one floor box with at least four 20-amp circuits and one HDMI cable. Consider several floor boxes throughout the room coordinated with furniture as necessary. Assume at least one flat panel monitor, including up to a 4x4 matrix video wall system, and at least two back boxes or an overhead projection system. Assume at least four back boxes and infrastructure for overhead projection including power, RS-232 serial, Ethernet CAT 6 and HDMI connectivity. A credenza may be necessary for local mounting of AV equipment however consider a separate but attached AV room where possible. Overhead speakers for teleconferencing and goose neck microphone provisions should be considered when selecting floor boxes. Provide for a room scheduling system cabled to the nearest IDF room**.**

5.11.13.7 Huddle room: Provide telecom data and VoIP TOs cabled to the nearest IDF room. Provide recessed, wall-mounted back box installation for power and either wired or wireless collaboration. Provide at least two 20-amp circuits and one HDMI cable. Assume one flat panel monitor not to exceed 42" unless otherwise required by room dimensions and aspect ratio.

5.11.13.8 Training Rooms and Conference Center Rooms: There are many functional variants to these special purpose spaces: refer to the solicitation for specific programmatic requirements. Subdivision of large spaces via operable partitions will require sophisticated audiovisual solutions: assume data and audiovisual infrastructure and equipment to achieve specified program requirements.

5.11.14 Distributed Antenna System ("DAS"): Provide for First Responder DAS per IFC 2012. Plan for including communications infrastructure and rack space for a FR DAS system in the IDF and MDF rooms. A BOD system may be the Commscope ION-E DAS system. Digital system design using telecommunications infrastructure and rack space is preferred. Where acceptable to the local AHJ, a cellular DAS may be used.

5.11.15 Wayfinding Signage: External signage shall be used to direct all staff, visitors, and delivery and service personnel to the proper access points. Internal wayfinding signage shall be used to direct visitors to the building to the proper tenant agency. A graphical floor plan may be developed and displayed in the lobby, showing visitors the general layout of the building including building exits.

A data drop shall be provided in the main building lobby and each elevator lobby for the potential deployment of electronic lobby signage. A floor plan graphic may be developed and displayed in the lobby showing general floor plan, building egress paths, and sufficient detail to locate entrances to the tenant agencies; however, no detail shall be shown of the interior tenant spaces.

5.12 **Building Controls**

5.12.1 Building Automation System: For the project building(s), provide separate control systems, panels, conduit and wiring for the BAS, fire alarm, smoke management, security systems and lighting controls. The BAS control system and sequences of operation shall be designed to accommodate the mechanical HVAC design, including controls for maintenance of pressurization requirements. Use lighting control monitoring devices (e.g. dual technology type occupancy sensors) to share information with the BAS to optimize the use of HVAC and plug load energy. If indoor and outdoor relative humidity sensors are used for humidity control, those sensors shall be calibrated upon system startup.

5.12.2 Cabling and wiring: All controls wiring shall conform to NEC requirements. Low voltage and high voltage wiring shall not be permitted to share conduit. Plenum-rated cabling may be used in select areas, e.g., risers. Conduit shall not be filled beyond 40 percent capacity. All writing shall be labeled at both ends of the run and at any intermediate splice points.

All sensor and control cabling shall be wired to the local panel without any splicing or joints in between. Dedicated circuits shall be used to power terminal units such as VAV box controllers. No more than eight units per 20-amp circuit at 120 VAC are allowed.

5.12.3 Control Panels/Racks: Building main control panels shall be located in the telecom equipment room and installed in the vicinity of the BCN patch panels. Likewise, equipment and field controllers shall be located in telecom rooms on the building floors.

A lockable, 19-inch, four-post enclosure within the room shall be used for mounting the BAS controllers. All racks shall be provided with a UPS sized to accommodate the controller and I/O within the rack space. Each BCN enclosure shall have two dedicated 120 VAC, 20 Amp power feeds with an insulated ground. A non-volatile memory shall be incorporated for critical controller configuration data, and battery back-up shall provide real-time clock and volatile memory for at least 72 hours.

5.12.4 Eligible BAS provider: An eligible BAS provider shall have an office within 30 miles of the project site, shall have been in operation at least 10 years, shall have successfully completed other projects of similar size and complexity, and shall have demonstrated such accomplishment by providing references in the proposal.

5.12.4.1 All integrators must be factory-trained and authorized in their respective control system offerings and in integration with Tridium Niagara 4 integration. An eligible BAS provider shall demonstrate accomplishments by providing references and shall maintain at least three staff members factory-trained to integrate the Niagara framework.

5.12.4.2 An eligible BAS provider for the Capitol Complex Phase 1 Central Utility Plant (CUP), shall also be factory trained and authorized in integration with Siemens Desigo integration.

5.12.4.3 Unless specified otherwise in the solicitation, allowable controls contractors include the following:

Johnson Controls Inc., Metasys BACnet communications only;
Siemens Inc., Apogee BACnet controllers;
Schneider SmartStruxure BACnet controllers only; or
Trane Tracer BACnet only.

For guidance on the typical I/Os for the BAS, refer to Appendix B.

5.12.5 BACNet: The BAS shall be a BACNet / IP based control system with a common user interface throughout the new buildings subject to the 2016 CapCom MP (and subsequent versions) and the preliminary NAC MP (and subsequent versions), with the goal of integrating all campus buildings. The BAS shall be integrated with the building control network (BCN) and shall be separate and distinct from the DIR DATA network. The software is a HTML 5-based browser software with no special modifications needed to request and view information from the supervisor 4 server (assuming proper access credentials). LON and LON talk are not acceptable.

5.12.6 BAS Subsystems: The BAS shall be comprised of two subsystems. The Niagara Framework™ ("Niagara"), a Java-based technology developed by Tridium. The Niagara 4 supervisor is the server application, and the JACE controllers are distributed controllers utilized as combination gateway / router devices. The field level controllers ("FLC") are where control algorithms reside and where sequences are implemented and accomplished, e.g. air handlers with associated VAV boxes, chillers, cooling towers, hydronic pumping systems, and boiler sequencing. This equipment shall operate as standalone and shall report status back to the higher level HMI. The FLCs consist of sensors, indicators, actuators, final control elements, software interfaces to the higher level HMI server.

5.12.7 Redundancy: The BAS design for the systems serving these facilities shall be robust and reliable such that no single independent failure can cause any of the systems to become non-operational. To that end, the following shall be provided as part of a complete design:

5.12.7.1 Control wiring for a redundant system or subsystem shall be run in a dedicated raceway.

5.12.7.2 Loss of control signal to a cooling control valve or damper actuator shall cause the valve or damper to fail to the open position. Loss of control signal to heating final control elements shall fail in the closed position. Final control elements used in both heating and cooling modes, shall fail in the open position.

5.12.7.3 Loss of any one controller or communication wire shall not cause the controller to fail to control; only visibility into the process shall be lost until communications are restored.

5.12.7.4 Redundant communications loops shall be run in separate raceways on diverse paths.

5.12.7.5 All panels, controllers, I/O, communications and end devices that serve mission critical systems shall be powered from two, independent power sources, one from the A source and one from the B source.

5.12.8 Communications: The existing Niagara 4 framework system communications shall be IP-based using the BCN wired and wireless infrastructure. The BCN is an Ethernet-based Fast Ethernet (100 MB/sec) network. Communications between application specific controllers (ASC) and equipment level controllers (ELC) shall be industry standard BACNet/IP or similar. BACNet/MSTP should only be deployed to systems in which vendor equipment does not have BACNet/IP capabilities. Lonworks network communication is not allowed. All BACNet components specified shall be BACNet Test Laboratory (BTL) tested and certified. Untested components shall not be allowed.

5.12.9 Graphical Screens: New graphical screens shall be developed within the existing Niagara 4 framework for new construction subject to these Requirements. The Niagara 4 supervisor software shall maintain all configuration, alarming and programming information for the BAS in addition to all trending, logging, historical archiving and security access. All alarms shall be texted to designated personnel within the TFC. Refer to the "TFC standard for Building Automation Graphics."

5.12.9.1 Because the Niagara framework is an open system that can be sold to and modified by third parties, creating the risk of incompatibilities between and among vendors and manufacturers during software integration, the A/E team shall take necessary measures to minimize the potential for those incompatibilities and ensure openness and multi-vendor capability. The Division 25 controls specifications shall at a minimum provide:

Device ID = Vykon

Station Compatibility In = All

Station Compatibility Out = All

Tool Compatibility In = All

Tool Compatibility Out = All

The intent is that all "clients" (i.e., stations in the Niagara framework terminology) shall be configured and information-compatible with all servers and controllers and that the engineering workbench programming tool can communicate with and configure all Niagara JACEs and "supervisor clients" (i.e., hosts in the Niagara framework terminology).

5.12.9.2 Graphical screens shall begin with an overall campus view. The campus and the weather data shall be shown on this view. Clicking on a building will open a screen of the first floor with options to select other floors. Mechanical HVAC systems will be designated on the screen showing the areas in the building they serve.

5.12.9.3 The VAV and terminal boxes used on the project shall be navigable from this screen and the graphical depiction of the Air Handler shown below in Image A.

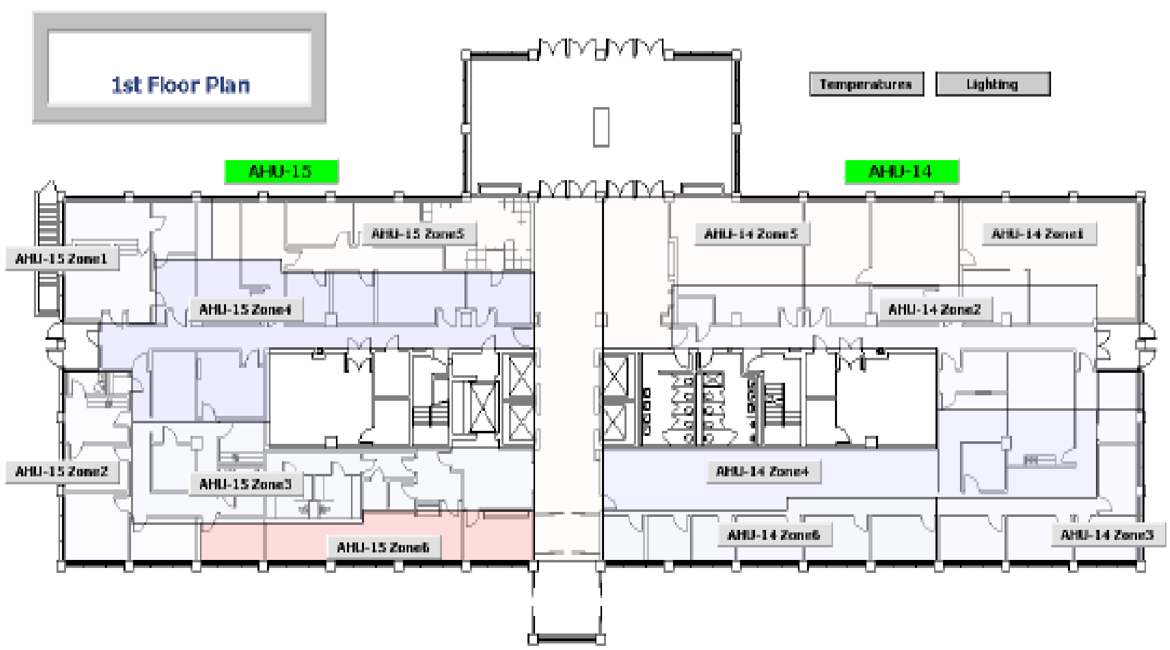


IMAGE A

A typical VAV/TB graphic screen shall resemble the image in Image B:

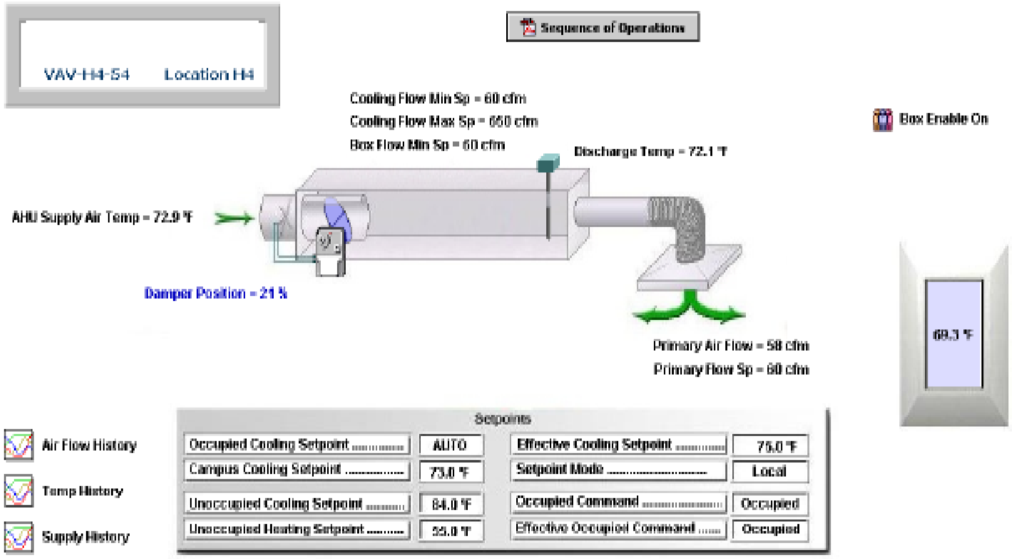


IMAGE B

By clicking on the Mechanical/HVAC button shown on the floor plan, the user shall be able to see a graphical depiction of the system itself, as in Image C.

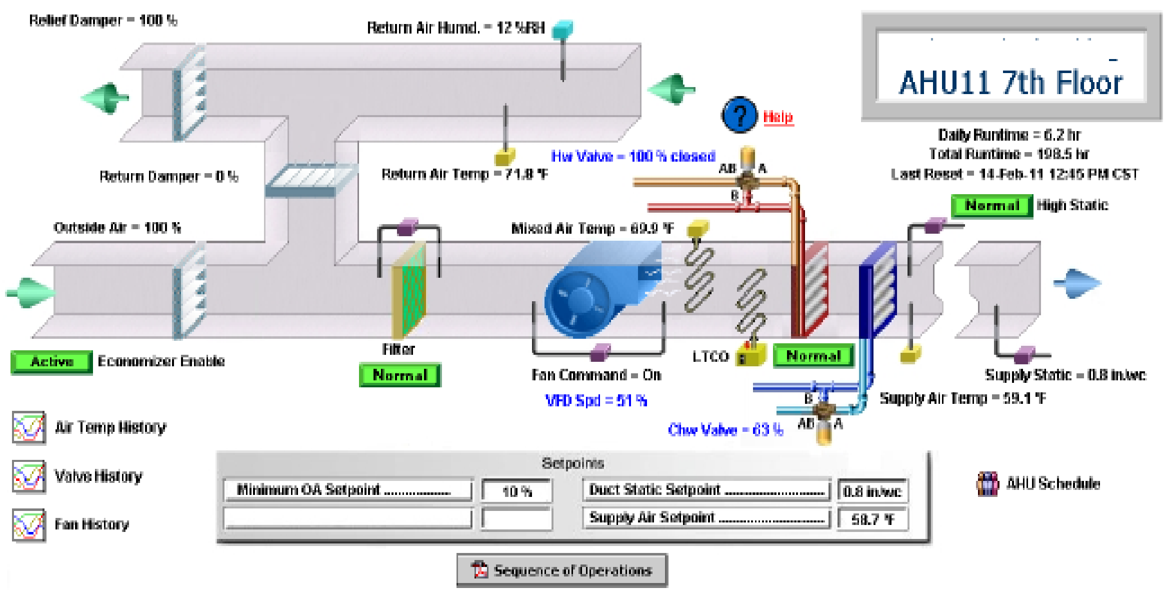
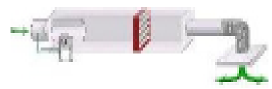


IMAGE C

VAV and other terminal boxes shall also be depicted and shall be able to navigate from either the floor plan drawing or the schedule. Each air handler graphics page shall have a navigable button to a VAV overview of all the devices served, as in the table shown in Image D.

VAVs

8th Floor Boxes Served By AHU-8



FPB

VAV Name	Room Name	Occ Cmnd	Space Temp	Effective SP	Setpoint Mode	Air Flow	Air Flow SP	HW Valve	Dmpr Position	Supply Temp
VAV_H5_64	Location H5	Occupied	70.9 °F	72.0 °F	Local	71 cfm	60 cfm	0 %	20 %	71.4 °F
VAV_H2_61	Location H2	Occupied	79.9 °F	72.0 °F	Local	248 cfm	250 cfm	0 %	30 %	72.5 °F
VAV_H2_64	Location H2	Occupied	70.7 °F	72.3 °F	Local	58 cfm	60 cfm	0 %	36 %	71.8 °F
VAV_H4_54	Location H4	Occupied	69.3 °F	70.0 °F	Local	62 cfm	60 cfm	66 %	21 %	71.9 °F
VAV_H2_53	Location H2	Occupied	74.3 °F	74.0 °F	Local	388 cfm	384 cfm	0 %	31 %	72.5 °F
VAV_H2_34	Location H2	Occupied	72.6 °F	73.7 °F	Local	62 cfm	60 cfm	0 %	24 %	72.3 °F
VAV_H4_15	Location H4	Occupied	74.2 °F	70.5 °F	Local	61 cfm	60 cfm	100 %	30 %	71.6 °F
VAV_G6_14	Location G6	Occupied	71.2 °F	73.6 °F	Local	62 cfm	60 cfm	0 %	18 %	72.3 °F
VAV_H1_22	Location H1	Occupied	74.2 °F	74.2 °F	Local	60 cfm	60 cfm	0 %	17 %	72.2 °F
VAV_H5_15	Location H5	Occupied	72.5 °F	72.8 °F	Local	98 cfm	94 cfm	0 %	48 %	72.3 °F
VAV_G5_24	Location G5	Occupied	74.2 °F	75.0 °F	Local	62 cfm	60 cfm	0 %	17 %	72.2 °F

IMAGE D

5.12.9.4 Sequences of operations: The design engineer in coordination with TFC, shall develop a detailed sequence of operations suitable for a building automation integrator / BAS programmer to develop control software for the facility. The design engineer shall require the BAS integrator to submit a detailed SOO back to the engineer and TFC for review prior to beginning any coding work.

5.12.9.5 Controls diagrams, points lists: The SOO, controls diagrams and points lists shall be developed and provided to TFC for review at the 100 percent design development phase, 50 percent construction document phase, and the 100 percent construction document phase. The SOO shall be fully integrated and coordinated with the MEP design documents. The sequences of operations ("SOO") for building systems shall, at a minimum, provide for the following.

5.12.9.5.1 Controls: The AHU control shall include all economizer and reset strategies. The terminal box control shall include all reset strategies. The Start/Stop and Fault handling of all motor driven loads such as fans, damper actuators, pumps and chillers shall include the following provisions: how the faults are detected; how the affected equipment is locked out; how the faults are cleared and reset; and the strategy for run time equalization. The control for steady state and dynamic operation of energized equipment shall address how the equipment capacity is modulated while in operational conditions. Define the process, manipulated variables and final control device(s). The SOO for normal versus economizer modes and for occupied versus unoccupied modes shall address how individual equipment modes of operation are the same or different and the transitions into and out of each mode. Provide for specific seasonal mode operations not covered elsewhere.

5.12.9.5.2 Reset strategies: Provide controls for all reset strategies including but not limited to supply air; duct distribution static pressure; condenser and CHW; morning warm up and cool down; CHW and CW static pressure; and outside air.

