Design Guidelines & Specifications

September 18, 2015

ADDENDUM #2

Effective date: September 18, 2015

This addendum forms a part of the FSU Design Guidelines & Specifications and modifies the current edition, posted effective August 2012. Projects beginning design after the effective date of Addendum #2 shall be reviewed relative to compliance with these requirements. Compliance requirements for projects which began design ***prior*** to the effective date of September 18, 2015, shall be reviewed by FSU Facilities on a case-by-case basis.

Technical Construction Specifications

A2-1 **DELETE** Existing Section: "Mechanical Narrative", Division 15000 – Mechanical Utilities and Equipment. **ADD:** new Division 15000 – Mechanical Utilities and Equipment, dated 10/13/14. **Click HERE to view attachment!**

A2-2 **DELETE** Existing Section: "BAS Integration Standard". ADD: new Division 15000 – "BAS Integration Standard", 2014. **Click HERE to view attachment!**

A2-3 **DELETE** Existing Section: "HVAC Controls". **ADD:** new Division 15000 – "Control Design Guidelines", dated 10/13/14. **Click HERE to view attachment!**

A2-4 **DELETE** Existing Section: Division 16000 – Electrical. **ADD:** new Division 16000 – "Electrical", dated 10/13/14. **Click HERE to view attachment!**

--End of Addendum No.2--

DIVISION 15000 - MECHANICAL UTILITIES AND

EQUIPMENT Part 1 – GENERAL

Introduction

The Florida State University Mechanical Design Guidelines were created to assist the design professional in the development of projects that meet the specific needs of the University. In general, the guidelines are not fully descriptive of all mechanical design. In fact, the intent is that engineers from the Utilities & Engineering Services team will be involved in the project from program development through commissioning. The team will work closely with the A/E team assigned to the project to assist in the development of a conceptual design that satisfies both the details specified in the Design Guidelines as well as a review of other design elements. The conceptual design will be reviewed for compatibility with other University priorities such as reliability, maintainability, and energy conservation.

The design review process, as provided by the Utilities & Engineering Services team will primarily review project documents for compliance with agreed upon design concepts. It is expected that the A/E team will be fully responsible for ensuring that the designs meet applicable codes. In the spirit of cooperation, the Utilities & Engineering Services team will willingly share any advice or recommendations that may simplify or enhance the final design.

Process Simplification

Mechanical Design has become unnecessarily complex over the past several years. Some of the reasons noted by design professionals are that compliance with LEED, the Florida Energy Code, and/or other initiatives necessitate the complexity. The reality of modern building design is that many of the challenges to MEP designers are more effectively resolved in the architectural design phase. The expectation is that the architectural design should facilitate a simple MEP design. The MEP design should have the minimum amount of complexity to meet the building performance requirements.

Energy Conservation

The Mechanical Design Guidelines direct the A/E team to determine an estimated EUI (kBtu/sqft) early in the conceptual design process. The projected building consumption should be in line with other buildings of the same type and occupancy. The specific energy design goal will be mutually agreed upon by the A/E and Utilities & Engineering Services teams.

1.1 Overview

A. Coordination of utility connections: All utility work shall be coordinated with and approved by Utilities & Engineering Services through the Project Manager.

B. Utility Connection Approval: Utility work and connections to University utility systems must be properly planned to prevent disruption of classes, research efforts or life in the Residence Halls... All utility work shall be coordinated with the Utilities Section through the University Project Management Section. Each drawing that shows a connection to existing utilities must have a note that states that the Contractor shall request permission for all outages as far as possible in advance. This shall be a minimum of 14 days except in case of emergency. It shall be noted that even with the advance notice, it will not always be possible to grant the requested time and date, as classes and research must have precedence. Permission must be obtained, through the project manager, from the Utilities Section. Explicit details must be shown for all connections to existing utilities. Utilities & Engineering Services must approve both the location and method of the proposed connection, in advance... Note: this applies both to temporary construction utility connections as well as the permanent utility connections.

1. It shall be the responsibility of the A/E to investigate and determine the actual location of all underground utilities or obstructions at the building site before beginning design work. The University will provide all available information as appropriate.
2. The construction contract specifications shall provide for the orientation and training of University personnel on all installed equipment and systems.
3. The contractor shall pay for utilities during construction, including, but not limited to electricity, chilled water, steam, and water. The contractor shall contract with the City of Tallahassee whenever possible. If it is necessary to have construction utilities supplied from the University, the contractor shall install temporary services in accordance with local codes. The University will bill the contractor monthly for utilities used. Shall the University wish to make an exception to this; the A/E will be so informed.
4. Heat, air conditioning, humidity control and any other environmental factors shall be the responsibility of the contractor throughout the construction period.

C. Life Cycle Cost Analysis: The Architect/Engineer shall conduct a life-cycle cost analysis of alternative architectural and engineering designs **prior to the creation of construction drawings** to evaluate the efficiency of energy utilization for competing designs in the construction of new buildings. These requirements also apply to major building renovations including the replacement of major energy consuming equipment in existing buildings. The University Project Manager will advise the A/E as to the time during the Design that this life cycle analysis is due.