5.12.9.5.3 Control loops: Provide all control loops including but not limited to static and differential pressure; variable and constant volume control flow; temperature; and level. Address the TAB information used for final setpoint values.

5.12.9.5.4 Safety: All safety interfaces to the fire alarm and code-mandated shutdowns (e.g., refrigerant levels) shall be addressed, including high pressure shutdowns; high temperature shutdowns; low refrigerant cutoff; and low flow alarms.

5.12.9.5.5 **Monitoring:** All analog inputs shall examine upper and lower range bits to validate data representing the process variable. Control systems shall provide for discarding low-range data (open circuit) or high-range data (short circuit) and transitioning to the back-up sensor measurements without operator intervention. The sequence of systems shall be addressed, including but not limited to air distribution systems, CW systems, CHW systems, and hot water systems.

5.12.9.5.6 **Chiller Plant Operations:** The chillers, fans and pumping systems within the plant shall operate to maintain a variable thermal load year around. Options for scheduling the plant off during holidays and for equipment maintenance shall be provisioned for in the SOO. It is anticipated that any CHW pump, condenser water pump and cooling tower shall be able to operate with any combination of chillers. The operator shall be able to set the equipment staging sequences from the Niagara Supervisor UI and shall be able to take any individual equipment out of the staging rotation for the purpose of maintenance.

5.12.9.5.6.1 **Cyber Security**: The design engineer shall specify that all possible provisions for security be provided by the integrator. The following shall be addressed:

User account management including strong password requirements, prohibited sharing of user accounts, role-based access configuration (ex. Supervisor, senior operator, operator, etc.); and

Connections to the Internet are prohibited without expressed and written approval by TFC.

VPN for external access, switch port security, router ports closed that are not used, firewall implementation should be specified in coordination with existing TFC standards.

Cyber Security controls should match or exceed TFC's controls.

Each integrator must sign both a TFC Confidentiality Agreement and TFC Computer Security Agreement.

All payload transport shall use the default Niagara 4 encryption.

5.12.9.5.7 **Primary CHW Production:** The chillers shall be given a supply temperature setpoint via a BACNet/IP or MS/TP interface. The CHW supply temperature setpoint range shall be 42ºF to 46 ºF. When a chiller is enabled, the following sequence shall occur.

Verify the chiller local/remote control switch is set for remote.

CHW and condenser water isolation valves shall be slowly opened and position status verified by the BAS within a predetermined time delay.

The chiller shall be enabled by the BAS to operate at the CHW supply setpoint provided by the BAS.

The chiller shall be monitored for the run status feedback within a predetermined time delay.

A minimum of two chillers/pumps shall be operational at any given time.

Additional chillers shall be called for by performing a calculation for the CHW plant tonnage. This value is compared to a similar tonnage calculation for the secondary CHW loop. As the available plant production exceeds 90 percent capacity for a preset time delay, additional CHW production shall be enabled by the controller.

Primary CHW pumps shall control differential pressure across the parallel evaporator bundles of the chillers.

Pump interfaces shall be via the VFD. All control points such as the start / stop, status, general fault, HOA status and commanded speed output shall be hard-wired. All other parameters shall be via BACNet/IP communications protocol.

5.12.9.5.8 Condenser Water System Sequencing

5.12.9.5.8.1 A minimum of two pumps / cooling tower fans shall be operational at any given time.

5.12.9.5.8.2 Cooling tower fans and the cooling tower bypass control valve shall modulate in sequence beginning with the bypass valve and continuing the successive stages to add heat rejection capacity. The cooling tower fans and bypass valve shall modulate to maintain a constant condenser water supply temperature to the chillers.

5.12.9.5.8.3 Condenser water supply temperature reset schedule.

5.12.9.5.8.4 Condenser water pumps shall control differential pressure across the parallel condenser bundles of the chillers.

5.12.9.5.8.5 Pump and cooling tower fan interfaces shall be via the variable frequency drive. All control points such as the start / stop, status, general fault, HOA status and commanded speed output shall be hard wired. All other parameters shall be via BACNet/IP communications protocol.

5.12.9.5.9 Secondary CHW Distribution Loop: The secondary CHW distribution loop is comprised of secondary CHW pumps that move CHW to the buildings for consumption. To maintain CHW differential pressure controllability and as high a differential temperature as possible, each building shall have a CHW heat exchanger to separate the secondary CHW from the tertiary CHW distributed throughout the building.

5.12.9.5.9.1 Secondary CHW pumps shall control differential pressure across the secondary CHW loop by monitoring in several locations and controlling from the worst case. PID setpoint reset strategies via IP-based communications shall be used to reset the local differential pressure setpoint.

5.12.9.5.9.2 Pump interfaces shall be via the variable frequency drive. All control points such as the start / stop, status, general fault, HOA status and commanded speed output shall be hard wired. All other parameters shall be via BACNet/IP communications protocol

5.12.9.5.9.3 A minimum of two pumps must be operational at any time.

5.12.9.5.9.4 The secondary loop tonnage calculation shall be performed based on flow and differential temperature to be compared with the production tonnage calculation.

5.12.9.5.9.5 Within each building mechanical space, two (2) heat exchangers shall provide CHW isolation. A CHW valve located in the primary, leaving water side shall be modulated to provide a constant 14ºF differential temperature on the primary side.

5.12.9.5.10 Building Tertiary CHW Distribution Loop: The tertiary CHW distribution loop is comprised of building CHW pumps that move CHW within the buildings from the heat exchangers to the air handling units. Each building will have a CHW heat exchanger to separate the secondary CHW from the tertiary CHW distributed throughout the building.

5.12.9.5.10.1 Secondary CHW pumps shall control differential pressure across the secondary CHW loop by monitoring in several locations and controlling from the worst case. PID setpoint reset strategies via IP based communications shall be used to reset the local differential pressure setpoint.

5.12.9.5.10.2 Pump interfaces shall be via the variable frequency drive. All control points such as the start / stop, status, general fault, HOA status and commanded speed output shall be hard wired. All other parameters shall be via BACNet/IP communications protocol.

5.12.9.5.10.3 A minimum of two pumps must be operational at any time.

5.12.9.5.10.4 The secondary loop tonnage calculation shall be performed based on flow and differential temperature to be compared with the production tonnage calculation.

5.12.9.5.10.5 Within each building mechanical space, a heat exchanger shall provide CHW isolation. A CHW valve located in the primary, leaving water side shall be modulated to provide a constant 14ºF differential temperature on the primary side.

5.12.9.6 Air Handling Operations

5.12.9.6.1 Air handling systems shall generally have the following operational characteristics:

Occupancy schedule;

Unoccupied night setback features with morning warm-up as appropriate;

Local override of the thermostat setpoint within the range of 68ºF to 75ºF;

Duct static pressure and supply air temperature reset based on VAV box inlet damper position or flow capacity;

Interface with fire alarm;

Variable flow control based on downstream duct static pressure;

Return air, relief air and outside air dampers for air side economizer mode operation; and

Demand ventilation control when not in air-side economizer mode by measuring CO_2 concentration in return air. The mechanical EOR may consider placing CO_2 sensors in high density spaces such as conference rooms in lieu of measuring CO_2 in the main return ducts, which may be diluted.

Each hydronic coil shall have an electrically actuated control valve for modulating the manipulated variable and controlling the process variable to the appropriate setpoint.

5.12.9.7 Graphical interface programming: TFC will provide log-in credentials to qualified contractors to upload graphical screens and configuration data. Such work shall be closely coordinated with the TFC BAS group; no system may be considered "live" until commissioning is complete and accepted by TFC.

5.12.9.8 Communications: Communications requirements for the BAS shall be provided to the telecommunications engineer for incorporation into the Division 27 documentation, including locations of TOs, quantities, and any special bandwidth requirements. The Division 25 contractor shall be responsible for providing TO locations within 3 meters of the field controllers and shall provide a 2- gauge, stranded, CAT 5e minimum work area cable.

5.12.9.9 Wireless communications: Wireless communications and sensors may be acceptable on a project-by-project basis. Acceptable protocols include IEEE 802.15.4 base standard (Zigbee or Zigbee/IP) Wi-Fi access points, but any wireless design must be approved by TFC prior to design implementation.

5.12.9.10 Consumption management monitoring: All utilities that enter a building shall be monitored for consumption management, including electrical consumption and demand, domestic water consumption, natural gas, CHW, and hot water if purchased from district heating and cooling distributions.

5.12.10 Energy Conservation Strategies: Where possible, specify economically justifiable energy conservation strategies at the control or field level and shall be implemented on the field level to the greatest extent possible.

5.12.10.1 Demand-Controlled Ventilation: Consider demand-controlled ventilation in lieu of ASHRAE CFM minimums in areas for which its use is shown to be economically feasible.

5.12.10.2 An air-side economizer shall be considered wherever feasible.

5.12.10.3 Preference shall be given to variable volume AHU duct pressure reset based on VAV box inlet damper positions.

5.12.10.4 Variable volume AHU supply air temperature reset shall be based on VAV box inlet damper positions when the AHU is running at minimum system speed.

5.12.10.5 Building hot water reset shall be based on the outside air temperature reset schedule.

5.12.10.6 Night setback, morning warm up: Implement night setback and morning warm-up for occupied and unoccupied modes and other strategies as appropriate. Refer to Appendix B as a guideline for typical I/O requirements. This Appendix should be used as a guide to the engineer for establishing the appropriate level of monitoring and control of HVAC equipment in a typical office building.

5.13 **Surveillance and Access Control Systems**

5.13.1 Description: The security infrastructure design shall be based on TFC standards, building user input, and the specific program requirements for the building(s). TFC representatives must all be included in all reviews related to door hardware.

5.13.2 Electronic access control: All building entries shall have a door locking system that uses an access card as the access credential in addition to a keyed, mechanical override in case of power failure. The typical system shall include electric door-locking mechanisms, card reader adjacent to the door, door status sensor, and door prop alarm device. Typical system configuration is card- or schedule-controlled entry with free exiting.

All rooms that house telecommunications equipment, servers, HVAC equipment, or electrical equipment shall be protected by electronic access control. At a minimum, provide electronic access control at each entry to a tenant agency suite, at each building entry, at all elevator cabs for each served floor, and at each egress-stair re-entry point.

5.13.3 Intrusion detection system: Provide a system to monitor areas for any unauthorized entrance or intruder. The system may consist of PTZ surveillance cameras, motion sensors, door status sensors, glass break sensors and one or more control keypads. A keypad may be used to arm or disarm system by entering a numeric code.

5.13.4 Duress button: Provide duress buttons, also known as panic buttons, at locations where potential personal safety or security threats exist. Depressing the button shall send a silent priority alarm signal with location and specific alarm information to DPS or the local police department with authority to respond. Hard-wired devices are preferred and recommended. The panic button shall typically be located in the knee space underneath a desk or service counter.

5.13.5 Emergency call station: Provide emergency call stations at a minimum at parking lots, exterior spaces intended for use or circulation, and any other remote area where personal safety may be a reasonable concern. Each emergency call station shall be a distinct box or pole with a call button, “Emergency” signage, and a blue locator lamp. Depressing the call button shall put the individual in direct voice contact with either DPS, a security officer in a 24/7 operated security office, or the local police department, along with specific location information. These can be interior or exterior installations. The duress phone system may either utilize PBX lines or interconnect with the building intercom. Duress phones and cameras shall have a descriptor so that when a device is activated, the persons monitoring the system will know its exact location, e.g.: Campus – Building ID – Floor/Level – Area – Device type.

5.13.6 Surveillance: Surveillance cameras shall be located to provide situational awareness throughout the building(s) for forensic review and alarm assessment. The system shall provide electronic surveillance using high-resolution IP cameras to monitor security-sensitive areas for alarm assessment and forensic investigations.

In buildings subject to these Requirements, provide views of activity and people at all building entries, elevator cabs, elevator lobbies, common ground-floor lobbies, stairs, and loading docks with sufficient resolution to personally identify actors within the space. Provide views of the roof(s). Provide cameras to record based on detection of motion or detection of an alarm in the area. Provide digital storage capacity to ensure video images will be available for 90 days based on reasonable estimates of activity in the facility.

5.13.6.1 Video surveillance network IP cameras: The VCS system shall perform the following functions: maximize the use of auto-target tracking and analytics; relieve and support law enforcement personnel (“LEP”) by the use of analytics; notify LEP of abnormal conditions using techniques such as virtual fencing; create interlocking fields of view at the building exterior; track people and objects using multiple cameras; and alert law enforcement to breaches and excessive loitering outside the facility. The VCS system may also consider: providing additional forensic analytical capabilities; use high-resolution cameras to minimize camera quantity; minimize direct LEP observational requirements; interface and communicate with the intrusion detection system; and maintain constant observation of emergency duress and blue telephone systems. The Basis of Design for security system software is to be S2 VrX software for the cameras. Mounting height for all cameras should be approximately 12 feet. Any variations must be approved by TFC Director of Security.

5.13.6.2 **VCS capabilities:** The VCS shall have geospatial capability and intelligence for fixing the location of a security related event and vectoring the LEP response to the security event. It is recommended that the VCS stream IP data to a network video recorder and shall encode and transmit video data using H.264 / MPEG-4 Part 10 embedded codec with profile and level settings sufficient for forensic analysis.

5.13.6.3 **Exterior VCS:** An exterior VCS shall be specified with back-light compensation and day / night capability with auto switch over, including viewing in the near-IR spectrum. If supplemental IR illumination is required, it shall be LED lamped.

5.13.6.4 Duress phones and cameras shall have a descriptor so that when a device is activated, the persons monitoring the system will know its exact location, e.g.: Campus – Building ID – Floor/Level – Area – Device type.

5.13.7 **Lockdown control:** For spaces or areas designated by TFC, provide a system that will lock all exterior doors on command during an emergency.

5.13.8 **Parking structure:** At each parking structure entry and exit, provide for identification of vehicles entering and exiting the site with sufficient camera resolution to view license plates. At each parking structure entry, provide for RFID device access control. Provide high-resolution camera surveillance in all parking structure elevator lobbies, and stairs. For areas in parking structures that may accessed by the public, visitors, or third-party customers, consider the use of gated zones to sequester credentialed State agency employees. Radio relays shall be provided for underground parking structures to ensure adequate communication coverage for DPS personnel.

5.13.9 **Emergency command centers:** Design of data systems for monitoring and control of security equipment shall be coordinated with TFC and DPS, with particular attention to integration with the ECCs. Throughout the Capitol Complex, TFC will operate emergency command centers ("ECC"). Each ECC will be capable of "three-level watch" surveillance: the street level, building entries, and building interiors and security-sensitive areas. The ECCs may or may not be located within the envelopes of buildings subject to these Requirements. The monitoring room specifications will be coordinated with TFC and DPS.

5.13.10 **Security-sensitive tenant agencies:** A tenant agency that receives, holds, or keeps cash or firearms on its premises, within a building subject to these Requirements, shall be considered to be located in a security-sensitive area. Certain high-value tenant agency employees may be considered high-value, and their workspaces within a tenant agency's space may be security-sensitive.

5.13.11 **Sub-systems:** Provide design and coordination for electronic security infrastructure sub-systems including spaces, pathways, and security device wiring requirements. Security cabling terminations shall be in wall-mounted panels or rack mounted equipment. System grounding and bonding will be to a single reference point.

5.13.12 **Security connectivity:** The security cabling system standard shall be a minimum of 4 conductors to each device and a minimum of 8 conductors to card readers. All security device wiring shall be home run from the head end panels (point of termination) to the security device location (point of origin). Network surveillance video shall be run from the cameras (point of origin) to the head end equipment on a cabling distance basis.

5.13.13 Compatibility: The access control (S2) and video surveillance (VRx) systems shall be compatible with and connected to existing TFC systems as required for optimum functionality. Building infrastructure shall be designed with pathways, physical locations, and spaces that shall support state-of-the-art security applications.

5.13.14 Risk and hazard assessment: A risk and hazard assessment shall be based upon information and data provided by DPS and TFC. The threats considered in this assessment include those criminal and accidental threats that may cause physical injury to occupants and damage to the building(s). The assessment will identify threats to the safety and security of occupants and operation of the building(s) and will provide reasonable and prudent recommendations to mitigate identified threats. Identified threats will serve as the basis for development of a list of risks, based upon threat probability and threat impact, and will be used to develop a risk assessment. Refer to sections 5.13.17 and 5.13.18 below, accordingly. Mitigation recommendations shall be prepared that address identified threats, including threats related to natural disasters, power grid failures, and other *forces majeures*. If specific tenant agencies have not been identified at the time of solicitation issuance, it may be assumed that tenant-agency occupied areas have moderate risk assessment.

5.13.15 Terrorism: The risk assessment shall include consideration of the building's symbolic or iconic terrorism value and whether it is an attractive target in that regard. If the building has inherent political or social terrorism value, i.e., it houses politically sensitive or controversial organizations, the building may be an attractive terrorism target, and the security system shall be designed to mitigate the related risks

5.13.16 Criminal activity: Criminal activity includes LEP-reported activity and statistics, including the records of DPS, Austin Police Department, and other law enforcement agencies or organizations with enforcement authority within or near the building.

5.13.17 Threat probability: The probabilities of different kinds of threats shall be categorized according to the following examples of "low," "moderate" and "high" probabilities. These are lists of example threats and not intended to be exhaustive.

5.13.17.1 Low: non-local terrorism attack, bomb threat, weapons threat, major fire, explosion, hostage situation, homicide, or suicide.

5.13.17.2 Moderate: minor fire, vandalism, stalking, or assault and/or battery.

5.13.17.3 High: public intoxication, driving while intoxicated, drug offense, domestic dispute, suspicious activity, criminal trespass, or criminal mischief.

5.13.18 Threat impact: The impacts of different kinds of threats shall be categorized according to the following examples of "low," "moderate" and "major." These are lists of example impacts and not intended to be exhaustive.

5.13.18.1 Low: non-local terrorism or minor fire.

5.13.18.2 Moderate: bomb threat, weapons threat, vandalism, public intoxication, driving while intoxicated, drug offense, domestic dispute, suspicious activity, criminal trespass, or criminal mischief.

5.13.18.3 Major: local terrorism, major fire, explosion, hostage situation, homicide, suicide, stalking, or assault and/or battery.

5.13.19 Vulnerability to threat: The threat impact shall be defined by the following descriptions of low, moderate, and major impacts.

5.13.19.1 Low: The facility sustains damage to up to 5 percent of its usable area. Critical infrastructure is unaffected. There are no breaches of the exterior building envelope. There are minor injuries to fewer than 2 persons. Limited facility closure to repair the damaged areas is not required. Facility assets are unaffected.

5.13.19.2 Moderate: The facility sustains damage to up to 20 percent of its usable area. Critical infrastructure sustains moderate damage and is partially inoperable. There are there are no breaches of the exterior building envelope. There are minor to moderate injuries to fewer than 25 persons. Limited facility closure to repair the damaged areas is required for up to one month. Facility assets must be relocated to remote facilities while repairs are completed.

5.13.19.3 Major: The facility sustains damaged to greater than 50 percent of its usable area. Critical infrastructure is severely damaged and inoperable. There are breaches of the exterior building envelope and smoke, impact, or fi re damage to the interior. There are moderate to severe injuries to fewer than 50 personnel; fatal injuries to fewer than 5 personnel. Many facility assets are damaged beyond repair, but the facility structure remains intact. Substantial facility closure is required, with the entire facility closed for up to two weeks, and a portion of the facility closed for an extended period of time greater than one month. Facility assets will require relocation to remote facilities to protect them from environmental damage while repairs are completed.