1. Such life-cycle costs shall be the sum of:

    a. The reasonably expected fuel costs over the life of the building, that are required to maintain illumination, power, temperature, humidity, and ventilation and all other energy-consuming equipment in a facility, and

    b. The reasonable costs of probable maintenance, including labor and materials, and operation of the building.

2. To determine the life-cycle costs the analysis shall include, but not be limited to:

(a) The orientation and integration of the facility with respect to its physical site.

(b) The amount and type of glass employed in the facility and the directions of exposure.

(c) The effect of insulation incorporated into the facility design and the effect on solar utilization of the properties of external surfaces.

(d) The variable occupancy and operating conditions of the facility.

(e) An energy consumption analysis of the major equipment of the facility's heating, ventilating, and cooling system, lighting system, hot water system, and all other major energy-consuming equipment and systems as appropriate. This analysis shall include:

(f). The comparison of alternative systems.

(g). A projection of the annual energy consumption of major energy-consuming equipment and systems for a range of operation of the facility over a 25 year life of the facility. The analysis shall include the replacement costs of major equipment that has a life expectancy of less than 25 years. Projections must accurately reflect anticipated kBtu/sqft. Building EUI must be demonstrated to be within the range of other best performing within its class.

(h). The evaluation of the energy consumption of component equipment in each system, considering the operation of such components at other than full or rated outputs.

3. The Architect/Engineer shall prepare data, make the input and run the analysis on an appropriate Life-Cycle Cost Computer Program such as the Trane Trace Ultra 600, Carrier HAP 3.0, Elite Software's Energy Program or other program based on DOE standards and approved by the University.

4. Before preparing the data, the Architect/Engineer shall discuss the energy-saving schemes proposed for the Project with the university Project Manager and the Director of Utilities & Engineering Services. The Architect/Engineer shall submit two sets of the following to the Owner: cover letter discussing the energy saving schemes considered, the computer results, the Architect/Engineer's recommendations and discussion of other energy-saving measures incorporated into the Project design, copy of the university Project Manager's written concurrence with the schemes and the complete computer run printout. The university Project Manager will notify the Architect/Engineer of the approved scheme to incorporate into the project.

D. Owner Project Requirements - LEED: The intent of the Owner's Project Requirements Document is to detail the functional requirements of a project and the expectations of the building's use and operation as it relates to commissioned systems.

The Owner's Project Requirements Document should be completed before the start of design and furnished to the design team and Utilities & Engineering Services. It must be completed prior to the approval of Contractor submittals of any commissioned equipment or systems to meet LEED requirements.

E. Metering: All utilities are to be metered for each building, including electricity, water, steam, natural gas and chilled water. All utility metering must be coordinated with the University Project Manager prior to construction. All metering devices must have the capability to report to the Campus Energy Management System via the BAS secondary field level network used in the building. If the building contains Auxiliary occupants in addition to E&G occupants, separate metering must be provided for each Auxiliary occupant. This shall be coordinated with Utilities & Engineering Services and Utilities Accounting through the Project Management Section. All meter selections and their installation location for any meter used for Utility billing purposes must be approved by the Director of Utilities & Engineering Services.

F. Separation for noise control: separate mechanical equipment and other noisy areas from academic and office areas.

G. Outdoor air inlet location: Care shall be taken in the placement of all outdoor air inlets to ensure that odors and other pollutants (automobile exhaust, generator exhaust, fume hood exhaust, etc.) do not enter the building.

H. Mechanical Room Access: Mechanical rooms must have adequate openings to facilitate the removal and replacement of major pieces of equipment. Provide double 3'-0" doors which swing outward, with active/inactive leafs.

I. Equipment Access: There must be adequate space in mechanical rooms to provide ample access space around all equipment for routine maintenance items and procedures, such as filter replacement, lubrication, and so on. Equipment room size must be approved by the Director of Facilities Maintenance and the Director of Utilities & Engineering Services once final equipment selections are complete.

J. Access to mechanical rooms: shall not be through other rooms. It is preferred that access to these spaces be achieved from a main corridor and/or exterior space. Access shall not be by ladders. Where possible, penthouse rooms shall have elevator access.

K. Storage in Mechanical Rooms: Mechanical rooms and similar spaces are not to contain storage areas. All power disconnects to equipment shall be so located as to be easily accessed.

L. All HVAC controls: shall be of the direct digital type and conform to the standard outlined in Building Automation and Central Monitoring Systems.

M. Air eliminators: All hydronic systems shall have adequate air eliminators installed.

N. Central-Station air filtration: Provide MERV 9 air filtration or approved alternate rating on all central-station air handling units.

O. Steam Manhole design: shall be carefully coordinated with the University Project Manager and the Utilities Section. Contact Director of Utilities & Engineering Services for latest manhole standards.

P. Underground piping installation: All piping utilized for underground piping is required to have the ends sealed prior to storage or use on site. No end seals shall be removed until the end in question is actually ready for welding or otherwise connecting. In no event shall any piping be left in a trench with an open end at any time. This requirement shall be strictly enforced. All pre-insulated pipe must be installed per manufacturer's instructions.

Q. Systems Test & Balance: will be provided through the A/E as an additional service. The specifications will require the contractor to participate in the testing, make any changes necessary and pay for any re-testing that may be required to make the systems meet specifications. A copy of the Testing & Balance report shall be made available upon completion to the Utilities & Engineering Services team.

R. Air Handling Unit Condensate Drains: All air handling unit condensate drain pans must drain to the storm sewer system, with a by-pass to the floor drains when using chemicals to clean coils.

S. Return air plenums: Mechanical rooms shall not be utilized as return air plenums.

T. Ventilating and cooling of Mechanical rooms: Mechanical rooms that generate heat such as steam rooms and pump rooms shall be cooled using a thermostatically controlled forced air ventilation system utilizing outdoor air. Generally, pump rooms and similar spaces with electronic systems such as variable speed drives, shall be separated from rooms containing steam reducing stations and condensate pumps. Wherever possible, intake air shall be directed into the pump room and removed from the steam room. If cooling using outdoor air is considered not feasible, an alternative cooling scheme shall be submitted to the Director of Utilities & Engineering Services for approval.

U. Labeling of mechanical equipment: such as air handlers, pumps, exhaust fans, etc., shall be referred to and labeled by floor number, i.e., EF3-5 would be the fifth exhaust fan on the third floor. Equipment schedules shall indicate use, area served and power source.

V. Demarcation between new insulation and existing asbestos insulation: The A/E shall contact the University Department of Environmental Health and Safety Asbestos Coordinator prior to the commencement of a renovation project in order to determine the specifications for labeling and demarcation of the extent of new (non-asbestos) pipe insulation applied by the mechanical contractor following any abatement of asbestos pipe insulation for the project.

W. Piping & Valve signage: Pipe signage shall include color coded labeling for material conveyed as well as direction of flow. All physical valve tags must correspond to the mechanical drawings.

Z. Utilitzation of the district utilities:

Steam - Whenever possible, utilize the campus steam system as a heating source with pumped condensate return to the Central Utilities Plant.

Chilled Water - Utilize the campus chilled water system for cooling if at all possible. When the air conditioning system cannot be connected to the Central Chilled Water System, contact the Director of Utilities & Engineering Services to discuss potential alternatives.

Part 2 - PLUMBING

2.1 Overview

A. Floor drains: are to be provided in all toilet rooms, custodial closets and mechanical rooms. Where necessary, are to be placed at the lowest point in the area.

B. Strainers: All piping system strainers shall be equipped with valves for blowdown cleaning.

C. Hose bibs: shall be provided in toilet rooms located underneath the sink, mechanical rooms and at 100-foot intervals in exterior areas for maintenance use.

D. Joint sealer: Teflon containing joint sealer shall be utilized in all screwed piping installations.

F. Valve Boxes: All exterior valves shall be fitted with a complete one-piece valve box unit constructed of concrete, steel or plastic. The box shall have a protective cover and be set in concrete. The installation shall be such to support small vehicle and lawn maintenance equipment.

G. Urinals: Urinal model and type will be specified by Florida State University Design & Construction and approved by the Director of Facilities Maintenance. Urinals shall be

provided with automatic flushing sensors. Urinals shall be designed to meet the gallon per flush requirements of the Florida Building Code.

H. **Lavatory Faucets:** shall be provided with automatic sensors. Where sensors are not considered cost effective, timed shut off valves shall be used. Flow rates shall comply with the Florida Building Code.

Washbasins: Standard type washbasin shall have strainer type drain, lever handles equipped for handicapped use, cold water faucets, no hot water faucets (except in dormitories and service buildings) and soap dispensers. Use of hot water in any other locations is prohibited except when approved by the Director of Utilities & Engineering Services.

J. Water Closets: shall be wall mounted and designed to meet the gallons per flush criteria of the Florida Building Code.

K. Custodial closet faucets: shall be single delivery mixing type with hot and cold water and have threaded spout equipped with a vacuum breaker and a three-foot hose. Place faucets 30" - 36" above sink rim.

L. Bottle Refilling Stations: In new facilities, provide at least one drinking fountain which includes a bottle refilling station. This unit should be located on the ground floor and be readily accessible from the main entry. Installation should be ADA compliant.

M. Domestic Water Piping: Below grade, all domestic cold water piping exterior to building shall be ductile iron or PVC. Underneath buildings, piping shall be type K copper or ductile iron. All domestic water piping inside the building and above grade shall be type L copper, except for high purity water. Materials for high purity water systems shall be coordinated with the University Project Manager.