5.13.20 Protection tiers: At the site boundary or building exterior perimeter, territorial reinforcement in the form of a defined visual or tactile transition between public space and the building shall deter unwelcome visitors who do not belong at the facility. At each boundary or at select boundaries, e.g., at the site or building perimeter, an intervention zone shall provide an opportunity to view and delay a visitor to confirm identity. Visitors without authority to proceed to the next boundary may be turned away. If an unauthorized visitor attempts to breach the intervention zone, technical security measures shall prevent access beyond the intervention zone.

5.13.21 Lighting: Lighting is an important element of crime prevention through environmental design ("CPTED") and plays an important role in deterring crimes, maintaining a safe environment inside and around the building, and reinforcing territorial boundaries. Appropriate lighting is important for discouraging potential intruders and helping security personnel to view, identify and respond to security situations. Adequate lighting shall be provided at the site perimeter, vehicle and pedestrian entrances, pedestrian walkways, perimeter(s) of buildings(s); service, shipping and receiving areas; and interior lobbies, corridors, and walkways, using Dark-Sky-compliant LED fixtures and limiting light trespass along site boundaries. The following tables are based upon IESNA recommendations.

Light fixtures appurtenant to security cameras shall have adequate CRI to ensure highest possible fidelity video recording.

Exterior Lighting

Application	FC	Lux	Uniformity (Max:Min)
Building entrances	5	50	
Building exits	1	10	
Shipping/receiving areas	20	200	
Buildings surroundings	1	10	
Walkways	1.5	15	
Roadways	0.5	5	
Landscaped areas	0.5	5	
Surface parking	3	30	10:1
Covered parking	3	30	10:1

Interior Lighting

Application	FC	Lux	Uniformity (Max:Min)
Elevators	10	100	
Lobbies	5	50	
Stairways	10	100	

Building entrance exterior light levels should meet or exceed entry vestibule interior light levels to eliminate reflected light on interior windows or glass doors that face the building entrance.

5.13.22 Flexibility: The security design shall be flexible so the building(s) may escalate and harden the security posture in response to an elevated threat environment. For example, in the event of a local terrorism threat, the building shall have the flexibility to respond by closing the site to inbound vehicle traffic and to secure exterior perimeter doors remotely.

5.14 **Operation and Maintenance Requirements**

5.14.1 Commissioning ("Cx"): Minimum commissioning requirements shall be provided in the Project specifications. At a minimum, commissioning shall be performed for mechanical, electrical, plumbing, fire, controls, and security systems. The minimum requirements shall be similar to "Enhanced Commissioning" as prescribed by the USGBC / LEED BD+C Manual. Provide a general commissioning specification as well as a specific commissioning specification for each division or trade that will be commissioned.

5.14.2 Building enclosure commissioning ("BECx"): A building enclosure commissioning process shall be developed and implemented in accordance with NIBS Guideline 3, based on individual project requirements and BOD. The BECx process shall be developed in coordination with TFC and with attention to the control of moisture and condensation; heat and water vapor flow; noise and vibration; ultraviolet radiation; durability and resiliency; security; constructability; and maintainability.

5.14.3 Cx authority: The Cx Authority who will administer the Cx process shall be identified and retained by TFC no later than the end of the Programming phase. Incorporate the Cx Authority's input into the design to provide the best value for the scope.

5.14.4 Test procedures: The Cx Authority shall provide performance and functional test procedures for all installed systems and integrated systems no later than the submittal of final Construction Documents. Coordinate fire protection, fire alarm, mass notification, and smoke management systems testing requirements. Avoid testing during noise-sensitive times. Third party testing is required on all Fire and Life Safety Systems. AHJ will perform quality control testing after completion of third party commissioning and certification.

5.14.5 Ongoing Cx plan: A final Cx plan and report shall be provided in the closeout documentation. Should future renovations or remodeling in the base building occur, the Cx plan shall be reviewed and edited to document all coordination required, including performance and functional test procedures. The Cx authority will be identified for each successive renovation.

5.14.6 Test, adjust, and balance ("TAB"): Preliminary TAB equipment data shall be provided prior to performance testing. Equipment labels shall be installed prior to final completion.

5.14.7 Above-ceiling elements. All above-ceiling elements and light fixtures shall be located so they are accessible with an 8-foot ladder. Such items shall be coordinated with furniture placement, door swings, and egress routes. Equipment replacement or relocation shall generally not require demolition. Any equipment replacement path that requires minor demolition shall be disclosed to and coordinated with TFC during design.

5.14.8 Mechanical rooms: Provide access for delivery of equipment and maintenance accessories to main Mechanical Rooms where practical. Major pieces of mechanical system equipment (e.g., AHUs and RTUs) shall be located such that ease of access for maintenance and a pathway for removal for replacement are preserved. Equipment replacement or relocation shall generally not require demolition of interior or exterior walls. Major equipment replacement may require minor demolition at interior or exterior walls; that eventuality shall be disclosed to and coordinated with TFC during the design phases. Provide at least 1-1/2 times the minimum recommended or code-required clearance around all major equipment.

5.14.9 O&M Manuals: Provide submittals and O&M Manuals in a format that can be searched by equipment ID ("EQID"). Product warranties for finishes shall not be limited to specific, brand-name cleaning products. An ongoing preventative maintenance plan and schedule for item replacement and checkup shall be included in the O&M Manual.

5.14.10 Durability: Architectural elements should be designed so they are easy to clean and maintain and avoid catching dust. Provide interior finish products that are durable, hardworking, and that can be washed without ruining them. Mechanical and electrical room floors and housekeeping pads and exposed concrete floors beneath raised floor systems shall be sealed to prevent dusting. CMU walls in such areas shall be painted.

5.14.11 Custodial operations: Provide space for custodial services in Project building(s), commensurate with project size, scope and function. Locate one custodial closet near each pair/set of toilet rooms where practical. Provide a minimum of 50 sf of space per custodial closet. A minimum of 1 custodial closet must be located on each floor of a building. The closet must contain a floor mounted mop sink and a floor drain. Locate custodial closet(s) so they can be directly accessed from a corridor or public space, without passing through an intervening room. Provide electrical outlets in public circulation spaces at a maximum spacing of 75 feet to accommodate custodial operations, circuited separately with rugged grade outlets. Coordinate outlet locations with ergonomics, building space function, and aesthetics in mind. Provide a direct path that allows rolling carts to be moved between service areas and dumpsters.

5.14.12 miniMAX Program: TFC has implemented a recycling program, miniMAX, that entails each employee using a miniature trash receptacle (“mini-bin”) at their deskside as well as a deskside recycling bin. Employees empty their own mini-bins and recycling bins at central collection stations rather than relying on custodial staff. The building design shall accommodate conveniently located collection stations for the miniMAX program use.

5.14.13 Window Washing: Provide capability for cost effective exterior window washing. Provide exterior wall hydrants for cleaning and verify the spacing requirements, and identify the design of window washing equipment required.

5.14.14 Warranty: Define maintenance and equipment warranty requirements and periods, including start dates during design. For fire and life safety systems, equipment under warranty shall be checked at least once during the warranty period to confirm proper functioning.

5.15 **Construction Requirements**

5.15.1 Refer to the most recently published version of the TFC Uniform General Conditions for Construction Contracts for a detailed review of contractors' minimum responsibilities under a TFC contract for construction.

5.15.2 Prevent dust infiltration from construction area to non-construction areas during deconstruction, site preparation and construction activities. Coordinate construction activities with area events, known deadlines or heavy public use. Coordinate sequence of work to minimize disruption to occupants. Hazardous material abatement, if required, must occur prior to deconstruction. Provide daily clean-up of work areas.

5.15.3 Pre-occupancy and post-occupancy indoor air quality plans shall be implemented.

5.15.4 Coordinate construction staging, access, deconstruction, and discard removal to minimize conflicts with adjacent facilities and pedestrian ways. Manage and secure contractor's lay-down area to avoid access and use by unauthorized persons. Provide crane or other lifting devices for all equipment over 500 pounds during construction.

5.15.5 Coordinate parking requirements and street closures with city, county or State authorities as needed. Provide dedicated path(s) and method for removal of demolition materials and installation of new equipment. Provide emergency vehicle access during construction. Request approval of and schedule storm water and sanitary sewer discharge activities at least five days ahead of planned activity.

5.15.6 Maintain a secure facility at all times during construction. Provide interim life safety requirements, including exiting, fire extinguishers, etc., during the complete duration of construction activities.

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Appendix A: TFC Building Name Codes

Code	Building	Code	Building
OFFICE		PARKING/GARAGES	
ARC	Lorenzo de Zavala Archives & Library	PKA	Parking Garage A
BHB	Brown-Heatly Building	PKB	Parking Garage B
CSB	Central Services Building	PKC	Parking Garage C
CSX	Central Services Annex	PKE	Parking Garage E
CUB	Credit Union Building	PKF	Parking Garage F
DARS	DARS Administration Building	PKG	Parking Garage G
DHB	DSHS Headquarters Building (Old MHMR HQ)	PKH	Parking Garage H
DHF	DSHS Building F	PKHW	Parking Garage H West
DHG	DSHS Building G	PKJ	Parking Garage J
DHK	DSHS Building K	PKK	Parking Garage K Thomas J. Rusk Bldg.
DHR	DSHS Records Building	PKL	Parking Garage L William P Hobby Bldg.
DHSB	DSHS Service Building	PKM1	Parking Garage M1 Price Daniel Bldg.
DHT	DSHS Tower	PKM2	Parking Garage M2 Tom C Clark Bldg.
DHX	DSHS Annex (Old MHMR Annex)	PKN	Parking Garage N
ELP	El Paso State Office Building	PKP	Parking Garage P
ERB	Elias Ramirez State Building	PKQ	Parking Garage Q
FTW	Fort Worth State Building	PKR	Parking Garage R
GJS	G.J. Sutton Building	EPG	El Paso State Building Garage
GJSW	G.J. Sutton Building West	PK02	Parking Lot 2
INS	Insurance Building	PK03	Parking Lot 3
INX	Insurance Annex	PK06	Parking Lot 6
JER	James E. Rudder Building	PK07	Parking Lot 7
JHR	John H. Reagan Building	PK08	Parking Lot 8
JHW	John H. Winters Building	PK8A	Parking Lot 8A
LBJ	Lyndon B. Johnson Building	PK8B	Parking Lot 8B
P35A	Park 35 Building A	PK11	Parking Lot 11
P35B	Park 35 Building B	PK12	Parking Lot 12
Code	Building	Code	Building
OFFICE		PARKING/GARAGES	
P35C	Park 35 Building C	PK14	Parking Lot 14
P35D	Park 35 Building D	PK15	Parking Lot 15
P35E	Park 35 Building E	PK18	Parking Lot 18

PDB	Price Daniel, Sr. Building	**PK19**	Parking Lot 19
RDM	Robert D. Moreton Bldg. DSHS Campus	**PK22**	Parking Lot 22
REJ	Robert E. Johnson Building	**PK24**	Parking Lot 24
SCB	Supreme Court Building	**PK25**	Parking Lot 25
SFA	Stephen F. Austin Building	**PK26**	Parking Lot 26
SFB	State Finance Building	**PK27**	Parking Lot 27
SHB	Sam Houston Building	**PK28**	Parking Lot 28
TCC	Tom C. Clark Building	**CUBP**	Credit Union Building Parking Lot
THO	E. O. Thompson Building	**DHP**	DSHS Parking Lots
TJR	Thomas Jefferson Rusk Building.	**ELPP**	El Paso State Building Parking Lot
TRC	Carlos F. Truan Natural Resource Center	**ERBP**	Elias Ramirez Building Parking Lots
TYL	Tyler State Office Building	**FTWBP**	Fort Worth Building Parking Lots
WAC	Waco State Building	**GJSP**	G. J. Sutton Building Parking Lots
WBT	William B. Travis Building	**HSWP**	Human Services Warehouse/DROC Parking Lots
WPC	William P. Clements Building	**P35P**	Park 35 Parking Lots
WPH1	William P. Hobby Building Twr. I	**PROMP**	Promontory Point Parking Lots
WPH2	William P. Hobby Building Twr. II	**SFBP**	State Finance Building Parking Lot
WPH3	William P. Hobby Building Twr. III	**SRCP**	State Records Center Parking Lots
DBGL	DSHS New Lab Building		
WAREHOUSE		**SUR1P**	Surplus Property, San Antonio Parking Lot/Storage
DHH	DSHS Building H	**SUR2P**	Surplus Property, Fort Worth Parking Lot/Storage
HSW	Human Services Warehouse	**SUR3P**	Surplus Property, West Texas Parking Lot/Storage
INW	Insurance Warehouse	**SUR4P**	Surplus Property, Houston Parking Lot/Storage
SRC	State Records Center	**TYLP**	Tyler State Parking Lot
SUR1	Surplus Property, San Antonio	**WHBP**	Warehouse at Bolm Road Parking
SUR2	Surplus Property, Fort Worth District	**WSBP**	Waco State Building Parking Lots

Appendix B: Guidelines for Typical BAS or I/O Points Matrix

NON-CRITICAL BYPASS VFD

NON-CRITICAL BYPASS VFD

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
START/STOP	VFD								X		ON	ON	X	X	X			X		
VFD HOA STATUS	VFD							X					X	X	X			X	X	
VFD SPEED COMMAND	VFD						X				LAST	LAST		X	X		Hz	X		
MOTOR RPM FEEDBACK	VFD					X									X		RPM			
VFD FREQUENCY FEEDBACK	VFD					X								X	X		Hz	X	X	
VFD FAULT STATUS	VFD							X						X	X			X	X	
VFD LAST FAULT	VFD					X									X			X		
VFD PREVIOUS FAULT 1	VFD					X									X			X		
VFD PREVIOUS FAULT 2	VFD					X									X			X		
VFD ALARM STATUS	VFD							X						X	X			X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X		
VFD OUTPUT CURRENT	VFD					X									X		AMPS	X		
VFD OUTPUT TORQUE	VFD					X									X		%	X	X	
VFD POWER	VFD					X									X		kW	X		
VFD DC BUS VOLTAGE	VFD					X									X		VDC	X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X	X	
VFD ENERGY CONSUMED	VFD					X									X		kWh	X		
VFD RUNTIME	VFD					X											HRS	X		
VFD DRIVE TEMPERATURE	VFD					X									X		F	X	X	
BYPASS SELECT	BYPASS								X											
BYPASS HOA STATUS	BYPASS							X					X	X	X			X	X	
BYPASS FAULT STATUS	BYPASS							X						X	X			X	X	
BYPASS LAST FAULT	BYPASS					X									X			X		
BYPASS PREVIOUS FAULT 1	BYPASS					X									X			X		
BYPASS PREVIOUS FAULT 2	BYPASS					X									X			X		
BYPASS CURRENT	BYPASS					X									X		A	X		
BYPASS RUNTIME	BYPASS					X											HRS	X		
BYPASS INPUT VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS PHASE AB VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS PHASE BC VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS PHASE CA VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS ENERGY CONSUMED	BYPASS					X									X		kWh	X		
BYPASS TEMPERATURE	BYPASS					X									X		F	X	X	

NON-CRITICAL NON-BYPASS VFD

NON-CRITICAL NON-BYPASS VFC

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
START/STOP	VFD								X		ON	ON	X	X	X			X		
VFD HOA STATUS	VFD							X					X	X	X			X	X	
VFD SPEED COMMAND	VFD						X				LAST	LAST		X	X		Hz	X		
MOTOR RPM FEEDBACK	VFD					X									X		RPM			
VFD FREQUENCY FEEDBACK	VFD					X								X	X		Hz	X	X	
VFD FAULT STATUS	VFD							X						X	X			X	X	
VFD LAST FAULT	VFD					X									X			X		
VFD PREVIOUS FAULT 1	VFD					X									X			X		
VFD PREVIOUS FAULT 2	VFD					X									X			X		
VFD ALARM STATUS	VFD							X						X	X			X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X		
VFD OUTPUT CURRENT	VFD					X									X		AMPS	X		
VFD OUTPUT TORQUE	VFD					X									X		%	X	X	
VFD POWER	VFD					X									X		kW	X		
VFD DC BUS VOLTAGE	VFD					X									X		VDC	X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X	X	
VFD ENERGY CONSUMED	VFD					X									X		kWh	X		
VFD RUNTIME	VFD					X											HRS	X		
VFD DRIVE TEMPERATURE	VFD					X									X		F	X	X	

CRITICAL BYPASS VFD

POINT NAME	FIELD DEVICE	POINT TYPE: PHYSICAL AI	PHYSICAL AO	PHYSICAL BI	PHYSICAL BO	NETWORK AI	NETWORK AO	NETWORK BI	NETWORK BO	CALCULATED/ USER DEFINED	FAIL POSITION/ STATUS: LOSS OF CTRL POWER	LOSS OF SIGNAL	GRAPHICS: FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS	TRENDING	ALARM	NOTES
START/STOP	XS1				X						ON	ON	X	X	X			1		8, 10
VFD HOA STATUS	VFD							X					X	X	X			1	1	4
VFD SPEED COMMAND	SC1		X								60	60		X	X		Hz	4		8, 10
MOTOR RPM FEEDBACK	VFD					X									X		RPM			
VFD FREQUENCY FEEDBACK	VFD					X								X	X		Hz	X	5, 6, 24	
VFD FAULT STATUS	ALM1			X										X	X			X	1	8, 10
VFD LAST FAULT	VFD					X									X			X		25
VFD PREVIOUS FAULT 1	VFD					X									X			X		25
VFD PREVIOUS FAULT 2	VFD					X									X			X		25
VFD ALARM STATUS	VFD							X						X	X			X	1	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X		
VFD OUTPUT CURRENT	VFD					X									X		AMPS	X		
VFD OUTPUT TORQUE	VFD					X									X		%	X	X	
VFD POWER	VFD					X									X		kW	X		
VFD DC BUS VOLTAGE	VFD					X									X		VDC	X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X	X	
VFD ENERGY CONSUMED	VFD					X									X		kWh	X		
VFD RUNTIME	VFD					X											HRS	X		
VFD DRIVE TEMPERATURE	VFD					X									X		F	X	X	
BYPASS SELECT	XS2				X															
BYPASS HOA STATUS	BYPASS							X					X	X	X			X	X	
BYPASS FAULT STATUS	ALM2			X										X	X			X	X	
BYPASS LAST FAULT	BYPASS					X									X			X		
BYPASS PREVIOUS FAULT 1	BYPASS					X									X			X		
BYPASS PREVIOUS FAULT 2	BYPASS					X									X			X		
BYPASS CURRENT	BYPASS					X									X		A	X		
BYPASS RUNTIME	BYPASS					X											HRS	X		
BYPASS INPUT VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS PHASE AB VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS PHASE BC VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS PHASE CA VOLTAGE	BYPASS					X									X	480	VAC	X	X	
BYPASS ENERGY CONSUMED	BYPASS					X									X		kWh	X		
BYPASS TEMPERATURE	BYPASS					X									X		F	X	X	

CRITICAL BYPASS VFD

CRITICAL NON-BYPASS VFD

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
START/STOP	XS1				X						ON	ON	X	X	X			X		
VFD HOA STATUS	VFD							X					X	X	X			X	X	
VFD SPEED COMMAND	SC1		X								60	60		X	X		Hz	X		
MOTOR RPM FEEDBACK	VFD					X									X		RPM			
VFD FREQUENCY FEEDBACK	VFD					X								X	X		Hz	X	X	
VFD FAULT STATUS	ALM1			X										X	X			X	X	
VFD LAST FAULT	VFD					X									X			X		
VFD PREVIOUS FAULT 1	VFD					X									X			X		
VFD PREVIOUS FAULT 2	VFD					X									X			X		
VFD ALARM STATUS	VFD							X						X	X			X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X		
VFD OUTPUT CURRENT	VFD					X									X		AMPS	X		
VFD OUTPUT TORQUE	VFD					X									X		%	X	X	
VFD POWER	VFD					X									X		kW	X		
VFD DC BUS VOLTAGE	VFD					X									X		VDC	X	X	
VFD OUTPUT VOLTAGE	VFD					X									X		VAC	X	X	
VFD ENERGY CONSUMED	VFD					X									X		kWh	X		
VFD RUNTIME	VFD					X											HRS	X		
VFD DRIVE TEMPERATURE	VFD					X									X		F	X	X	