N. Domestic water pipe insulation: all domestic hot water piping shall be insulated with Armaflex pipe insulation and the domestic cold water piping that is exposed in unconditioned spaces shall be insulated with Armaflex to prevent sweating. All elbows should be void free. In general a pre-formed or 3 three sectioned mitered elbow should be sufficient. All insulation must be installed as to be a continuous system.

O. Water Meters and Taps: The City will furnish water meters and taps for domestic and fire water.

P. Tap fees and system charges: shall be paid for by the Contractor. The City of Tallahassee has jurisdiction over the installation. Install water meters and water backflow preventers above grade and provide insulated cover. Install backflow preventers in accordance with City Ordinance. Contact the City for their requirements and information. The City's approval for all proposed connections must be received prior to completion of the 100% documents. Written proof of the City's approval must be provided to Utilities & Engineering Services prior to bidding the project.

2.2 - WATER BASED FIRE EXTINGUISHING SYSTEMS (Where required)

A. Water Based Extinguishing System: The contractor shall furnish all labor and equipment for the complete installation of a water based fire-extinguishing system and shall be the installing contractor or site representative with the required license. No subcontracting will be allowed. The contractor must be NICET level III certified and must possess the appropriate class I or class II fire sprinkler license as required by the State of Florida.

B. Codes: Fire water based systems shall be installed, inspected, tested and certified per appropriate NFPA 13, 14, 20, 24, 25, including NFPA 101. Any applicable codes shall apply to meet State of Florida and Fire Marshal requirements, local and state jurisdiction.

C. Warranty: The fire system contractor shall be responsible for equipment, materials and workmanship of the system for one year. The warranty shall be enforced 24 hours a day, contractor will also respond after being advised of his responsibility and the nature and/or

condition of the equipment that has failed by the FSU Fire Systems on-call technician. After notification has been made to the responsible equipment contractor, a maximum of one hour will be allowed to respond and arrive on site. When the problem has been secured or corrected to the satisfaction of the technician o the FSU Police Department will be notified.

D. Backflow preventers: The installation of fire water mains shall included backflow preventers in accordance with TREEO (Training Research & Education for Environmental Occupations) set forth by the University of Florida and NFPA requirements including City Ordinance. Contact them for their requirements and information. All fire mains and/or valves shall be painted and labeled to indicate the proper building name controls. The City must approve all connections to the City water mains. The City's approval must be received prior to completion of the 100% documents. Written proof of the City's approval must be provided to the Utilities Section prior to bidding the project.

E. Connections and fittings: Fire water system connections and fittings shall be compatible with the City of Tallahassee Fire Department fittings. Contact them for information.

F. Spare escutcheon plates: Provide six extra Escutcheon Plates of each type installed on any system, installer will provide manufacturer name and address, supplier name and address and parts number.

G. Drains and inspectors test drains: The main drains and inspectors test drains be piped to an adequate drain or outside the building. When piped outside the drain shall not affect the architectural design and landscaping of the building. When piped outside the building, the water flow shall not pose a threat to persons on sidewalks or streets adjacent to the building.

H. Gauges: Provide 3-1/2" gauges with a connection not smaller than 1/4", and each gauge connection equipped with a shutoff valve and provisions for draining.

I. Valves: All control, drain and test connection valves shall be provided with permanently marked weatherproof metal or rigid plastic identification signs. The sign shall be secured with corrosion-resistant wire, chain or other approved means.

J. Valve signage: All control valves will have proper signage to indicate the areas of coverage. This will start from the feed supply into the building through all branch lines.

K. On systems with fire pumps: the use of PVC and/or plastic pipe, fittings, or components will not be acceptable.

2.3- HEATING AND STEAM

A. Steam Pressure: Steam is supplied at pressures varying between 70 psig and 125 psig, depending on the season. The building steam systems shall have a maximum utilization pressure of 50 psig and shall be designed to operate with the inlet pressure to the building varying between 70 psig and 125 psig.

B. Pipe Materials: All high pressure and low pressure steam piping shall be Grade A ASTM A53B, schedule 40 seamless piping, and condensate return lines shall be schedule 80 seamless pipe. The use of pre-insulated steam and condensate return piping is permissible. Contact the Director of Utilities & Engineering Services for currently approved types and manufacturers.

C. Expansion Loops: All steam and steam condensate lines underground shall have properly sized expansion loops, which shall be properly anchored. If pre-insulated piping is used, the expansions loops shall be sized and located per manufacturer's instructions.

D. Valves: Valves installed above grade as part of the high-pressure steam system, and valves installed below grade, shall be 300 lb. valves. Valves that are 2-1/2" and larger shall be flanged, and all valves less than 2-1/2" shall be screwed. For valve requirements in steam manholes, contact Director of Utilities & Engineering Services for latest manhole standards. See Controls Design Guidelines for control valve standards.

E. Pipe connections: All piping that is 2-1/2" and larger shall be welded, not

screwed. A certified welder shall weld all underground fittings.

F. Steam pipe fittings: High pressure steam fittings 2" and larger shall be butt-welded and flanges shall be weld neck flanges. 1-1/2" and smaller shall be forged steel screwed or socket weld. Unions that are 2" or smaller shall be 300 lb. screwed cast iron or forged steel. High pressure steam nipples shall be schedule 80. Low pressure steam fittings that are 2" and larger shall be schedule 40 butt welded fittings, and flanges shall be weld neck type. Low pressure steam fittings that are 1-1/2" and smaller shall be 150-lb. cast iron using 300 lb. cast iron unions and schedule 40 nipples.

G. Condensate pipe fittings: Condensate lines that are 2-1/2" and larger shall be schedule 80 butt weld fittings and steel weld neck flanges that are the same pressure class as the valves. Condensate lines that are less than 2-1/2" shall be forged steel or socket weld using 300 lb. screwed unions and schedule 80 nipples.

H. Condensate receiver vents: All steam condensate receiver unit vents shall be run full size from unit to a safe discharge location. In no case is the discharge to be over a sidewalk or other public area. In addition, discharges shall not be located near air intakes.

I. Insulation:

Above Grade:for high and low pressure steam and condensate lines above grade shall consist of 2" Foamglas.

Below Grade: Condensate and steam lines shall be a 2" Foamglas outer layer wrapped with Pitwrap SS jacketing. Where Foamglas components are formed, Pittsburgh Corning Hydrocal B-11 shall be used as the bonding compound. All seams and joints shall be sealed with silicone caulking. Condensate lines below grade shall have Foamglas insulation wrapped with Pitwrap SS jacketing. The attachments for the insulation below grade shall be stainless steel wiring or bands, or 16 gauge copper wire, on 9" centers. Deviations from the above shall be approved by the Director of Utilities & Engineering Services. If pre-insulated pipe is considered, approval must be granted from the Director of Utilities & Engineering Services. See latest manhole standards for manhole insulation requirements.

J. Manufacturer's instructions: All insulation materials shall be installed according to the manufacturer's instructions.

K. Gauges: All pressure and temperature gauges shall be 4-1/2" face, bottom connection, and industrial grade. All temperature gauges shall be mounted in wells.

L. Steam pressure reducing valves: All steam pressure reducing valves shall be approved by the Director of Utilities & Engineering Services. Contact Director of Utilities & Engineering Services for currently approved steam pressure reducing valves.

M. Condensate pumping units: All condensate pumping units shall be above grade and shall be duplex electric pumps with cast iron receivers and ceramic seals. The pumps shall be equipped with balanced mechanical seals. Steam pressure powered pumps are not acceptable.

N. Water pumps: shall be equipped with balanced mechanical seals.

O. Drip traps: Install drip traps before all thermostatic temperature-regulating valves and pressure reducing valves. All drip traps should be TLV JS3X series. Use #10 orifice for pressures over 30 psi and #2 orifice for pressures 30 psi or lower. If a larger trap is required, contact Utilities & Engineering Services for recommendations.

P. Bolts and nuts: shall be hex configuration, coarse threaded, and be of ASTM A-193, Grade B7 alloy steel such as USS Supertanium alloy, or equivalent.

2.4 - CENTRAL UTILITY PLANT (CUP) CENTRAL CHILLED WATER SYSTEM/BUILDING INTERFACES

A. General: The following are requirements for new building designs in order to best produce the most efficient utilization of the Central Utility Plant (CUP) system, utility distribution system, and the building.

1. The Central Utility Plants are designed as a variable flow system to achieve maximum energy economics. The design of the building shall be such as to operate over a varying pressure range.
2. The connection between the building and the Central Chilled Water Distribution System shall be approved by the Director of Utilities & Engineering Services. The building pump(s) and the distribution pump(s) shall be completely decoupled.
3. The CUP is operated to produce 45 to 48 degrees F. chilled water depending on overall system needs and energy conservation measures being utilized.
4. Existing pressures leaving the CUP vary from 50 to 85 psig. Be aware that the maximum operating pressure for the existing chilled water underground piping is 100 psig. Any additions to this system shall be designed for 150 psig.

2.5 - AIR CONDITIONING

A. Chilled Water- A fine mesh monel or stainless steel strainer shall be installed in the chilled water supply line of each building to prevent contamination of the building chilled water system. All chilled water strainers shall have a pressure gauge installed across the strainer so as to quickly determine when strainers are fouled.

B. Air conditioning condensate lines: All air conditioning condensate lines shall be of insulated type "L" copper or approved equal.

C. Equipment surface condensation: If condensation occurs on the outside of insulated ducts, HVAC equipment, VAV boxes, flex ducts, piping, etc. during the construction period, the Project Team shall take immediate action to determine the reasons, and initiate corrective action. Substantial Completion shall not be approved until corrections are completed. The contractor shall be required to rework the insulation until satisfactory if condensation occurs on any cold surface at any time during the warranty period.