HEAT EXCHANGER

POINT NAME	FIELD DEVICE	POINT TYPE: PHYSICAL AI	PHYSICAL AO	PHYSICAL BI	PHYSICAL BO	NETWORK AI	NETWORK AO	NETWORK BI	NETWORK BO	CALCULATED/ USER DEFINED	FAIL POSITION/ STATUS: LOSS OF CTRL POWER	LOSS OF SIGNAL	GRAPHICS: FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS	TRENDING	ALARM	NOTES
HX ISOLATION VALVE CMD (SOURCE SIDE)			X								LAST	0%			X	0	%	X		
HX ISO VALVE POSITION FEEDBACK (SOURCE SIDE)		X												X	X		%	X	X	
HX BYPASS VALVE CMD (SOURCE SIDE)			X								LAST	100%			X	100	%	X		
HX BYPASS VALVE POSITION FEEDBACK (SOURCE SIDE)		X												X	X		%	X	X	
HX ENTERING TEMP (SOURCE SIDE)		X												X	X		F	X		
HX LEAVING TEMP (SOURCE SIDE)		X												X	X		F	X		
HX LOAD										X				X	X		TONS	X		
HX ISOLATION VALVE CMD (LOAD SIDE)					X						LAST	CLOSED			X	CLOSED		X		
HX ISO VALVE OPEN (LOAD SIDE)				X										X	X			X	X	
HX ISO VALVE CLOSED (LOAD SIDE)				X										X	X			X	X	
HX BYPASS VALVE CMD (LOAD SIDE)					X						LAST	OPEN		X	X	OPEN		X		
HX BYPASS VALVE OPEN (LOAD SIDE)				X										X	X			X	X	
HX BYPASS VALVE CLOSED (LOAD SIDE)				X										X	X			X	X	
HX ENTERING TEMP (LOAD SIDE)		X												X	X		F	X		
HX LEAVING TEMP (LOAD SIDE)		X												X	X		F	X		

WC CHILLER - CRITICAL

WC CHILLER - CRITICAL

POINT NAME	FIELD DEVICE	POINT TYPE: PHYSICAL				POINT TYPE: NETWORK				CALCULATED/ USER DEFINED	FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		AI	AO	BI	BO	AI	AO	BI	BO		LOSS OF POWER	CONTROL FAILURE	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
CHILLER START/STOP	XS1				X						ON	ON		X	X			X		
CHILLER STATUS (NETWORK)								X					X	X	X			X	X	
CHILLER LOCAL/REMOTE								X						X	X			X	X	
CAPACITY LIMITED								X							X			X	X	
CHILLER AT MAX CAPACITY								X							X			X	X	
COMPRESSOR RUN STATUS (NOTE: PER COMPRESSOR)								X							X			X		
CHILLER ALARM	ALM1			X									X	X	X			X	X	
CHWS TEMPERATURE (CHLR)						X									X		F	X		
CHWS TEMPERATURE SETPOINT	TC1		X								60	60			X	60	F	X		
CHWS TEMPERATURE ACTIVE SETPOINT						X							X	X	X	60	F	X	X	
CHWR TEMPERATURE (CHLR)						X							X		X		F	X		
CHW FLOW SWITCH STATUS	FS1			X											X			X	X	
CWS TEMPERATURE (CHLR)						X							X		X		F	X		
CWR TEMPERATURE (CHLR)						X							X		X		F	X		
CW FLOW SWITCH STATUS	FS2			X											X			X	X	
RUNNING CAPACITY						X							X	X	X		%	X	X	
SUCTION PRESSURE (NOTE: PER CIRCUIT)						X									X		PSI	X		
EVAP SAT REFRIGERANT TEMP (NOTE: PER CIRCUIT)						X									X		F	X		
COND SAT REFRIGERANT PRESSURE (NOTE: PER CIRCUIT)						X									X		PSI	X		
COND SAT REFRIGERANT TEMPERATURE (NOTE: PER CIRCUIT)						X									X		F	X		
UNIT POWER CONSUMPTION						X									X		kW	X		
CHILLER FAILED										X			X	X	X			X	X	

COOLING TOWERS

POINT NAME	FIELD DEVICE	POINT TYPE: PHYSICAL AI	PHYSICAL AO	PHYSICAL BI	PHYSICAL BO	NETWORK AI	NETWORK AO	NETWORK BI	NETWORK BO	CALCULATED/ USER DEFINED	FAIL POSITION/ STATUS: LOSS OF CTRL POWER	LOSS OF SIGNAL	GRAPHICS: FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS	TRENDING	ALARM	NOTES
CT-0XA FAN VIBRATION		X												X	X	ALM LIMIT PER MANUF.	INCH/S	X	X	
CT-0XA MOTOR VIBRATION		X												X	X	ALM LIMIT PER MANUF.	INCH/S	X	X	
CT-0XA FILL ISOLATION VALVE CMD					X						LAST	OPEN			X	CLOSED		X	X	
CT-0XA FILL ISOLATION VALVE OPEN				X										X	X			X	X	
CT-0XA FILL ISOLATION VALVE CLOSED				X										X	X			X	X	
CT-0XA VFD	CRITICAL VFD																			
CT-0XA ATS	ATS																			
CWP-0XA VFD	CRITICAL VFD																			
CWP-0XA ATS	ATS																			
CT-0X MAKEUP VALVE 1 CMD			X								LAST	100%			X		%	X		
CT-0X MAKEUP VALVE 1 POSITION		X												X	X		%	X	X	
CT-0XA SUMP LEVEL SENSOR		X												X	X		FT	X	X	
CT-0XB FAN VIBRATION		X												X	X	ALM LIMIT PER MANUF.	INCH/S	X	X	
CT-0XB MOTOR VIBRATION		X												X	X	ALM LIMIT PER MANUF.	INCH/S	X	X	
CT-0XB FILL ISOLATION VALVE CMD					X						LAST	OPEN			X	CLOSED		X	X	
CT-0XB FILL ISOLATION VALVE OPEN				X										X	X			X	X	
CT-0XB FILL ISOLATION VALVE CLOSED				X										X	X			X	X	
CT-0XB VFD																				
CT-0XB ATS																				
CWP-0XB VFD																				
CWP-0XB ATS																				
CT-0X MAKEUP VALVE 2 CMD			X								LAST	0%			X		%	X		
CT-0X MAKEUP VALVE 2 POSITION		X												X	X		%	X	X	
CT-0XB SUMP LEVEL SENSOR		X												X	X		FT	X	X	

CW SYSTEM

POINT NAME	FIELD DEVICE	POINT TYPE: PHYSICAL AI	PHYSICAL AO	PHYSICAL BI	PHYSICAL BO	NETWORK AI	NETWORK AO	NETWORK BI	NETWORK BO	CALCULATED/ USER DEFINED	FAIL POSITION/ STATUS: LOSS OF CTRL POWER	LOSS OF SIGNAL	GRAPHICS: FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS	TRENDING	ALARM	NOTES
GEN HX-01	GEN HX																			
GENERATOR HX 1 FLOW	FT7	X												X			GPM	X		
GEN HX-02	GEN HX																			
GENERATOR HX 2 FLOW	FT8	X												X			GPM	X		
CT-01	COOLING TOWERS																			
CT-01 BYPASS VALVE CMD	FV1		X								LAST	0%			X		%	X		
CT-01 BYPASS VALVE POSITION	ZT1	X												X	X		%	X	X	
CT-01A VFD	CRITICAL VFD																			
CT-01A ATS	ATS																			
CWP-01A VFD	CRITICAL VFD																			
CWP-01A ATS	ATS																			
CT-01A CW SUPPLY TEMPERATURE	TT1	X												X	X		FT	X	X	
CT-01B VFD	CRITICAL VFD																			
CT-01B ATS	ATS																			
CWP-01B VFD	CRITICAL VFD																			
CWP-01B ATS	ATS																			
CT-01B CW SUPPLY TEMPERATURE	TT2	X												X	X		FT	X	X	
CH-01 CHILLER ISOLATION VALVE CMD	XV1				X						LAST	OPEN		X		CLOSED		X	X	
CH-01 CHL ISO VALVE OPEN	ZSO1			X										X				X	X	
CH-01 CHL ISO VALVE CLOSED	ZSC1			X										X				X	X	
CH-01 CONDENSER FLOW METER	FT1	X												X			GPM	X	X	
CH-01 CONDENSER BYPASS PUMP START/STOP	XS1				X						X	X			X			X	X	
CH-01 CONDENSER BYPASS PUMP STATUS	IS1			X										X	X			X	X	
CH-01 CONDENSER TEMPERATURE BYPASS VALVE COMMAND	FV4		X								LAST	0%			X		%	X		
CH-01 CONDENSER TEMPERATURE BYPASS VALVE POSITION	ZT4	X												X	X		%	X	X	
CH-01 CONDENSER TEMPERATURE THROTTLING VALVE COMMAND	FV5		X								LAST	100%			X		%	X		
CH-01 CONDENSER TEMPERATURE THROTTLING VALVE POSITION	ZT5	X												X	X		%	X	X	
OUTSIDE AIR WETBULB SENSOR 1	MT1	X											X	X			F	X		
OUTSIDE AIR WETBULB SENSOR 2	MT2	X											X	X			F	X		
OUTSIDE AIR DRYBULB SENSOR 1	TT20	X											X	X			F	X		
OUTSIDE AIR DRYBULB SENSOR 2	TT21	X											X	X			F	X		
CWS TEMPERATURE (SYSTEM) SENSOR 1	TT7	X											X	X			F	X	X	
CWR TEMPERATURE (SYSTEM) SENSOR 1	TT8	X											X	X			F	X		

CW SYSTEM CONTINUED

CWS TEMPERATURE (SYSTEM) SENSOR 2	TT9	X											X	X			F	X	X	
CWR TEMPERATURE (SYSTEM) SENSOR 2	TT10	X											X	X			F	X		
CH-01 CWS TEMPERATURE	TT11	X											X	X			F	X		
CH-01 CW DISCHARGE TEMPERATURE	TT12	X											X	X			F	X	X	
CH-01 CWR TEMPERATURE	TT13	X											X	X			F	X		
CW SUPPLY TEMPERATURE SETPOINT										X				X			F	X		
CW BYPASS TEMPERATURE SETPOINT										X				X	X	40	F	X		
CW SYSTEM LOAD										X			X	X			TONS	X		
BLOWDOWN WATER FLOWMETER	FT4	X												X			GPM	X		
EVAPORATION TOTAL										X				X			GPD	X		

NON-CONDENSING BOILER

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
BOILER ENABLE									X						X			X		
BOILER STATUS								X						X	X			X		
RUNTIME						X									X		HRS	X		
CYCLES						X									X			X		
BOILER SUPPLY TEMPERATURE SETPOINT							X							X	X		F	X		
BOILER SUPPLY TEMPERATURE						X							X	X	X		F	X	X	
BOILER RETURN TEMPERATURE						X								X	X		F	X		
MODULATION						X								X	X		%	X	X	
LOCAL/REMOTE								X						X	X			X		
GENERAL ALARM								X					X	X	X			X		
LOW WATER CUTOFF ALARM								X					X	X	X			X		
HIGH LIMIT ALARM								X					X	X	X			X		
IGNITION ALARM								X					X	X	X			X		

SVAV-CV SCR HEAT

SVAV-CV SCR HEAT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
HEATER OUTPUT							X								X		%	X	X	
COOLING SETPOINT - OCCUPIED										X				X	X		F	X		
COOLING SETPOINT - UNOCCUPIED										X				X	X		F	X		
HEATING SETPOINT - OCCUPIED										X				X	X		F	X		
HEATING SETPOINT - UNOCCUPIED										X				X	X		F	X		
SUPPLY AIRFLOW SETPOINT - OCCUPIED										X				X	X		CFM	X		
SUPPLY AIRFLOW SETPOINT - UNOCCUPIED										X				X	X		CFM	X		

SVAV-CV NO HEAT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
SUPPLY AIRFLOW SETPOINT - OCCUPIED										X				X	X		CFM	X		
SUPPLY AIRFLOW SETPOINT - UNOCCUPIED										X				X	X		CFM	X		

SVAV-CV NO HEAT

SVAV-CV HYDR HEAT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
HEATING COIL VALVE POSITION							X								X		%	X	X	
SPACE TEMPERATURE	TT1					X								X	X		F	X		
COOLING SETPOINT - OCCUPIED										X				X	X		F	X		
COOLING SETPOINT - UNOCCUPIED										X				X	X		F	X		
HEATING SETPOINT - OCCUPIED										X				X	X		F	X		
HEATING SETPOINT - UNOCCUPIED										X				X	X		F	X		
SUPPLY AIRFLOW SETPOINT - OCCUPIED										X				X	X		CFM	X		
SUPPLY AIRFLOW SETPOINT - UNOCCUPIED										X				X	X		CFM	X		

SVAV-CV HYDR HEAT

SVAV-VV-NO HEAT

SVAV-VV NO HEAT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
SUPPLY AIR TEMPERATURE						X								X	X		F	X	X	
SPACE TEMPERATURE						X							X	X	X		F	X	X	
SPACE TEMPERATURE SETPOINT - OCCUPIED										X				X	X		F	X		
SPACE TEMPERATURE SETPOINT - UNOCCUPIED										X				X	X		F	X		

SVAV-VV SCR HEAT

SVAV-VV SCR HEAT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
SUPPLY AIR TEMPERATURE						X								X	X		F	X	X	
HEATER OUTPUT							X								X		%	X	X	
SPACE TEMPERATURE						X							X	X	X		F	X	X	
COOLING SETPOINT - OCCUPIED										X				X	X		F	X		
COOLING SETPOINT - UNOCCUPIED										X				X	X		F	X		
HEATING SETPOINT - OCCUPIED										X				X	X		F	X		
HEATING SETPOINT - UNOCCUPIED										X				X	X		F	X		

SVAV-VV HYDR HEAT

SVAV-VV HYDR HEAT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
SUPPLY AIR TEMPERATURE						X								X	X		F	X	X	
HEATING COIL VALVE POSITION							X								X		%	X	X	
SPACE TEMPERATURE						X							X	X	X		F	X	X	
COOLING SETPOINT - OCCUPIED										X				X	X		F	X		
COOLING SETPOINT - UNOCCUPIED										X				X	X		F	X		
HEATING SETPOINT - OCCUPIED										X				X	X		F	X		
HEATING SETPOINT - UNOCCUPIED										X				X	X		F	X		

EVAV

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
AIRFLOW						X								X	X		CFM	X		
PRIMARY AIR VALVE POSITION							X							X	X		%	X	X	
EXHAUST AIRFLOW SETPOINT										X				X	X		F	X		

EVAV

EXHAUST FAN

EXHAUST FAN

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF POWER	CONTROL FAILURE	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
EXHAUST FAN START/STOP	XS1				X						ON	ON			X			X	X	
EXHAUST FAN STATUS	IS1			X										X	X			X	X	
EXHAUST FAN ISOLATION DAMPER COMMAND	XV1				X						OPEN	OPEN			X			X	X	
EXHAUST FAN ISOLATION DAMPER OPEN	ZSO1			X										X	X			X	X	
EXHAUST FAN ISOLATION DAMPER CLOSED	ZSC1			X										X	X			X	X	

REFRIGERANT EXHAUST

REFRIGERANT EXHAUST

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF POWER	CONTROL FAILURE	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
REFRIGERANT EXHAUST FAN START/STOP	XS1				X						ON	ON			X			X	X	
REFRIGERANT EXHAUST FAN STATUS	IS1			X										X	X			X	X	
EXHAUST FAN ISOLATION DAMPER COMMAND	XV1				X						OPEN	OPEN			X			X	X	
EXHAUST FAN ISOLATION DAMPER OPEN	ZSO1			X										X	X			X	X	
EXHAUST FAN ISOLATION DAMPER CLOSED	ZSC1			X										X	X			X	X	
REFRIGERANT MONITOR STATUS (PER CHILLER)	RM1					X								X	X			X		
REFRIGERANT LEVEL (PER CHILLER)	RM1					X							X	X	X		% LEL	X		
REFRIGERANT LEAK DETECTED (PER CHILLER)	RM1							X										X	X	
EMERGENCY POWER OFF	ES1				X								X	X	X			X	X	

CRAHU

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
UNIT STATUS								X					X	X	X			X	X	
SUPPLY AIR TEMPERATURE						X								X	X		F	X		
SUPPLY AIR TEMPERATURE SETPOINT							X			X				X	X		F	X		
RETURN AIR TEMPERATURE						X									X		F	X		
FAN SPEED COMMAND							X								X		%	X	X	
FAN SPEED ACTUAL						X								X	X		%	X	X	
COOLING VALVE POSITION						X								X	X		%	X	X	
INPUT VOLTAGE A-N						X									X	277	VAC	X	X	
INPUT VOLTAGE B-N						X									X	277	VAC	X	X	
INPUT VOLTAGE C-N						X									X	277	VAC	X	X	
INPUT RMS CURRENT PHASE A						X									X		A	X		
INPUT RMS CURRENT PHASE B						X									X		A	X		
INPUT RMS CURRENT PHASE C						X									X		A	X		
INSTANTANEOUS POWER						X									X		kW	X	X	
ENERGY CONSUMPTION						X									X		kWh	X		
MAIN FAN OVERLOAD								X					X	X	X			X	X	
FAN FAILURE								X					X	X	X			X	X	
CLOGGED AIR FILTER								X					X	X	X			X	X	
LOSS OF AIRFLOW								X					X	X	X			X	X	
SERVICE REQUIRED								X					X	X	X			X	X	
SHUTDOWN - LOSS OF POWER								X					X	X	X			X	X	
SMOKE DETECTED								X					X	X	X			X	X	
TEMPERATURE CONTROL SENSOR ISSUE								X					X	X	X			X	X	
AIRFLOW SENSOR ISSUE								X					X	X	X			X	X	
AIRFLOW VOLUME						X								X	X		CFM	X		
CHW RETURN TEMPERATURE						X									X		F	X		
CHILLED WATER CONTROL VALVE FAILURE								X					X	X	X			X	X	

CONTROL ROOM AIR TOWER

CONTROL ROOM AIR TOWER

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
FAN VFD	REDUND-ANT VFD																			
SUPPLY AIR TEMPERATURE	TT2	X												X	X		F	X	X	
SAT SETPOINT										X				X	X	65	F	X		
RETURN AIR TEMPERATURE	TT1	X													X		F	X		
RETURN AIR HUMIDITY	MT1	X													X	60	%	X	X	
SPACE CO2 LEVEL	GS1	X														500 ABOVE OUTDOOR	PPM	X	X	
COOLING VALVE COMMAND	FV1		X								LAST	100%		X			%	X		
COOLING VALVE POSITION	ZT1	X											X	X			%	X	X	
AIR FILTER PRESSURE DIFFERENTIAL	PDT1	X													X		iwc	X	X	
FAN 1 STATUS	IS1							X						X	X			X		
FAN 2 STATUS	IS2							X						X	X			X		
FAN 3 STATUS	IS3							X						X	X			X		
SMOKE DETECTED	SD1			X									X	X	X			X	X	