D. Chilled water system taps: All chilled water taps into the Central Chilled Water System shall be made without system interruption, where feasible. Each juncture shall be provided with a shut off valve and valve box for easy access. Note that much of the existing underground Chilled Water System piping is constructed of asbestos bearing material, i.e. Transite. "Hot tapping" details will be provided by the University. All chilled water connections, whether external or internal, must be coordinated with and approved by the Utilities Section. Initial coordination concerning the approved location of new connections must be done prior to completion of the Schematic Design Phase.

E. Exterior chilled water piping: shall be schedule 40 black steel with welded joints. The use of pre-insulated black steel pipe is permissible. Contact Director of Utilities & Engineering Services for currently approved types and manufacturers.

F. Chilled water pipe insulation (field insulated): Above grade shall consist of foamglas that is covered with a .016 inch thick aluminum weatherproof jacket that has a factory applied integral vapor barrier. The foamglas shall be glued to the piping. Fasten with aluminum bands located not

more than 12 inches apart. Insulation below grade shall be foamglas with Pittwrap cover. Piping 2" or less in a mechanical room may be insulated with Armaflex. All elbows should be void free. In general a pre-formed or 3 three sectioned mitered elbow should be sufficient. All insulation must be installed as to be a continuous system.

G. Variable flow chilled water requirement: All building chilled water systems served from central chilled water shall be designed to have variable flow characteristics compatible with the central system.

H. Chilled water shutoff valves: All chilled water piping shall be installed with shut-off valves at each floor and at each AHU. Valves 2" and smaller should be a ball valve with 316S SS ball and teflon seats. Larger valves should be butterfly valves.

I. Chilled water coil temperature rise: All major air handling unit coils shall be designed for not less than 15 degrees Fahrenheit temperature rise, and be provided with two way control valves.

J. Fan coil ventilation air: If fan coils are approved for use, they shall be provided with ducted, pre-conditioned ventilation air if feasible. The direct connection of un-conditioned ventilation air to fan coil units is generally prohibited.

K. Interior of air handling units: A/C Air Handling Units shall be double wall construction with a solid inner liner (no insulation exposed to airstream).

L. Internal vibration isolation: Air Handling Units shall have fans mounted on internal vibration isolators (2" static deflection).

M. Drain pan: Air Handling Units shall have stainless steel double wall insulated drain pan.

N. Air handling units installed in spaces exposed to outdoor air conditions: (such as attics) must be sufficiently insulated to prevent surface condensation.

P. Classroom ventilation: In classrooms, the HVAC system shall provide an adequate rate of fresh air in compliance with the Florida Energy Code. Where feasible, ventilation strategies shall be utilized to reduce ventilation air under conditions of reduced occupancy.

Q. Air Handling Units: Fan-wall systems are preferred, where appropriate. The fan management system for fan wall air handlers shall be approved by the Director of Utilities & Engineering Services.

R. **Hydronic System:** Circuit setters and pressure independent control valves shall not be used without approval of the Director of Utilities & Engineering Services.

2.6 - FUME HOODS

A. General: Due to safety and energy consumption implications of fume hoods and the constantly changing technology, the University has not established standards for fume hoods. Each installation shall be coordinated with the Project Manger and approved by Environmental Health and Safety and the Utilities & Engineering Services Director. In general the intent is to use hoods that can provide a minimum of 100 fpm face velocity and to provide remote monitoring of the sash position through the campus energy management system.

B. System Type: All fume hood flow control devices shall be of the blade style.

C. Performance: Fume hoods shall meet the following performance requirements: Supplier to provide factory ANSI/ASHRAE 110-1995 test of hood. Hood to have a rating of 4.0 AM 0.01 using the above test. Hood to be tested using ANSI/ASHRAE 110-1995 after installation in lab (testing to be provided and paid for by the hood supplier) and shall achieve a rating of 4.0 AI 0.05. If the hood does not achieve the rating, and the CFM and static pressure meet the supplier performance data, the fume hood supplier shall be responsible for any system changes and upgrades needed to achieve the "as-installed" rating.

2.7 - REFRIGERANT MANAGEMENT REQUIREMENTS

A. General Requirements

1. The contractor and mechanical engineering design professionals shall work with the Director of Facilities Maintenance, to identify specific requirements for each project and interpret requirements from this section as they pertain to upcoming work.
2. Mechanical engineering design professionals shall incorporate the requirements of this section in their equipment and contract specifications.
3. Contractor shall be responsible and accountable for compliance with the EPA Clean Air Act (CAA) Section 608, 40 CFR Part 82 and any state and local codes for all refrigerant-related work. Contractor shall ensure that all contractor employees are made aware of the content of these practices prior to beginning work on refrigerant containing equipment.
4. Contractor shall provide only proper level EPA certified technicians using EPA certified and registered recovery/recycle units to perform work on FO&M refrigerant equipment.

2.8 - BUILDING AUTOMATION AND CENTRAL MONITORING SYSTEMS

Contact the campus Director of Utilities & Engineering Services for the current requirements at the beginning of the Design Development Stage of the project.

Control System Integration Requirements
for connection to the Siemens Building Automation System at
Florida State University

PART 1 – GENERAL

1.01 All non Siemens Building Systems that communicate with the Campus BAS shall conform to the standard for communication for the University as stated herein. Proof of compliance will be required prior to listing in project specifications as an approved vendor. Listing as an approved vendor shall not reduce the requirements of this specification to be met.

1.02 Communication protocols to the BAS shall be fully described in the project specifications. The required communication method for all devices shall be via the *Secondary Network (FLN)* (See PART 2 – PROTOCOLS).

1.03 If there is no solution available utilizing a device that is native to the *Secondary Network*, devices that utilize a *Gateway* to translate to the *Secondary Network (FLN)* protocol may be considered. Vendors requiring the use of *Gateway* devices require pre-approval by the University and Siemens prior to being listed in project specifications as an approved vendor.

1.04 Vendor shall certify, via the *Systems Integration Certification form*, that their system fully integrates with the Siemens BAS for all agreed upon points. The form shall be signed off by both the vendor and Siemens.

1.05 Submittals including PICS statements shall be required prior to design development of projects for review and approval by the University. Equipment samples may be required for consideration and testing by the University and Siemens prior to review and approval.

1.06 Non Siemens Building Systems (Devices) is defined as equipment utilized at Florida State University within facilities for HVAC, Lighting, Power, etc to operate the facilities that this University intends to connect to the Campus Building Automation System of Siemens Field Panels and Servers. The connection shall allow the communication (bi-directionally) for building control, monitoring, alarming, scheduling, occupancy status, etc.

1.07 The Control Systems Integration Requirements document has attempted to minimize all potential integration issues. There shall be no variances to this standard granted without written approval of the Florida State University Central Utilities Department and Siemens.

PART 2 – PROTOCOLS

2.01 Accepted Protocols for Direct Connection to the BAS *Secondary Network (FLN)*

The project specifications will determine the protocol(s) available for connection to the BAS *Secondary Network (FLN)*. Since each project has specific requirements, the vendor should not assume that all of the protocols listed below are available for each project. Each Siemens field panel has a limited number of *Secondary Networks (FLN)* available and the protocols selected for each project are based on the systems architecture required to meet the overall design goals.

Accepted Protocols

A. Siemens P1
B. BACNet MS/TP
C. MODBUS RTU

2.02 Communication:

A. The required communication method for all devices shall be via the *Secondary Network (FLN)*

B. Primary Network – Campus APOGEE VPN Ethernet Communication:

1. All Siemens Building Controllers and Servers shall directly reside on the *Primary Ethernet Network* (ALN) such that communications may be executed directly between Building Controllers, or directly between server and Building Controllers on a peer-to-peer basis.

2. Non Siemens Building Controllers shall not connect to the Siemens Campus VPN Network except through the *Secondary Network (FLN)* as described below.

A. *Secondary Network (FLN)*: P1

1. Devices shall communicate directly via EIA-485 Twisted cabling to a Siemens Field Panel.

2. Devices covered under this section shall be currently listed in the Siemens *"APOGEE Integration Compatible Products Guide"* .

3. A maximum of (99) Devices may be configured on individual secondary networks to ensure adequate global data and alarm response times.

B. *Secondary Network (FLN)* : BACNet MS/TP

1. Devices shall communicate directly via EIA-485 Twisted cabling to a Siemens Field Panel.

2. Communication over the secondary network shall be BACnet MS/TP data layer protocol and MS/TP physical layer as is defined in ASHRAE 135-2004.

3. Devices covered under this section must meet BTL (BACnet Testing Laboratories) standards and shall be listed by BTL.

4. A maximum of (50) Devices may be configured on individual *Secondary Network*s *(FLN)* to ensure adequate global data and alarm response times.

C. *Secondary Network (FLN)*: MODBUS RTU

1. Siemens Field Panel shall operate as Modbus Master- MODBUS RTU shall only be used with permission from the Director of Utilities & Engineering Services.

2. Slave Devices shall communicate directly via EIA-485 Twisted cabling to a Siemens Field Panel.

3. Communication over the secondary network shall be Modbus RTU data layer protocol via RS-485.

4. A maximum of (31) Slave Devices may be configured on individual secondary networks without repeaters to ensure adequate global data and alarm response times. Additional addressing up to a total of (247) may be allowed subject to prior approval by FSU and Siemens.

2.03 Gateways

Some systems do not have a native communications protocol suitable for connection to the Siemens *Secondary Network (FLN).* If no other equipment is available that will fulfill the requirements of the design, upon special approval, equipment may be connected to the *Secondary Network (FLN)* via a *Gateway* Device that has been approved by FSU and Siemens.

Approved Devices

A. ICC ETH-1000
B. ICC XLTR-1000
C. Siemens PXC as a gateway for large BACNet MS/TP integrations.

Gateway Devices shall not be used without approval by the University and Siemens. In addition, the devices must conform to the requirements described in the Database section of this document.