CONTROL ROOM SUPPORT AIR TOWER

POINT NAME	FIELD DEVICE	POINT TYPE: PHYSICAL AI	PHYSICAL AO	PHYSICAL BI	PHYSICAL BO	NETWORK AI	NETWORK AO	NETWORK BI	NETWORK BO	CALCULATED/ USER DEFINED	FAIL POSITION/ STATUS: LOSS OF CTRL POWER	LOSS OF SIGNAL	GRAPHICS: FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS	TRENDING	ALARM	NOTES
FAN VFD	NON-CRITICAL VFD																			X
SUPPLY AIR TEMPERATURE	TT2	X												X	X		F	X	X	
SAT SETPOINT										X				X	X	65	F	X		
RETURN AIR TEMPERATURE	TT1	X													X		F	X		X
RETURN AIR HUMIDITY	MT1	X													X	60	%	X	X	X
SPACE CO2 LEVEL	GS1	X														500 ABOVE OUTDOOR	PPM	X	X	
COOLING VALVE COMMAND	FV1		X								LAST	100%		X			%	X		
COOLING VALVE POSITION	ZT1	X											X	X			%	X	X	
AIR FILTER PRESSURE DIFFERENTIAL	PDT1	X													X		iwc	X	X	
SMOKE DETECTED	SD1			X									X	X	X			X	X	

CONTROL ROOM SUPPORT AIR TOWER

WHITE SPACE

WHITESPACE

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
CRAHU 1	CRAHU DF																			1
SPACE TEMPERATURE 1	TT1	X											X	X	X		F	X	X	
SPACE TEMPERATURE 2	TT2	X											X	X	X		F	X	X	
SPACE TEMPERATURE 3	TT3	X											X	X	X		F	X	X	
SPACE TEMPERATURE SETPOINT										X				X	X	75	F	X		
SPACE DEWPOINT	MT1	X											X	X	X		F	X	X	
SPACE DIFFERENTIAL PRESSURE SENSOR 1	PDT1	X												X	X		iwc	X	X	
SPACE DIFFERENTIAL PRESSURE SENSOR 2	PDT2	X												X	X		iwc	X	X	
SPACE DIFFERENTIAL PRESSURE SENSOR 3	PDT3	X												X	X		iwc	X	X	
SPACE PRESSURE SETPOINT										X				X	X		iwc	X		

BATTERY ROOM

BATTERY ROOM

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
EVAV 1	EVAV																			
EVAV 2	EVAV																			
HYDROGEN SENSOR 1	GS1	X											X	X			%LFL	X	X	
SPACE TEMPERATURE	TT1	X											X	X		77	F	X	X	

FAN COIL UNIT

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
START/STOP	XS1								X		ON	ON			X			X	X	
UNIT STATUS	IS1							X						X	X			X		
SUPPLY AIR TEMPERATURE	TT1					X								X	X		F	X		
SPACE TEMPERATURE	TT2					X							X	X	X		F	X	X	
SPACE TEMPERATURE SETPOINT										X				X	X	75	F	X		
COOLING VALVE POSITION	ZV1						X							X	X		%	X	X	

FAN COIL UNIT

TELECOM ROOMS

POINT NAME	FIELD DEVICE	POINT TYPE									FAIL POSITION/ STATUS		GRAPHICS					TRENDING	ALARM	NOTES
		PHYSICAL				NETWORK				CALCULATED/ USER DEFINED	LOSS OF CTRL POWER	LOSS OF SIGNAL	FLOOR PLAN	SYSTEM	EQUIPMENT	NOM. VALUE/ SETPOINT	UNITS			
		AI	AO	BI	BO	AI	AO	BI	BO											
UNIT STATUS								X					X	X	X			X	X	
SPACE TEMPERATURE	TT1					X								X	X		F	X	X	
SPACE TEMPERATURE SETPOINT							X			X				X	X		F	X		
RETURN AIR TEMPERATURE						X									X		F	X		
FAN FAILURE								X					X	X	X			X	X	

TELECOM ROOMS

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Appendix C: North Austin Complex Central Utility Plant Owner's Project Requirements

1 Applicability of Appendix C

The Texas Facilities Commission (“TFC”) intends this Appendix to the Owner’s Project Requirements (the “OPR” or “Requirements”) to apply generally to construction of the new Central Utility Plant (“CUP”) at the State of Texas North Austin Complex and potentially to other State CUP construction projects.

For guidance on any issue not directly addressed in this Appendix, refer to the TFC OPR and to the solicitation. In the case of conflict between this document and the OPR, or the solicitation, or the governing code(s), those other documents or authorities shall control.

2 Fundamental Design Criteria

2.1 Exterior Appearance and Finish

Refer to the NAC MP and the solicitation for descriptions of appropriate exterior finishes for the CUP.

2.2 Interior Appearance and Finish

The CUP is intended to be accessed and maintained solely by TFC maintenance personnel and their authorized agents. Interior finishes shall reflect the economy and durability required in a plant environment.

2.3 Functionality

The organization of the space within the CUP shall be in service of the efficient and effective operation of the mechanical and related equipment within. A small office shall be provided for intermittent use.

2.4 Building occupancy type

The CUP will generally qualify as occupancy group U, Utility and Miscellaneous.

2.5 General Project Site

Refer to the solicitation for a description of the CUP location and attendant site requirements. If the thermal energy storage tank is to be located above-ground, its prominence shall be minimized to the greatest degree possible through the careful and considered use of cladding and architectural massing of neighboring building(s).

2.6 Safety

The CUP shall comply with OSHA guidance and ANSI Z358.1 standards regarding the provision of emergency eyewash stations and shower equipment if personnel within the CUP may be exposed to hazardous materials, as defined in by ANSI, including caustics or other substances that may be harmful to health and safety.

3 Expected Lifespans for CUP Building Elements

For design lifespans for building elements and to establish the design criteria by which appropriate building equipment and systems can be selected and designed that are fit for the CUP Project’s specific, refer to the OPR, section 3.

4 Economic Cost Parameters for Life Cycle Costs Analysis (“LCCA”)

4.1 Life Cycle Cost Assessments: The design team shall provide three complete LCCAs during the schematic design phase. Refer to the OPR LCCA requirements for guidance in developing these LCCAs.

5 Architectural and Engineering Criteria

5.1 Architectural

5.1.1 Building enclosure attributes: Refer to the NAC MP and the solicitation for descriptions of appropriate exterior finishes for the CUP. The architectural prominence of the CUP shall be minimized to the greatest degree possible.

5.1.2 Enclosure requirements

5.1.2.1 Moisture control: The location of the cooling towers may create the potential for discharge to collect on nearby surfaces. To the greatest extent possible, that potential shall be minimized for those areas frequently accessed or inhabited by occupants of the NAC and/or the general public, including all parking areas.

5.1.2.2 Wall systems

5.1.2.2.1 Cladding: Refer to the NAC MP regarding appropriate exterior cladding. Refer generally to the OPR for minimum requirements regarding stone, masonry, and other cladding materials.

5.1.2.2.2 Entrance Doors: Entrance doors shall be heavy duty construction. Steel exterior doors and frames must meet the requirements of SDI Grade III with a G-90 galvanic zinc coating. Where required, push plates are the preferred actuating devices.

5.1.2.2.3 Overhead doors: Overhead coiling or garage doors shall be capable of withstanding positive and negative wind loads of 28 psf without undue deflection or damage. A counterbalance, helical torsion spring-type and housed in a steel tube or pipe barrel, shall support the curtain with a maximum deflection of 0.03 inch per foot of span. Motor-operated doors shall be equipped with a UL-listed electric operator, sized to move door in either direction at least 2/3 foot but no faster than 1 foot per second. Provide an electric sensing edge and a push-button and/or key-operated control station. The finish shall be galvanized steel with rust-inhibitive, baked-on paint, with a back-on polyester topcoat, unless otherwise specified. Provide a vinyl bottom seal with exterior guides and internal hood seals. Provide a hard-wired single-flash warning strobe if the door's exterior approach has limited visibility, e.g. located on an alleyway with an obstructed view. Overhead coiling doors at exterior walls shall be insulated.

5.1.2.3 Access to maintain equipment: Major pieces of mechanical system equipment (e.g., AHUs and RTUs) shall be located such that ease of access for maintenance and a pathway for removal for replacement are preserved. Equipment replacement or relocation shall not require demolition of interior or exterior walls. Provide at least 1-1/2 times the minimum recommended or code-required clearance around all major equipment.

5.1.3 Interior performance requirements

5.1.3.1 Floors: Commercial grade epoxy floor coating is the preferred finish for the general interior CUP spaces. Vinyl composite tile or similarly durable and economical materials are appropriate for floor finishes in rooms or spaces intended for extended occupation, e.g., the CUP personnel office.

5.1.3.2 Walls: Gypsum wallboard wall finish is required only in the CUP personnel office and in corridors or other discrete spaces frequently accessed by maintenance personnel.

Rubber or vinyl cove base is appropriate for those walls finished with gypsum wallboard. In areas frequently accessed with carts or other rolling equipment, provide full-height, steel corner guards; vinyl wall guards at a height above finished floor coordinated with cart specification; abuse-resistant gypsum wallboard; and full-height steel protection plates for doors.

5.1.3.3 Ceilings: The only space within the CUP requiring a ceiling shall be the CUP personnel office; provide an accessible 4-foot by 2-foot vinyl-coated acoustical tile ceiling.

5.1.3.4 Millwork: Plastic laminate used for cabinet door and drawer facings shall be applied with contact cement. For interior cabinet carcass and typical shelving, particleboard shall not be used. Provide pre-finished woodwork where possible. Where in-field finish must be performed, coordinate environmental concerns, ventilation requirements, shutdowns, etc. Any area where woodwork is to be installed shall have been satisfactorily conditioned for temperature and humidity control prior to introducing woodwork into the space.

5.1.3.5 Doors and hardware: Typical doors shall be solid-core, flush-panel wood. Doors that must achieve a two-hour or more fire rating shall be painted steel, with a correspondingly rated hollow-metal door frame. Unless noted otherwise, door hardware shall include a keyed lockset.

5.1.3.6 Signage and Wayfinding: Default signage shall be code-minimum room identification plate with Braille. Refer to the most current update to the applicable Master Plan for guidance regarding the aesthetics, appearance, preferred location(s), and performance requirements for exterior signage and wayfinding.

5.1.4 Workplace Performance Attributes: The CUP shall have, single-user restroom equipped with one hose bib under the lavatory. The CUP shall have one custodial closet equipped with a floor-mounted mop sink and wall-mounted faucet. Refer to OPR for additional custodial closet requirements.

5.2 Structural

5.2.1 General Structural Criteria

5.2.1.1 Finish Class: Occupied areas shall be constructed using minimum ACI Class B formed surfaces. Parking structures shall be constructed using ACI Class C formed surfaces.

5.2.2 Foundations: A site-specific geotechnical investigation shall be conducted to determine the appropriate foundation type for the project site.

5.2.3 Substructures

5.2.3.1 Retaining Wall: Walls shall be designed to limit horizontal deflections to a long term limit of H/600 with consideration of cracked sections and creep. Backfill operations shall be tightly controlled to ensure wall backfill is placed as specified by in the design documents. Walls shall be designed with due consideration of the surcharge loading of the adjacent soils.

5.2.3.2 Waterproofing and Drainage: Blind-side water proofing and drainage systems are not permitted. Drainage systems shall provide for maintenance and inspection through the use of readily accessible cleanouts at regular intervals. Wall drains shall be hydraulically isolated from other systems and shall be protected against back-charging of the backfill.

5.2.3.3 Construction Phase Retention System: The construction phase retention system shall be carefully coordinated with property lines and existing underground construction. All necessary measures shall be taken to protect existing infrastructure.

5.2.4 Superstructures

5.2.4.1 Floor Levelness: Elevated slabs shall be designed to receive a self-leveling cap after formwork and shoring removal to ensure floor levelness and flatness. In no event shall the levelness variation exceed one quarter inch over ten feet. The weight of the topping material shall be included in the design dead loads for the structure. High areas shall be identified and ground down as required to avoid excessive topping thickness.

5.2.4.2 Vibration Criteria: Fixed equipment shall be supported in a manner that prevents objectionable structural borne vibrations being transmitted through the building.

5.2.4.3 Lateral System: Where feasible, concrete moment frame systems shall be utilized to maintain open and flexible floor spaces. Where required to meet lateral loading requirements, concrete shear walls may be used but shall be located to minimize their impact on the future flexibility of the building use.

5.2.5 Design Loading

5.2.5.1 Gravity Loads: Structures shall be designed for code-minimum loading based on the intended use but in no case shall be less than a uniformly distributed live loading of 80 psf with the additional code-required partition-loading allowance. Dead loads shall include the self-weight of the building construction and shall include a minimum superimposed dead load of 15 psf for ceiling, mechanical, and other suspended systems.

5.2.5.2 Lateral Loads: The CUP shall be designed for the code-required loads for essential facilities (Risk Category IV).

5.3 Mechanical

5.3.1 Scope of Work: At a minimum, the following systems shall be included in the mechanical scope of work for the building(s): centrifugal chillers; induced draft cooling towers; chilled water pumping systems; condenser water pumping system, air handling/distribution systems; exhaust systems; refrigerant monitoring system; and direct digital controls.

5.3.2 Design Criteria

5.3.2.1 Energy Use Intensity (EUI): The Project shall establish a goal to use at least 17 percent less energy on an annual basis compared to ASHRAE 90.1 2013. Provide system descriptions for at least three systems for LCCA purposes:

System 1: 17 percent energy efficiency above ASHRAE 90.1 2013.
System 2: 20 percent energy efficiency above ASHRAE 90.1 2013.
System 3: 23 percent energy efficiency above ASHRAE 90.1 2013.

All systems must focus on initial cost, system efficiency, and maintainability.

5.3.2.2 Design Temperatures: With reference to the ASHRAE Handbook Fundamentals 2013 1% data, design temperatures shall be as follows:

Sensible Cooling Outside Summer 1%: 97.8°F DB / 75.1°F WB
Latent Cooling Outside Summer 1%: 75.4°F DP / 80.5 °F MDB
Outside Winter: 25.2°F DB
Inside: 75°F DB / 50% RH Cooling; 70°F DB / 50% RH Heating

Ventilation shall meet ASHRAE 62.1 requirements.

5.3.2.3 Piping Design Criteria: Hydronic piping systems shall be variable primary with a closed loop with C-factor of 120, a maximum pressure drop of 3.0 feet/100 feet or maximum fluid velocity of 8 fps (whichever is more restrictive), and a minimum fluid velocity of 1 fps.

5.3.2.4 Ductwork Design Criteria: All ductwork shall be designed in accordance with requirements of the construction specified as stated in the most current SMACNA standards**.**

5.3.2.5 Chilled Water ("CHW") System: The chilled water system shall consist of multiple high efficiency centrifugal water-cooled water chillers, and primary chilled water pumps, sized for N+1 capacity**.**

5.3.2.6 Chilled Water Distribution: The chillers shall feed into a primary loop system provided to serve the building(s); the initial mains shall be sized to handle future building expansion. All utility piping from the main campus loops shall be installed in the pipe tunnel for entrance into the building. The tunnel shall be sized to provide access, ventilation, and maintenance. The building(s) shall have plate-and-frame heat exchangers to decouple the CUP.

5.3.2.7 HVAC Load Calculations: The HVAC load calculations must be performed by a computer-based program capable of providing full-year, hourly analysis. The load calculations must be provided for review at each design phase submission.

5.3.2.8 Isolation of Piping at Equipment: Isolation valves and shutoff valves with bypass circuit shall be provided at all pieces of equipment to allow equipment repair and replacement. Isolation valves shall be provided at each floor level on all piping system to allow isolated shutdown for repair or replacement.

5.3.2.9 Housekeeping Pads: All floor mounted equipment shall be provided with 4-inch-tall chamfered concrete pads which extend at least 4 inches beyond the installed equipment.

5.3.2.10 Meters and Gauges: All equipment requiring flow, temperature, pressure, current or status shall be provided with appropriate measuring devices and such devices must be capable of transmitting the appropriate information to the central BMS.

5.3.2.11 Water Treatment: Proper water treatment for closed loop system must be integrated into the design. The system must address scaling, dissolved solids, biologic growth and corrosion protection.

5.3.3 Equipment

5.3.3.1 Water Cooled Centrifugal Water Chillers: Chillers shall be motor-driven centrifugal chillers with unit-mounted VFD. Chilled-water-supply temperature shall be designed to 40ºF with a minimum of 14ºF delta T. Chillers shall be at least 1,000 tons with N+1 configuration. Provide a minimum five-year parts-and-labor warranty with alternate pricing for an optional ten-year warranty.

5.3.3.2 Cooling Towers: Cooling towers shall be four-cell, FM-rated, counter-flow design, with 304 stainless steel with elevated basins. Towers shall have 95ºF inlets and 85ºF outlets with high-efficiency drift eliminators. VFDs shall be provided for each fan. Outdoor design condition 78ºF WB. Provide with an exterior-mounted motor, out of the air stream. Towers shall be capable of being isolated from each other for maintenance, designed with an equalization line between the cells, and each cell capable of isolating off of this line for cleaning purposes independently. Provide automated isolation valves on inlet and outlet of each tower cell to allow BAS to independently control operation.

5.3.3.3 Chilled Water/Condenser Water Pumps: CHW/CW pumps shall be vertical in-line, double-suction, centrifugal type with premium-efficiency motors with VFD selected to operate at 1750 rpm.

5.3.3.4 Expansion Tanks: Provide non-bladder-type expansion tanks with pumped make-up water.

5.3.3.5 Line Size Air/Sediment Separator: The line shall be sized for 100 percent CHW flow (similar to Spirotherm).

5.3.3.6 Bridge Crane: For the bridge crane, provide a VFD for the hoist and trolley.

5.3.3.7 Condenser Water Sand Filter: The condenser water sand filter shall be sized for full flow of the cooling tower, plant piping, and equipment volume and for use with reclaimed water. Provide a pressurized sand filter and media bed with fresh water backwash.

5.3.3.8 Strainers: Line-sized fabricated tee strainers shall be installed on all CHW and CW suction lines: provide 300-series stainless steel baskets with 3/16-inch hole diameter. The maximum DP when clean shall be an operating flow of 0.5 psi, and the minimum allowable DP design shall be 10 psi.

5.3.3.9 Chemical Treatment System: Provide a chemical treatment system with analyzers, controllers, pumps, and double-walled chemical storage tank(s).

5.3.3.10 Thermal Energy Storage Tank: Provide an all-welded, steel thermal energy storage tank system. The exterior surface of the tank shall have two-coat epoxy coating per ICS-1, and the interior shall have a three-coat epoxy coating system per ICS-2. The tank shall be insulated and jacketed with a maximum heat gain of 2 percent of rated capacity in a 24-hour period, with ambient dry bulb temperature of 110ºF.

5.3.3.11 Refrigerant Monitoring System: The refrigerant monitoring system shall be provided and installed in accordance with safety and environmental guidelines and rules. The system shall provide for proper alarming and activation of plant louvers and fans as required for evacuation of refrigerant. The refrigerant monitor shall be tied into BAS to indicate alarm.

5.3.4 Materials

5.3.4.1 Pipe: CHW/HW piping shall be ASTM A53 black steel schedule 40 with steel fittings for larger pipes and malleable iron fittings for smaller pipes. Pipe shall be threaded for piping 2 inches and smaller and welded and flanged for piping over 2 inches. For CHW pipe 2 inches and smaller, brazed Type L copper pipe with brass/bronze socket type fittings is acceptable. All pipe shall be installed within an accessible tunnel.

5.3.4.2 Valves: Valves shall be brass with stainless steel ball for 2 inches and smaller and lug-type butterfly for larger piping for isolation service and plug type valves for throttling service.

5.3.5 Basic Materials and Methods

5.3.5.1 Duct Systems: All main ductwork shall be G-90 grade, galvanized sheet metal fabricated in accordance with SMACNA standards and shall have pressure classifications suitable for the static pressure of each system. Branch ducts to ceiling registers shall be insulated, flexible ductwork. Ductwork downstream of low velocity air units and all return and exhaust ducts shall be low velocity pressure class 1.

5.3.5.2 Ductwork, Low Velocity: Low-velocity ductwork shall be hot-dipped galvanized steel, low pressure type construction, air leakage not more than 5 percent of total. Duct-tape all joints and seams.

5.3.5.3 Grilles, Registers, and Diffusers: Grilles, registers, and diffusers shall be prime-coated steel and/or extruded aluminum.

5.3.5.4 Insulation: Insulation shall be rated for a flame spread of 25 or less; smoke developed of 50 or less. All CHW piping shall be insulated with closed-cell phenolic foam insulation with all-purpose scrim foil jacket. Piping insulation shall be 1 inch thick for piping 1 inch and smaller and 2 inches thick for piping larger than 1 inch. Piping exposed in mechanical rooms and inside building shall have PVC jacket. Piping exposed in crawl space and exterior to building shall have aluminum jacket.

5.3.5.5 Rectangular ductwork Insulation: Round ductwork and ducts shall be 1.5 pounds per cubic foot density, provide for 1-1/2-inch-thick flexible glass fiber with reinforced foil kraft facing, all joints sealed, all external.

5.3.5.6 Exhaust Systems: All areas requiring exhaust shall be ventilated to the exterior by the exhaust fans.

5.3.5.7 Vibration Isolation: Basis of design isolators shall be Amber-Booth, Kinetics, or Vibration Eliminator. Springs shall have a minimum K to KY ratio of 1.5.

5.3.5.8 Testing, Adjusting, and Balancing: Testing, adjusting, and balancing shall be in accordance with NEBB and AABC standards.

5.3.5.9 Direct Digital Controls: Refer to Section 5.12 of the OPR.

5.4 Plumbing Criteria

5.4.1 Domestic water sizing criteria: Main distribution piping shall be sized per criteria in IPC and 3 psi pressure drop per 100 feet of piping and 6 fps maximum velocity. However, pipe sizes may be increased to reduce overall pressure losses. Minimum pipe sizing shall be 3/4 inch.

5.4.2 Hot Water: Basis of design shall be tankless gas water heaters. A mixing valve shall be located under each lavatory with distributed hot water supply at 140ºF for sanitation.

5.4.3 Storm Water & Roof Drainage: The roof drainage design shall be based upon a 100-year storm with 60-minute duration at 5 inches-per-hour intensity.

5.5 **Electrical**

This Division covers the furnishing and installation of lighting fixtures, receptacles, 600-volt conductors, conduits, distribution panels, circuit breakers, transformers, lighting and receptacle panels, lighting control panels, motor control centers, switchboards, and switchgear, herein called "Electrical", complete and ready for intended service.

5.5.1 Energy Conservation: Electrical building systems shall be designed using sustainable energy efficiency goals.

5.5.2 Electrical Service: Dual electrical services to the CUP shall be provided by Austin Energy from separate utility substations. Service to the main switchgear located within the main electrical room shall be at 480Y/277 Volts, 3-phase, 4-wire. Utility metering shall be installed at the service entrance by Austin Energy. The service provider will provide the requirements for locating the meter enclosure. Utility transformers and metering vaults shall be provided within the building envelope wherever possible, and they shall comply with Austin Energy building standards. All feeders shall be copper.

5.5.3 Alternate for Medium Voltage Campus Distribution: Prepare a cost/benefit analysis for bringing medium voltage to the CUP from Austin Energy and distributing medium voltage from the CUP to all new buildings in the NAC, included projected construction in the future phase(s) of the NAC MP.

5.5.4 Normal Power Distribution:

5.5.4.1 Main switchgear: The main switchgear, sized to include all loads at worst case power density plus 25 percent spare capacity, shall be 480Y/277 Volts, 3-phase, 4-wire, and mounted on a housekeeping pad. The main switchgear shall have silver-plated copper bus and shall be UL labeled for service entrance. Switchgear shall be configured as a main-tie-main configuration, have an electronic circuit monitor, external SPD, and ground fault protection on devices as required. Switchgear shall not be located below street level. Main service entrance switchgear shall be UL 1558 switchgear with draw-out type circuit breakers. Breakers shall be injection-tested.

5.5.4.2 Power factor correction: Provisions shall be made for the addition of capacitors for power factor correction and harmonic mitigation. Provisions shall include physical space in main electrical room as well as spare breaker in the Main Switchgear. Addition of capacitors shall be determined on a case by case basis.

5.5.4.3 Distribution: Mechanical and elevator loads shall be fed from 480Y/277 Volt, 3-phase, 4-wire switchboards as required, sized to all loads at worst case power density plus 25 percent spare capacity.

5.5.4.4 Power Monitoring: Electrical loads shall be grouped according to load type in order to facilitate monitoring of power usage through an energy dashboard application or Building Automation System.

5.5.4.5 Capacity: Each panel shall be sized to include all loads at worst case power densities plus 25 percent spare capacity.

5.5.4.6 Coordination: All power feeder and branch circuit overcurrent protective devices, shall selectively coordinate 0.01 seconds over the entire range of available fault current. This may require the use of fused distribution equipment, fused panel boards, and/or fused elevator disconnects to serve emergency feeder and branch circuit loads.

5.5.5 Raceways:

5.5.5.1 Rigid steel conduit shall be used in all locations unless otherwise specified herein.

5.5.5.2 MC cable shall only be used for lighting whips 6 feet or less in length. MC cable shall not be used for any other purpose.

5.5.5.3 PVC schedule 40 conduit shall be used for underground primary feeders, shall be concrete encased Type "EB" UL labeled utility duct rated at 90ºC, and shall be constructed to electrical utility company standards.

5.5.5.4 PVC schedule 40 conduit shall be used for underground raceways. In ground bearing floor slabs, except where specifically indicated or specified, raceways shall be galvanized rigid steel conduit. Provide insulated ground wires as required. Elbows used with PVC conduit shall be rigid galvanized, standard radius or long sweep. All stub-ups above finished grade or finished floor shall be PVC-coated rigid steel conduit.

5.5.5.5 Flexible steel conduit or liquid-tight flexible steel conduit shall be used for raceway connection to rotating or vibrating equipment in lengths not to exceed 48 inches. Provide bonding jumpers across flexible conduit lengths.

5.5.5.6 All power and fire alarm main risers shall be installed in conduit. All conduit for branch circuits shall be ¾-inch or larger except when feeding a single receptacle or switch. In no case shall MC cable or other flexible wiring exit a panel board.

5.5.5.7 PVC-coated rigid steel conduit shall be used at all “wet” and corrosive locations.

5.5.5.8 Do not use Re-Lock wiring system or under-floor electrical systems in any new facility.

5.5.5.9 New buildings shall follow the Austin Utility Criteria Manual for color coding phases.

5.5.6 Safety Switches: All safety switches shall be of the heavy-duty type, with a NEMA 1, 3R or 4X enclosure, and fused or non-fused as required. NEMA 3R enclosures shall be used at "wet" locations, NEMA 4X (304 SS) at corrosive locations.

5.5.7 Grounding: The electrical distribution system and all equipment shall be grounded in accordance with the NEC. An insulated ground wire shall be included with all distribution feeders and with all branch circuits. The building grounding system shall consist of a minimum 4/0 bare stranded copper ground loop with 7/8-inch X 10-foot copper clad steel ground rods encircling the building, a concrete encased grounding electrode, connections to reinforcing steel, and the main incoming water line to the building. Ground rods shall be on 50-foot centers or every other column footing, whichever is closer. The building grounding system shall provide a resistance to ground of not more than five ohms. Installing contractor shall submit a signed test document certifying grounding system resistance to ground. Provide at least two ground test wells along the ground loop at locations dictated for each specific structure. Grounding bushings shall be used on electrical systems of 277/480 volt or higher. There shall be at least one ground copper bus bar on each side of the building. Each ground bus bar shall have two stranded copper whips connected between the ground bus bar and the building ground loop. Grounding whips shall be exothermically welded at each end.

5.5.8 Wiring Devices

5.5.8.1 All 20 ampere, 125 or 277 volt wiring devices shall be decorator style where recessed, and standard where surface mounted. Receptacles shall be side-wired specification grade. Receptacles shall be mounted vertically.

5.5.8.2 All cover plates for 15 and 20 ampere single and multi-gang wiring recessed devices shall be stainless steel specification grade.

5.5.8.3 Wiring device mounting heights shall be in accordance with applicable accessibility codes. Conduit and boxes installed in rated partitions shall comply with UL requirements.

5.5.8.4 All circuits shall be labeled using a labeling machine on junction box covers, receptacles, switches and other devices, the labels shall contain the designated panel from which the circuit originates and the corresponding circuit number.

5.5.8.5 No in-floor branch circuiting will be allowed.

5.6 **Lighting Design**

5.6.1 General: The lighting system shall be designed for enhanced visual quality while minimizing connected lighting power density and lighting energy use. General lighting shall be provided by, suspended high-bay, industrial-facility quality luminaires. Provide basic switched lighting controls for safety of maintenance personnel. The lighting system shall be designed to provide average illuminance levels in keeping with IESNA recommendations. Luminaires shall use primarily high efficacy, long life, and high color rendering lamping. Provide a life cycle cost analysis for lighting design.

5.6.2 Luminaires: Lighting shall include ambient and task lighting using economical technologies. Luminaire construction quality, especially with regard to reflectors, shielding, and lenses, is critical. All luminaires shall be high quality specification grade equipment by reputable manufacturers and CE/UL/IP- listed for the application, unless otherwise noted. Lighting fixtures shall be waterproof and be equipped with wire guards. Where required, lighting fixtures shall conform to UL Class 1, Divisions 1 & 2, explosion-proof standards per the National Electrical Code, Article 501. Luminaires shall be specified and located for ease of future maintenance.

5.6.3 Controls: All lighting equipment shall be non-automatic, manually switched, unless otherwise specified.

5.6.4 Exterior Circulation: Photo sensors and programmable astronomical time clocks shall control the lights in response to available daylight and seasonal changes. A suitable bypass or override switching system shall be included to enable temporary manual energizing of lighting covered by this section in case of controller failure.

5.7 **Information Technology Systems**

5.7.1 Standards: All design standards and practices from the OPR shall apply to the CUP.

5.7.2 Entrance Facility ("EF"): A combination EF/MDF/IDF room shall be provided in the CUP. This room shall be used to terminate the OSP, house the TMGB and all passive and active racks for the facility. DATA and BCN segregations shall be maintained in the room. The BCN shall incorporate rack space for the security access, surveillance and control systems. The CUP has no wireless or Wi-Fi infrastructure.

5.7.3 Entrance Facility ("EF"): An integral or separate EF shall be sized per standards; however, the minimum size shall be no less than 4' x 6'. The purpose of the EF is to terminate the outside plant cabling onto fiber optic shelving and establish the grounding for the Telecom system throughout the building using the Telecom Main Grounding Bus (TMGB).

5.8 Building Controls

5.8.1 Building Automation System: For the CUP, provide separate control systems, panels, conduit and wiring for the BAS, fire alarm, smoke management, security systems, and lighting controls. The BAS control system and sequences of operation shall be designed to accommodate the mechanical HVAC design.

5.8.1.1 BAS Subsystems: The BAS shall be comprised of two subsystems. The Niagara Framework™ ("Niagara"), a Java-based technology developed by Tridium. The Niagara 4 supervisor is the server application, and the JACE controllers are distributed controllers utilized as combination gateway / router devices and plant controllers. The field level controllers ("FLC") are where control algorithms reside and where sequences are implemented and accomplished. These controllers can be manufacturer-specific so long as they can report to the Niagara Framework system; or, they can be JACE controllers configured with a Niagara workbench. This equipment shall operate as standalone and shall report status back to the higher-level HMI. The FLCs consist of sensors, indicators, actuators, final control elements, software interfaces to the higher-level HMI server.

5.8.1.2 Communications: The existing Niagara 4 framework system communications shall be IP-based using the BCN wired infrastructure.

5.8.1.3 Graphical Screens: New graphical screens shall be developed within the existing Niagara 4 framework for the CUP. The Niagara 4 supervisor software shall maintain all configuration, alarming and programming information for the BAS in addition to all trending, logging, historical archiving and security access. All alarms shall be texted to designated personnel within the TFC.

5.8.2 Sequence of Operations ("SOO") – Development

5.8.2.1 Preliminary Sequence of Operations: The SOOs described in this section is preliminary and should be considered guidance for the design team. The final version should conform to this Appendix as closely as practical considering the mechanical and electrical system design.

5.8.2.2 Operator adjustability: All setpoints, alarm limits, and timers are to be adjustable at the operator-interface level through a higher security login; they should not be hard-coded in the program code.

5.8.2.3 Local controller algorithms: All algorithms defined herein and required for operation of the plant shall be implemented in the local controller. Any communications required for plant operations or equipment sequencing may occur if the following is true:

The status of those communications is monitored and loss of communications link results in an alarm generated at the HMI; and

Redundant paths shall be established through the network to allow alternate communications such as use of Rapid Spanning Tree Protocol (RSTP).

5.8.2.4 Layers: Under no circumstance shall a P, PI or PID implementation be allowed to occur over the IP based layer 2 network. This includes the process variable, manipulated variable or other outputs and inputs including cascade and feedforward variables. Setpoint resets may occur over a layer 2 network. No control system functionality shall be allowed to occur in a layers 3 and above. Control variables cannot be routed. This does not apply to data such as trends and setpoints from the HMI, data for archival storage and other non-timing parameters associated with PID loops.

5.8.2.5 Autonomous operation: The local plant or AHU controller shall contain all necessary application software and data to operate their respective systems autonomously upon a temporary loss of communications with the HMI servers. All data for archival and reporting purposes shall be sent to the HMI servers upon restoration of normal communications.

5.8.2.6 Independent operator selection: For all equipment, the operator shall be able to select the run sequence of fans, pumps and chillers. A dialogue window shall be created to allow and operator to independently select the sequence for:

Primary chilled water pumps;

Secondary chilled water pumps;

Cooling towers; and

Chillers.

5.8.2.6.1 In addition, the operator shall be able to remove specific equipment from the rotation in order to perform maintenance, repair, etc., using the dialogue box.

In the event of a failure, the remaining device shall ramp up to take full load and the failed device shall be faulted and the operator notified.

In all cases, a minimum of one device (pumps, chillers) shall be operated.

5.8.2.6.2 Chiller and primary chilled water pump redundancy is N+1, meaning thermal loading can be met with all but one of the total quantities of equipment.

The operator shall be able to designate any chiller, any primary chilled water pump and any cooling tower to be the standby equipment by selecting the starting sequence from 1 to N and stopping sequence from N back down to 1, where N is the number of equipment available for automatic control.

5.8.2.7 Commissioning: All sequences shall be verified by the commissioning agent, the owner or the owner’s representative during the commissioning of the control system.

5.8.2.7.1 Preliminary SOOs, IO matrices, and control diagrams shall be provided to TFC at the end of the design development phase.

5.8.2.7.2 Final SOOs, IO matrices and control diagrams (100 percent coordinated and complete) shall be provided to TFC at the 50 percent construction document submission.

5.8.3 SOO – Chilled Water Plant Production and Distribution Equipment

5.8.3.1 CHW system operational intent: The CHW system provides CHW service for the Complex HVAC systems. The control philosophy is to calculate the chilled water production tonnage and compare that value to the sum of all the secondary loop calculated tonnages and to sequence chillers and primary chilled water pumps on that basis.

5.8.3.2 Plant Manager ("PM") Control: The PM control panel shall:

5.8.3.2.1 Monitor and stage chillers and pumps and cooling towers as necessary to satisfy the load.

5.8.3.2.1.1 Monitor, stage and modulate the primary chilled water pump VFDs as required to maintain the chilled water system differential pressure and minimum water flow rates.

5.8.3.2.1.2 Chiller "system enable" shall start the following sequence of events:

The next chiller in the sequence will be enable by the plant controller.

The next CHWP in the startup sequence will be started.

The chiller isolation valves will be slowly ramped open at a rate not to exceed 3 degrees per second (30 seconds for a quarter turn butterfly isolation valve). The integrator shall optimize the travel rate so as not to stress piping and equipment.

Simultaneously, the cooling tower isolation valves for next cooling tower in the startup sequence will be ramped open at a rate not to exceed 3 degrees per second (30 seconds for a quarter turn butterfly isolation valve). The integrator shall optimize the travel rate so as not to stress piping and equipment.

Simultaneously, the next CW pump in the startup sequence will be started and ramped up to operational speed. The bypass valve is a NO valve that shall be modulated fully closed before enabling cooling tower flow and fan sequences.

The cooling tower bypass valve and fans shall be sequenced to control the condenser water supply temperature to setpoint. The PID algorithm shall add and remove fans from operational status and output the same control signal to all operational cooling tower fans.

5.8.3.2.1.3 The chiller shutdown sequence is the same starting with the chiller disablement and following the same sequence as the chiller enablement.

5.8.3.2.1.4 The final operational intent is to avoid any hardwired or logical associations between a chiller and ancillary equipment such as pumps or cooling tower fans. Any enabled pump or tower shall be able to operate with any of the chillers if the HOA is in the AUTO position.

5.8.3.2.1.5 The operator with sufficient privilege, shall establish the operational run sequences of each pump, chiller and cooling tower including the secondary chilled water pumps. If the next chiller, pump or fan is commanded to run and faults then that equipment is alarmed and the next equipment in the sequence is commanded to run.

5.8.4 SOO – Start-Stop Primary and Secondary CHWPs and Condenser Water Pumps

5.8.4.1 Plant Manager Control: Refer to the PM section for sequencing of all CHW and condenser water pumps.

5.8.4.1.1 Input Device:

VFD Run Status

VFD Fault Status

VFD HAND OFF AUTO Switch Status

5.8.4.1.2 Output Device: Binary output to start or stop the pump VFD.

5.8.4.1.3 When a start command is sent to the pump, the following actions occur:

5.8.4.1.3.1 The controller checks to ensure the HOA switch is in the AUTO position, else a “pump not available” message shall be generated for the operator.

5.8.4.1.3.2 The controller shall wait up to an adjustable 5 second delay to receive the status feedback that the pump is operational. Once received the pump shall be ramped up to the operational speed of the other water pumps. All pumps shall operate at the same speed and thereby generate the same discharge head.

5.8.4.1.3.3 If the ON status is not received or changes state during operation for any reason, then:

The ON run status is not received within the specified time delay.

The VFD general fault is TRUE.

During operation, the status changes from ON to OFF while commanded to be ON.

The pump shall be faulted and the operator notified. The next pump in the sequence shall be started.

5.8.4.1.3.4 Always operate a minimum of one pump.

5.8.4.1.3.5 All pumps should operate at the same speed and be controlled by a single PI or PID algorithm.

5.8.4.1.3.6 Resetting a pump fault shall require an operator to change the HOA status from AUTO to the OFF position and then back to AUTO. The operator shall be notified that the fault has been cleared.

5.8.4.2 Operational control of primary chilled water and condenser water flow through the evaporator and condenser bundles respectively: Start or stop pumps when the system is energized as described elsewhere in this Appendix.

5.8.4.2.1 A flow meter shall be installed on the condenser water and primary chilled water flow piping for the purpose of measuring condenser and evaporator flow.

The flow shall be modulated by the control valve via a PI control algorithm. The setpoint value is established by manufacturer for the optimum flow through each and verified during system commissioning.

5.8.4.2.2 The intent of maintaining a constant water flow across the condenser and evaporator bundles is to compensate for variations in equipment quantities and plant dynamics.

5.8.4.2.2.1 The process variable for controlling flow through chillers shall be enabled on all operating chillers. Chillers that are disabled shall have the PI flow control algorithm disabled.

5.8.4.2.2.2 Condenser and evaporator control valves shall all be fail open / normally open.

5.8.4.2.3 The control response is direct acting: as the flow decreases below setpoint, the associated control valve shall open, thereby increasing the water flow rate.

5.8.4.3 Operational Control of Primary Chilled Water Pumps: Start or stop pumps when the system is energized as described elsewhere in this Appendix.

5.8.4.3.1 The primary CHWPs shall have VFDs that are manually set during the TAB phase. No modulation of the pumps will be required.

5.8.4.3.2 When a chiller is enabled, then the next primary CHWP in the sequence shall start. Likewise, when a chiller is disabled, the last pump that was enabled shall stop.

5.8.4.3.3 If the feedback for the selected pump is not received by the controller within the adjustable time-delay period, then fault that pump and start the next pump in the sequence and set a high-level alarm.

5.8.4.4 Operational Control of Secondary Chilled Water Pumps: Start or stop pumps when the system is energized as described elsewhere in this Appendix.

5.8.4.4.1 The secondary chilled water pump speed shall be modulated via a PI algorithm to control the differential pressure process variable to a constant setpoint across the secondary chilled water loop. The setpoint value for each independent loop is established by the TAB Contractor during system Cx.

5.8.4.4.2 The control is a PI algorithm that measures the process variable, and the output response is reverse acting: as the differential pressure decreases, the secondary CHW flow rate shall increase proportionally to restore the process variable to the differential pressure setpoint.

5.8.4.4.3 CHW differential pressure transmitters located in other locations throughout the Complex shall be used to reset the setpoints of the of the pump controllers to ensure all areas have sufficient CHW differential pressure. The setpoint reset transmitters shall be able to communicate to the PID control algorithm via BACNet/IP based communications. The PID itself, however, shall be hard wired; it may not use an IP based protocol.

Setpoint reset schedules shall be determined during the TAB portion of Cx when the dynamics of the distribution can be evaluated.

Input Devices: Provide differential pressure transmitters in the chilled water supply and return piping.

Input Devices: Provide building setpoint reset differential pressure transmitters.

Output Device: Provide system command to VFDs.

Action: Modulate the variable speed drives for operating pumps as required to maintain differential pressure.

5.8.4.5 Operational Control of Tertiary (Building) Chilled Water Pumps and Heat Exchangers: Each building shall have two (2) chilled water heat exchangers with the primary connected to the secondary loop chilled water and the secondary side connected to the building or tertiary chilled water.

5.8.4.5.1 The HX process variable is the supply temperature on the secondary side. The setpoint shall be 42 to 45ºF and shall modulate a control valve located in the primary CHW return pipe. The position of these valves and subsequent flow rates shall influence the differential pressure across the secondary loop whose control is described elsewhere.

5.8.4.5.2 The secondary chilled water supply temperature, normally open control valve shall be modulated via a PID algorithm to control the supply temperature process variable to a constant setpoint for the HX primary inlet chilled water loop.

5.8.4.5.3 The output response of the HX differential temperature PID algorithm is reverse acting: as the supply pressure increases above setpoint, the fail-open or normally open CHW control valve shall close proportionally to restore the process variable to the differential pressure setpoint.

5.8.4.5.4 HX chilled water controllers shall report the position of the control valve in the secondary loop to the Plant controller. If, during the occupied mode, all of the valve positions are less than 20 percent open (adjustable) for more than 10 minutes or greater than 90 percent open for more than 10 minutes (adjustable), then the plant controller shall reset the CHW supply temperature setpoint per a reset schedule.

5.8.4.5.5 Start and stop for the tertiary CHWPs when the system is energized is described elsewhere.

5.8.4.5.6 The tertiary CHWPs shall be modulated via a PI algorithm to control the differential pressure process variable to a constant setpoint for the building chilled water loop. The setpoint value for each building loop is established by the TAB Contractor during system Cx of that building.

5.8.4.5.7 The output response of the building differential pressure PI algorithm is reverse acting: as the differential pressure decreases, the tertiary chilled water flow rate shall increase proportionally to restore the process variable to the differential pressure setpoint.

5.8.4.5.8 The pumps maintain CHW supply and return flows to the building loop through differential pressure sensors mounted within the loop.

5.8.4.5.9 If the operational pumps speed is greater than 90 percent for more than 2 minutes (adjustable), or if the operational pumps speed is greater than 95 percent for more than 5 seconds (adjustable), then the next pump in the rotation shall start.

5.8.4.6 Operational Control of Condenser Water Pumps: Start and stop for pumps when the system is energized as described elsewhere in this Appendix.

5.8.4.6.1 The condenser water pumps shall have variable frequency drives that are manually set during the TAB phase. No modulation of the pumps will be required.

5.8.4.6.2 When a chiller is enabled, then the next condenser water pump in the sequence shall start. Likewise, when a chiller is disabled, the last pump that was enabled shall stop.

5.8.4.6.3 If the feedback for the selected pump is not received by the controller within the adjustable time-delay period, then fault that pump and start the next pump in the sequence, and set a high-level alarm.

5.8.4.6.4 The operator shall be able to select the order in which the pumps shall be started and run.

5.8.4.7 Failure Modes

5.8.4.7.1 Analog Instrumentation Failure

5.8.4.7.1.1 All analog inputs shall use 0-10VDC or 4-20mA, 24 VDC transmitters.

5.8.4.7.1.2 The analog values shall be scaled to engineering units.

5.8.4.7.1.3 The analog values shall be validated to be in range and reliable.

Validation shall include the examination of the lower and upper range status bits.

All analog values must be validated before the value can be used in any program calculations.

Invalid analog data must generate a message to the operator at the HMI.

No single point of failure is allowed; therefore, the backup transmitter data must be validated and used in any algorithms if the primary value is invalid.

5.8.4.7.1.4 Output Device: System Alarm

5.8.4.7.1.5 Actions

Signal alarm to HMI;

Immediately initiate and validate data from the backup transmitter; and

Immediately lock out any transmitter with invalid data.

5.8.4.7.2 Valve Failure Modes

5.8.4.7.2.1 Chiller CHW Isolation Valves: Chiller CHW isolation valves located in Chilled Water Supply out of each chiller. Valves are two-position, fail last.

Input Device: Valve position end switches

Output Device: System Alarm

Action: At chiller start-up, if that valve fails to open, signal the alarm, initiate the start-up of next chiller in plant, and initiate the shut-down of the associated chiller.

Action: During chiller operation, if valve fails to remain open, signal the alarm, initiate the start-up of next chiller in plant, and continue operating the associate chiller (if it will remain operating) until manually commanded off by operator input.

Action: At chiller shut-down or during normal operations when chiller is off line, if that valve fails to close or remain closed, signal the alarm.

5.8.4.7.2.2 Chiller Condenser Water Isolation Valves: Chiller condenser water isolation valves shall be located in condenser water return out of each chiller. Valves are two-position, fail last.

Input Device: Valve position end switches

Output Device: System Alarm

Action: At chiller start-up, if that valve fails to open, signal the alarm, initiate the start-up of next chiller in plant, and initiate the shut-down of the associated chiller.

Action: During chiller operation, if that valve fails to remain open, signal the alarm, initiate the start-up of next chiller in plant, and continue operating the associated chiller (if it will remain operating) until manually commanded off by operator input.

Action: At chiller shut-down or during normal operations when chiller is off line, if that valve fails to close or remain closed, signal the alarm.

5.8.4.7.3 Loss of Communications/Unreliable at Chiller Control Panel: If there is a direct loss of communications with the a chiller control panel, or a signal from this controller is determined to be not reliable, the system shall deem this controller “COMM LOST,” and shall signal loss of communications alarm. All output functions shall hold the last valid input value.

5.8.4.7.4 Loss of Power, Utility Failure & “Short-Break” Mechanical Loads: The Control shall monitor the presence or the loss of electrical power to the central plant. Refer to electrical one-lines for more detail of electrical distribution.

Input Device: Statuses from Chiller Control Panel of kW consumption.

Statuses from any other electrical load indications as shown on drawings.

Output Device: System Alarms

Action: Signal the alarm; suppress all central plant equipment alarms in a power outage; and generate a power loss message for the operator at the HMI. Upon restoration of normal operation, restore the normal alarming capability after an adjustable time delay.

5.8.4.7.5 **Controls Failure/Loss of Communications/Unreliable at Local Controller Level:** In the event that there is a direct loss of communications with a local controller or, a signal from this controller is determined not reliable, the system shall deem this controller "FAILED", as well as the entire "daisy-chained" system associated with this controller, and shall:

5.8.4.7.5.1 Signal the alarm.

5.8.4.7.5.2 The local controller shall continue to control as normal and shall buffer all archival data until normal communications are restored; then all buffered data shall be uploaded.

5.8.4.7.5.3 Loss of communications shall only cause a loss of archival capability and visibility into the system operation by the operator.

5.8.4.8 SOO: Cooling Tower Control Sequences

5.8.4.8.1 **Cooling Tower System Operational Intent:** The cooling towers reject the heat of compression and the heat from within the building into the atmosphere. Control for each system shall be provided by the dedicated DDC controls that serve the chiller plant.

5.8.4.8.2 **Plant Manager Control:** The PM control panel shall monitor and control cooling tower fans to maintain the condenser water supply temperature at setpoint regardless of the outside air psychometric conditions.

5.8.4.8.3 The condenser water supply temperature is measured in the supply header. Starting and stopping variable speed cooling-tower fan(s):

5.8.4.8.3.1 When a start command is sent to the cooling tower fan motor, then:

The controller checks to ensure the HOA switch is in the AUTO position; if not, a "fan not available" message shall be generated for the operator.

The controller shall energize the two cooling tower isolation valves and open them. A positive confirmation from the feedback that the valve is open will allow the associated fan to be energized next. If an open status is not received within the time delay, that tower shall be faulted, all outputs de-energized, and the next tower in the sequence shall be enable. An alarm message shall be generated.

The condenser water temperature controller shall start the fan and wait up to an adjustable 5 second delay to receive the status feedback that the pump is operational.

5.8.4.8.3.2 If the ON status is not received or changes state during operation for any reason, then:

The ON run status is not received within the specified time delay.

The fan motor general fault is TRUE.

The fan motor vibration switch is set.

Oil safety in the transfer case is set (if used).

During operation the status changes from ON to OFF while commanded to be ON.

The fan shall be faulted and the operator notified. The next fan in the sequence shall be started.

5.8.4.8.3.3 Fans shall never be faulted regardless of their status, if the HOA switch is not in AUTO.

All fans should operate at the same speed and be controlled by a single PI or PID algorithm.

Resetting a fan fault shall require an operator to change the HOA status from AUTO to the OFF position and then back to AUTO. The operator shall be notified that the fault has been cleared.

5.8.4.8.4 Operational Control of Cooling Tower Fans

5.8.4.8.4.1 The cooling tower fans shall be controlled via a PI algorithm to control the condenser water supply temperature process variable to a constant setpoint. The setpoint value shall be established by the chiller manufacturer recommendations.

5.8.4.8.4.2 The condenser water setpoint shall be reset based upon the outside air wet bulb temperature plus a manufacturer specific recommended approach temperature. The reset schedule shall be set between limits of minimum and maximum condenser water supply temperature requirements of the selected chillers.

5.8.4.8.4.3 Input Devices: Temperature transmitters in common condenser water supply main and Outdoor Wet Bulb Sensor.

5.8.4.8.4.4 Output Device: System command to CW bypass valve and cooling-tower fan motor controllers / VFDs. All cooling tower fan VFD's shall be modulated together with the same signal.

5.8.4.8.4.5 If the combined operational fan speeds are > 90% for more than 2 minutes (adjustable) or if the combined operational fan speeds are >95% for more than 5 seconds (adjustable) then start the next fan in the rotation. Continue this sequencing until all fans required to meet setpoint are operational. The cooling tower bypass valve shall initially be open before any fans are enabled for operation. As the CWST begins to increase, modulate the bypass valve closed start the first fan in the sequence. Likewise, when sequencing down, modulate the bypass valve open to control CWST only after all cooling tower fans are off.

Sequence the cooling towers on based on an operator-selected order of operation. Towers shall be sequenced off based on highest accumulated runtime.

Upon failure of communication the control system, fans shall fail to last known fan speed.

5.8.4.8.4.6 The operator shall be able to select the order in which the pumps shall be started and run.

5.8.4.8.5 **Control of Cooling Tower Basin Makeup Water:** The condenser water level in the cooling tower cell basins shall be maintained. The pump system of at least two pumps shall have a lead/lag configuration. The lead pump shall be designated by run time accumulation.

5.8.4.8.5.1 **Basin Level:** Level transmitters in the basin shall be used in a low-select algorithm. Below the Low limit setpoint (adjustable), the lead makeup water pump shall start and operate at a constant minimum speed. The makeup water pump shall operate until all level transmitters indicate high level.

5.8.4.8.5.2 **Domestic water bypass valve:** Provide backup in case both makeup water pumps have failed, or

Low-Low level of the makeup water tanks shall prevent the pumps from operating; or

The operator shall manually initiate a sequence that can be used for maintenance.

If either of these conditions exist, the valve shall be opened unless a High-High condition is received from the level transmitters, in which case an alarm shall be sent and the valve closed.

5.8.4.8.5.3 **Maintenance on a tower that has a lower transmitter installed:** The radar sensor may be taken out of the low-select algorithm to prevent false control of the makeup water pumps or domestic water bypass.

5.8.4.8.5.4 **Flow meter:** A flow meter shall be installed on the discharge side of makeup water pumps and domestic water bypass totalizes makeup water flow.

5.8.4.8.6 **Failure Modes**

5.8.4.8.6.1 **Makeup Water Pump Start/Operating Failure:** In case of makeup water pump failure:

Input Device: Soft or Hard-wired Fault

Output Device: System alarm; start next pump in rotation.

Action: Signal the alarm, immediately initiate start-up of next makeup water pump in order, and immediately shut down associated makeup water pump, if operating.

5.8.4.8.6.2 **Cooling Tower Start/Operating Failure**

Input Device: Soft or Hardwired Fault

Output Device: System alarm

Action: Signal the alarm; immediately initiate start-up of next tower system in order; immediately shut down the failed cooling tower; and close isolation valves at failed tower.

5.8.4.8.6.3 **Valve Failure Modes:** Cooling tower condenser water isolations valves shall be located in condenser water supply to each cooling tower. Valves are two-position, fail to last position.

Input Device: Valve position end switches

Output Device: System alarm

Action: During tower operation, if the valve fails to remain open: Signal the alarm; initiate start-up of next tower in plant; immediately shut down the failed cooling tower. Continue to operate the associated tower, if it will operate, until manually commanded OFF by operator input.

At tower shut-down or during normal operations when the tower is offline, if that valve fails to close or remain closed, then signal the alarm.

5.8.4.8.6.4 In case of loss of power or utility feed, controls failure, loss of communications, or an unreliable local or plant controller level, refer to chiller sequences above.

5.8.5 SOO: Air Handling Unit with Economizer Control Sequence (Variable Volume):

The SOO can vary depending on the arrangement of the AHU and should be completed after the mechanical arrangement is finalized.

5.8.5.1 **AHU with ECON Operation Intent:** The outside air system for the building consists of one unit. The unit shall respond to a duct differential pressure control signal for supply and return fan control. Unit discharge air temperature control shall allow for independent control but utilizing a common discharge air temperature setpoint. The primary requirement of the outside air system is to provide outside air for the designated space within the building. This is accomplished by maintaining constant discharge conditions year around.

5.8.5.2 Start and Stop Supply Fan(s)

5.8.5.2.1 Permissive: Freeze Protection

Input Device: Duct-mounted averaging element thermostat TSL-1

Output Device: Hard wired through motor starter; DDC system alarm

Action: Allow start if duct temperature is above 37 F; signal alarm if fan fails to start as commanded.

5.8.5.2.2 Permissive: High-temperature Protection

Input Device: Duct-mounted thermostat located in return air TT/MT-1

Output Device: Hard wired through motor starter; DDC system alarm

Action: Allow start if duct temperature is below 150 F.

5.8.5.2.3 Permissive: Supply and Return Damper Position

Input Device: Return air damper position ZSO-1; supply air damper position ZSO-5.

Output Device: Return air damper actuator XD-1; supply air damper XD-5.

Action: Allow start if the position switches from both dampers indicate the dampers are in the open position.

5.8.5.2.4 Interlock: Smoke Control from Smoke Detection System

Input Device: Duct-mounted smoke detectors located in supply air duct

Output Device: Smoke detection system hard wired through motor VFD; DDC system alarm

Action: Allow operation if duct is free of products of combustion.

5.8.5.2.5 Start Fan

Input Device: DDC system command

Output Device: DDC system digital outputs to intake and discharge air damper actuators and supply air fan variable speed drive.

Action: Open the intake damper; open the discharge damper; and start the unit via signal to variable speed drive.

5.8.5.3 Normal Mode Operation: The normal mode of operations is distinguished from the economizer mode by the operation of the exhaust, return and outside air dampers. Refer to economizer mode for additional information.

5.8.5.3.1 Supply Fan Control

5.8.5.3.1.1 Volume Control

Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to conditioned-space static pressure

Output Device: DDC system analog output to motor speed drive. Set variable-speed drive to minimum speed when fan is stopped.

Action: Maintain constant supply-duct static pressure.

5.8.5.3.1.2 High Pressure

Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.

Output Device: DDC system binary output to alarm panel.

Action: Stop fan and signal alarm when static pressure rises above excessive-static-pressure set point.

5.8.5.3.2 Hydronic Cooling Coil Control: Discharge-Air Temperature

Input Device: Duct-mounted dry-bulb temperature sensor.

Output Device: Normally open modulating control valve for the chilled water.

Cooling Mode Action: Maintain discharge dry-bulb temperature PID set point (adjustable) with 1°F dead band.

5.8.5.3.3 Hydronic Heating Coil Control: Discharge-Air Temperature

Input Device: Duct-mounted dry-bulb temperature sensor.

Output Device: Normally open modulating control valve for the chilled water.

Cooling Mode Action: Maintain discharge dry-bulb temperature PID set point (adjustable) with 1°F dead band.

5.8.5.3.4 Modulating Damper Control: Discharge-Air Temperature

Input Device: Duct-mounted dry-bulb temperature sensor

Output Devices: Damper actuators

Output Device: Outside air damper in the minimum ventilation position with no modulation

Output Device: Exhaust air damper in the closed position with no modulation

Output Device: Return air damper in the fully open position with no modulation

Action: When the outside air enthalpy (Btu/lb) is greater than or equal to the return air enthalpy for more than 20 minutes (adjustable), then enable the normal mode of operation.

5.8.5.3.5 Supply Air Temperature Reset ("SATR") and Duct Static Pressure Reset ("DSPR")

5.8.5.3.5.1 The purpose of the reset strategies is to conserve energy when possible and to optimize system operation. The BAS shall poll the VAV box controllers for the positions of the inlet dampers. The goal is to keep all of the damper positions within the minimum VAV inlet to maximum VAV inlet of the total throttling range.

Minimum VAV Inlet = 30 percent open (adjustable)

Maximum VAV Inlet = 90 percent open (adjustable)

$$\sum_{1}^{0.5n} \text{VAV Inlet box positions} \big/ _{n} < \text{Minimum\_VAV\_Inlet}$$

where n = number VAV boxes served.

If more than 50 percent of the VAV box inlet damper positions are less than Minimum VAV inlet value, then the DSPR will be implemented first and the duct static pressure setpoint shall be adjusted downward to a minimum static pressure setpoint value to be established by the TAB contractor. If 10 percent (adjustable) of the VAV dampers serving a space is greater than 95 percent open (adjustable), then the SATR and DSPR modes of operation shall not be allowed.

If more than 50 percent of the VAV box inlet damper positions are still outside the desired throttling range for greater than the selected time delay, then the cooling discharge air temperature setpoint shall be adjusted upward to a progressively to a higher value. The maximum value of the supply temperature is 59°F.

$$\sum_{1}^{0.5n} \text{VAV Inlet box positions} \big/ _{n} > \text{Maximum\_VAV\_Inlet}$$

where n = number VAV boxes served.

If more than 50 percent of the VAV box inlet damper positions are greater than the maximum VAV inlet value, then the SATR will be recovered from first, and the discharge temperature setpoint shall be adjusted downward to an original setpoint of 55°F.

If more than 50 percent of the VAV box inlet damper positions are still outside the desired throttling range for greater than the selected time delay, then the duct static pressure setpoint shall be adjusted upward to the original static pressure setpoint value to be established by the TAB contractor.

5.8.5.3.5.2 The strategies shall be sequenced as follows:

DSPR will be implemented first down by resetting the duct static pressure setpoint downward to a minimum value.

If the TAB setpoint is established at 2” w.c. then, progressively adjust the duct static pressure setpoint to a minimum value of half the TAB-established setpoint.

Allow a minimum of 30 minutes (adjustable) to stabilize.

If the VAV box damper positions are within the desired throttling range then stop, else continue with the SATR.

The supply air setpoint shall be progressively adjusted upward to the maximum allowable value.

Allow a minimum of 30 minutes (adjustable) to stabilize.

SATR and DSPR

Input Device: VAV box inlet flow damper position

Output Device: Duct Static Pressure Control Algorithm then the Supply Air Temperature Control Algorithm. SA temperature is reset by adjusting the cooling and or heating coil positions via the PID setpoint.

Action: Adjust the setpoint of DSPR then SATR as described above.

Recovery to normal operations. As the VAV box damper positions begin to modulate to the fully open position the reverse sequence of operations described will occur.

SATR will reset the supply air temperature setpoint downward to the original setpoint value.

Allow a minimum of 30 minutes (adjustable) to stabilize.

If the VAV box damper positions are within the desired throttling range then stop, else continue with the resetting DSPR upward back to the original setpoint.

Allow a minimum of 30 minutes (adjustable) to stabilize before making any other changes.

5.8.5.4 Economizer Mode Operation: The system should be in this mode of operation for the majority of the year.

5.8.5.4.1 Description of Operations: This mode of operation is defined as the once-through air flow path that takes advantage of free cooling conditions when the outside air enthalpy is less than the return air enthalpy.

This mode is distinguished by the modulation control of the return, exhaust and outside air dampers. The setpoint for the economizer PID control is fixed between the setpoints for the hot water coil and the chilled water coil. Refer to those sections for the values.

5.8.5.4.2 Initiation and Recovery from the Economizer Mode

5.8.5.4.2.1 When $h_{outside}$ is greater than h_{return} for more than 30 minutes, begin economizer mode.

5.8.5.4.2.2 When the outside air dry bulb temperature is low enough that the outside air and return air streams blend to a mixed air temperature that is equal to the setpoint of the hot water loop with 1°F dead band, then the outside and exhaust air dampers shall be in the minimum position, and the return air damper shall be in the fully open position. As the damper arrangement can no longer blend heat from the space into the air stream, the mixed air temperature will begin fall. When the MAT is falls low enough, the hot water temperature control PID (see operations normal mode above) will begin to control the discharge temperature to setpoint.

5.8.5.4.3 Supply Fan(s) Volume Control

5.8.5.4.3.1 Volume Control

Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to conditioned-space static pressure.

Output Device: DDC system analog output to motor speed drive. Set variable-speed drive to minimum speed when fan is stopped.

Action: Maintain constant supply-duct static pressure.

5.8.5.4.3.2 High Pressure

Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.

Output Device: DDC system binary output to alarm panel.

Action: Stop the fan and signal alarm when the static pressure rises above excessive-static-pressure set point.

5.8.5.4.4 Return Fan(s) Volume Control

Input Device: Calculation to bias the speed of the return fan to be set initially at 5 percent slower that the supply fan. Bias is adjustable and will be finalized during TAB.

Output Device: DDC system analog output to motor speed drive. Set variable-speed drive to minimum speed when fan is stopped.

Action: Maintain constant bias of offset lower than the supply fan speed.

5.8.5.4.5 Hydronic Cooling Coil Control: No change from normal mode operation.

5.8.5.4.6 Hydronic Heating Coil Control: No change from normal mode operation.

5.8.5.4.7 Damper Control: Discharge Air Temperature

Input Device: Duct-mounted dry-bulb temperature sensor

Output Device: The outside air damper modulates using a direct acting signal proportional to the integrated PID error and increases flow as the process variable increases above the setpoint.

Output Device: The exhaust damper modulates in unison with the outside air damper.

Output Device: Return air damper, using a reverse-acting proportional to the integrated PID error, decreases flow as the process variable increases above the setpoint.

Action: The AHU mixed-air temperature PID algorithm shall modulate the three dampers to maintain the mixed-air temperature setpoint.

5.8.5.4.8 SATR and DSPR: No change from normal mode operation.

5.8.5.5 Start and Stop Hot Water Recirculation Pump

5.8.5.5.1 Enable the pump to operate independently of AHU operation. Start and stop control shall be enabled when the heating mode is active or when the freeze thermostat switch changes state due to low inlet dry bulb air temperature.

5.8.5.5.2 When outside air dry bulb low temperature limit is set, the pump shall be started.

Input Device: Hot water discharge temperature PID control output

Output Device: DDC system digital outputs to Pump MCC controller

Actions:

Check that HOA switch is in AUTO Position

If the PID-commanded output is greater than or equal to 1 percent (adjustable), then start the pump.

Ensure Run status is set within the adjustable time delay; if not, alarm the pump.

If the PID-commanded output is less than or equal to 1 percent (adjustable), then stop the pump and ensure Run status is reset within the adjustable time delay.

5.8.5.6 Filters: Differential Pressure

Input Device: Differential Pressure Transmitter

Output Device: DDC system alarm

Action: Signal the alarm on low- and high-pressure conditions.

5.8.5.7 Coordination of AHU Sequences: The controls contractor shall coordinate with the AHU-provided sequence to ensure that heating-coil and cooling-coil controls have common inputs and do not overlap in function.

5.8.6 SOO – AHU Recirculation Only (Constant Volume)

5.8.6.1 AHU Operation Intent: The unit shall be a constant volume air flow for supply fan control. The unit space temperature shall modulate the cooling coil to control space dry bulb temperature. The primary requirement of the air system is to provide sensible cooling in the spaces served. The VFD on the fan motor shall be set to soft start, and air flow will be set at the time of TAB.

5.8.6.2 Start and Stop Supply Fan(s)

5.8.6.2.1 Permissive: Supply and Return Damper Position

Input Device: Return air damper position; supply air damper position

Output Device: Return air damper actuator; supply air damper

Action: Allow start if the position switches from both dampers indicate the dampers are in the open position.

5.8.6.2.2 Interlock: Smoke Control from Smoke Detection System

Input Device: Duct-mounted smoke detectors, located in supply air duct

Output Device: Smoke detection system hard wired through motor VFD; DDC system alarm

Action: Allow operation if duct is free of products of combustion.

5.8.6.2.3 Start Fan

Input Device: DDC System Command

Output Device: DDC system digital outputs to intake and discharge air damper actuators and supply air fan variable speed drive

Action: Open intake damper; open discharge damper; and start unit via signal to variable speed drive.

5.8.6.2.4 Normal Mode Operation

5.8.6.2.4.1 Supply Fan(s) Volume Control

Input Device: Start Command from DDC

Output Device: DDC system discrete output to motor speed drive.

Action: VFD shall ramp up to the final operational speed.

5.8.6.2.4.2 Supply Fan(s) High Pressure

Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.

Output Device: DDC system binary output to alarm panel.

Action: Stop fan and signal alarm when static pressure rises above excessive-static-pressure set point.

5.8.6.2.4.3 Hydronic Cooling Coil Control: Space dry-bulb Temperature

Input Device: Duct-mounted dry-bulb temperature sensor

Output Device: Normally open modulating control valve for the chilled water

Action: Maintain space dry bulb temperature set point of 75°F (adjustable)

5.8.6.2.5 Filters: Differential Pressure

Input Device: Differential pressure transmitter

Output Device: DDC system alarm

Action: Signal alarm on high-pressure conditions.

5.8.7 SOO – Computer Room Air Handling Units ("CRAH")

5.8.7.1 General: Each CRAH unit is provided with its own manufacturer provided controller that will manage all internal controls specific to each unit. The DDC system shall monitor all critical white space conditions, via 2 controllers per data hall, and shall globally control the CRAHs by adjusting fan speeds to maintain static pressure setpoint. Also, the system shall give the operator the ability to set the supply air temperature setpoint remotely and to be locally controlled by the CRAH.

5.8.7.2 Communications: All communications for each CRAH unit shall be per the communications module with the BACNet/IP protocol.

5.8.7.3 Start and Stop CRAH(s)

5.8.7.3.1 Automatic Start/Restart

Input Device: System cooling demand request

Output Device: Hard-wired from dedicated white space controller to start/stop point on individual CRAH controller

Action: Command all white space CRAHs to start.

5.8.7.3.2 Manual Start/Restart

Input Device: Local operator interface to integral package controller

Output Device: Hard-wired from dedicated white space controller to start/stop point on each CRAH controller.

Action: Allow the operator to manually start and stop an individual CRAH unit via the available control interfaces.

5.8.7.4 Supply Fan Variable Speed Control: Volume Control

Input Device: Integral to manufacturer package controller.

Output Device: Integral to manufacturer package controller.

Action: Report fan speed to HMI.

5.8.7.5 Temperature, Chilled Water, and Return Air Control

Input Device: Integral to manufacturer package controller

Output Device: Integral to manufacturer package controller

Action: Report Return Temperature to HMI.

5.8.7.6 Referenced Equipment Tag Numbers: Refer to mechanical schedules.

5.8.8 SOO – Duct Mounted Humidifiers

5.8.8.1 General: Two units are provided in a duct for critical control areas. Refer to the mechanical Division 23 drawings for locations and areas served. Each individual humidifier unit is provided with its own self-contained package controller that will manage all internal controls specific to each unit. The system shall be provided with a BACNet/IP interface for communications with the Niagara Framework Supervisor 4 system via a dedicated CAT 6 connection. The operator shall be able to adjust the space dewpoint temperature setpoint remotely.

5.8.8.2 Start and Stop DH Units

5.8.8.2.1 Automatic Start/Restart

Input Device: Self-contained based on airflow availability

Output Device: Self-contained package controller

Action: Control humidification within the duct.

5.8.8.2.2 Manual Stop/Restart: Refer to manufacturer documentation.

5.8.8.3 Space Dewpoint Temperature Control: Space dewpoint temperature control is self-contained.

5.8.8.3.1 Input Device: One factory space dewpoint temperature sensor located in room.

5.8.8.3.2 Output Device: BACNet/IP communications to Niagara Supervisor 4

5.8.8.3.3 Action: Once CRAH unit fan speeds have been reduced to unit minimum, reset the supply air temperature setpoint of all CRAH units together as required to maintain space temperature.

5.8.8.4 Referenced Equipment Tag Numbers: Refer to Mechanical Schedules.

5.8.9 SOO – Terminal Unit Operating Sequence (not all terminal unit configurations apply)

5.8.9.1 Occupancy Sensors: Occupancy sensors shall be integral to terminal box thermostats and used to initiate features of the unoccupied mode during occupied hours. Features shall include local resetting of the room space temperature setpoint after an adjustable time delay has expired and reporting the unoccupied status to the Niagara Supervisor.

5.8.9.1.1 Occupancy sensors shall not be used in common areas such as corridors and entrance facilities.

5.8.9.1.2 Space temperature reset schedule shall be as follows:

Occupied Temperature

Summer 75°F

Winter 70°F

Unoccupied Temperature

Summer 78°F

Winter 68°F

5.8.9.2 All terminal unit controllers shall report the operational parameters to the controller of the AHU serving the boxes for the purpose of supply air static pressure and supply air dry bulb temperature reset strategies.

5.8.9.3 Four-Pipe, Two-Coil, Fan-Coil Unit with Hydronic heating and cooling, typical

5.8.9.3.1 Occupied Time Schedule

Input Device: System time schedule

Output Device: Binary output

Action: Start and stop fan and enable control

5.8.9.3.2 Room Temperature

Input Device: Electronic temperature sensor in room

Output Device: Electronic control-valve operators

Action: Modulate heating and cooling control valves. Sequence cooling valve from full open to full closed position, then heating valve from full closed to full open.

5.8.9.4 Two-Pipe, Two-Coil, Fan-Coil with Hydronic heating and cooling

5.8.9.4.1 Occupied/Unoccupied operations

Input Device: Occupancy Sensor/Occupancy Schedule

Output Device: Binary output

Action: Occupied Mode – Start fan and enable space temperature control.

Action: Unoccupied Mode – Cycle fan on/off in order to maintain unoccupied mode space temperatures.

5.8.9.4.2 Room Temperature

Input Device: Electronic temperature sensor in room

Output Device: Electronic control-valve operators

Action: Modulate heating and cooling control valves to maintain space temperature. Sequence cooling valve from full open to full closed position, then heating valve from full closed to full open.

5.8.9.5 Two-Pipe, Single-Coil, Fan-Coil without heat, typical

5.8.9.5.1 Occupied Time Schedule

Input Device: Occupancy Sensor/Occupancy Schedule

Output Device: Binary output

Action: Start and stop fan; enable control.

5.8.9.5.2 Room Temperature

Input Device: Electronic temperature sensor in room

Output Device: Electronic control-valve operator

Action: Modulate valve to maintain temperature.

5.8.9.6 VAV, Terminal Air Units with Hydronic Heating: Room Temperature

Input Device: Electronic temperature sensor

Output Device: Electronic damper actuators and control-valve operators

Action: Modulate damper and control valve to maintain temperature. Sequence damper from full open to minimum position, then valve from closed to full open.

5.8.9.7 Constant-Volume, Outside Air Terminal Air Units: Ventilation

Input Device: Box mounted airflow sensor

Output Device: System analog output

Action: Maintain constant supply air volume.

5.8.9.8 Constant-Volume, Exhaust Air Valves: Exhaust

Input Device: Box-mounted airflow sensor

Output Device: System analog output

Action: Maintain constant exhaust air volume.

5.8.9.9 Variable-Volume, Outside Air Terminal Air Units

Input Devices: Box-mounted airflow sensor; Exhaust air volume value for the exhaust terminal serving the associated battery room

Output Device: System analog output

Action: Using the exhaust air volume as the process variable, maintain constant air volume offset of negative 200 CFM.

5.8.10 SOO – Ventilation Sequences

5.8.10.1 Refrigeration Machinery Room Exhaust Fans for chiller plants: System shall start/stop the exhaust fans and monitor status.

5.8.10.1.1 "Normal" fan operation shall be with exhaust fan off and motorized dampers to fan coil units (purge air) shall be closed.

5.8.10.1.2 "Purge" mode, initiated upon signal from refrigerant leak detection system or the "Break Glass" switch, the system shall:

Start the exhaust fan to full flow.

Open dampers purge dampers to fan coils.

Signal an alarm at the central workstation.

System shall remain in this mode until manually reset by the operator at the Central Workstation.

5.8.10.1.3 If a fan fails to start or ceases to operate, indicate and alarm and notify the responsible party.

5.8.11 SOO – Boiler Control Panel and BAS Interface

5.8.11.1 Panel: The panel shall include the power switch, control power transformers, and all operating and safety controls, including but not limited to terminations for proof of water flow, contacts for feed water pump control, oil pump, gas train safety interlocks, combustion blower starters and alarm horn. The panel shall be a one-point interface for the BAS. At a minimum, the following BAS IO are required.

5.8.11.1.1 Inputs: Boiler Status, Operational Status, Low / High Fire and General Alarm; Local/Remote mode of operation

5.8.11.1.2 Outputs: Boiler Enable

5.8.11.1.3 Action: When all safeties and interlocks report safe condition, the boiler will enable itself to begin the heating mode of operation. \The boiler enable output from the control system will be disregarded if the local / remote switch is in the local position. BAS input only occurs in the remote position.

5.8.11.1.4 Burner: The manufacturer will be responsible for sequences to control ignition, starting and stopping of burner, and provide both pre-combustion purge and post combustion purge. The burner shall shut down in event of ignition, pilot, or main flame failure. The interlock shall shut down burner upon combustion air pressure drop.

5.8.11.1.5 Switches: The manual automatic selector switch and damper motor positioning switch shall permit automatic firing in accordance with load demand or manual control of firing rate at any desired point between low fire and maximum rating.

5.8.11.1.6 Indicator Lights: The panel shall include indicator lights to show operating conditions of low water level, flame failure, fuel valve open, and load demand. Mount indicator lights and switches in a hinged drop-panel for wiring to access.

5.8.11.2 Boiler Sequencing Control Panel (for multiple boilers)

5.8.11.2.1 Manufacturer furnished: The sequencing control panel shall be furnished by the boiler manufacturer to provide the sequencing of the boilers based on load demand.

5.8.11.2.2 Controls: The panel shall have the following pilot controls:

Power on;

Boiler lead, fail, status (one for each boiler);

Lead boiler selector switch;

Power ON/OFF switch;

Boiler sequence bypass switch (one for each boiler);

Alarm horn;

Alarm silence push button; and

Light test button.

5.8.11.2.3 Boiler Sequencing Control

A decrease in main header pressure will signal the control panel.

Control panel will then call the boilers on-line in sequence in proportion to the amount of variation from the setpoint. Lag boilers will not be energized until the lead boiler and subsequent lag boilers have been modulated to high fire.

Boilers shall be modulated down in sequence as the load is satisfied.

In the event the lead boiler fails to start, the sequencing panel shall energize and start the lag boiler.

A sequence bypass switch shall be provided for each boiler, returning the boiler to the control of the boiler-mounted control panel.

5.8.12 SOO – Miscellaneous Control Sequences

5.8.12.1 Refrigeration Machinery Emergency System: Break Glass type control switches, constructed, installed and identified in accordance with Section 606 of the IFC, shall provide positive shut-down of all nonessential equipment located in the Level 01 Mechanical Room. Verify that the existing system complies with these requirements.

5.8.12.1.1 System shall shut down the chillers within the associated central plant.

5.8.12.1.2 Operator Workstation – Display the following data:

Switch Location and Status

System Alarms

5.8.12.2 Analog measurements: signal validation

5.8.12.2.1 Analog input signals must be validated before their values can be used in control and measurement algorithms.

Over-range bits (or their functional equivalent in the selected control system) can be examined to determine if the process variable is above the upper limit of the range. This condition is usually caused by a short circuit in the field wiring or transmitter.

Under-range bits (or their functional equivalent in the selected control system) can be examined to determine if the process variable is below the lower limit of the range. This conditioned is usually caused by an open circuit in the field wiring or transmitter.

5.9 Surveillance Security Systems

Refer generally to the OPR for electronic surveillance and physical security requirements. Provide card-access control at all exterior entries; provide door monitor sensors at all exterior entries and at all overhead and coiling doors. Provide video surveillance with adequate lighting, CRI, and resolution for all exterior entries and overhead or coiling doors.

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