2.04 Database

BACNet

A. All database and system network layouts including items described below shall be submitted for review and shall be approved by Siemens prior to allowance of equipment release.
   1. BTL Listing and Product Datasheets
   2. BACnet Instance Numbers conforming to University allocations
   3. Object Naming conforming to University standards
   4. System Riser and Layout shop drawings (project specific)
   5. Database settings for data communications variables
   6. Ability of all requested points to be polled without additional front end programming to allow intermittent switching between monitoring of points on the system connected to the *Secondary Network (FLN).*
   7. Signed *Systems Integration Certification Form*

B. Verification that all approved requirements have been met shall be required prior to connection to the Campus BAS and acceptance of the device.

MODBUS

A. All database and system network layouts including items described below shall be submitted for review and shall be approved by Siemens prior to allowance of equipment release.
   1. MODBUS Listing and Product Datasheets
   2. MODBUS Metadrops conforming to University allocations
   3. MODBUS Integrated Systems Binary (ISB) files conforming to University allocations
   4. Object Naming conforming to University standards
   5. System Riser and Layout shop drawings (project specific)
   6. Database settings for data communications variables
   7. Ability of all requested points to be polled without additional front end programming to allow intermittent switching between monitoring of points on the system connected to the *Secondary Network (FLN).*
   8. Signed *Systems Integration Certification Form*

B. Verification that all approved requirements have been met shall be required prior to connection to the Campus BAS and acceptance of the device.

PART 3 – PRODUCTS

3.01 Products

A. Devices defined include but are not limited to:

   1. Variable Frequency Drives, Motor Controllers
   2. Generators, ATS, Switchgear, Power Meters, Lighting Control.

3. Unitary HVAC Equipment (Chillers, Boilers, Roof top Units, DX Split Systems, DX Variable Refrigerant Flow Systems, PTAC, Computer Room AC Units, Process Coolers, Ductless Split Systems.
4. Individual classroom or small group of rooms lighting controls.

All Devices require prior written approval before being added to design documents for inclusion on a project or the campus

B. Devices that are native to the *Secondary Network (FLN)* AND are listed in the *"APOGEE Integration Compatible Products Guide"* for the *Secondary Network (FLN)* chosen in project design documents will be given preference over products requiring a 3rd party *gateway* device.

C. The Siemens APOGEE system functions as the primary building control system. In addition to providing the HMI function, the system also allows remote programming, program restoration functions, and a common PPCL language. The central server also integrates with other BI software systems via OPC and XML and is not addressed in this document. The intent of control systems integration is to provide a means to integrate major pieces of equipment with complex on board controls and field level devices to operate as a extension of the APOGEE system. Listed below are some system types that are excluded for use via a gateway device for connection to the *Secondary Network (FLN):*

1. Building controllers with non-PPCL programming used to manage other sub controllers utilizing DALI or other forms of distributed I/O.
2. Visualization clients or other forms of hardware designed to export information from the APOGEE system.

PART 4 – EXECUTION

4.01 In addition to the project specifications the following shall apply

A. Coordination with Siemens for all requirements is the responsibility of the device vendor and University assigned project/construction manager prior to project pricing and award.

B. All runs of communication wiring shall be un-spliced.

C. All communication wiring shall be labeled to indicate origination and destination data.

D. Communications and Systems wiring unless otherwise approved by the University shall be installed by Siemens or the University directly in accordance with all applicable Florida Codes and standards.

E. The contractor shall be responsible to install all required raceway(s), including pull string, for all involved components of the control system(s).

*****END OF SECTION*****

Control Design Guidelines - 2014

Introduction

The intent of the Control Design Guidelines is to assist the designer regarding the appropriate selection of a control system that will be reliable, maintainable, and conserve energy. Modern control systems are complex, but decisions made by system designers can greatly add to the complexity. Many engineers do not fully anticipate potential failure modes of proposed control systems. In addition, there is often the presumption that a control system should be able to overcome mechanical design flaws.

Good control design starts with good mechanical design. A significant amount of the Control Design Guidelines will focus on the expectations of both the mechanical designer as well as the controls engineer.

It is also important for the designer to differentiate in documentation the devices that are used to control processes versus devices that solely monitor performance.

The Control Design Guidelines will include both the building automation system (BAS) standards as well as lighting controls.

Process Simplification

Simple processes have fewer failure modes. When complexity is introduced, reliability typically is lowered. The core control scheme and associated software should be simple and straightforward. Prior to designing the control system, the controls engineer should fully understand the intent of the mechanical design. The expectation is that the controls engineer should challenge the mechanical designer and ensure that the whole system is reliable, maintainable, and able to conserve energy.

Overview

The Control Systems Integration Requirements Appendix to the Control Design Guidelines defines the relationship between various components of the Building Automation System (BAS). The Overview section includes some general guidance regarding the controls design philosophy of Florida State University.

<u>Hardware – Primary Controller</u>

All controls used as the primary Building Automation System (BAS) controller in any Florida State University building shall be shall be Siemens Apogee and programmable via the Siemens PPCL programming language. The controller shall be mounted in a NEMA 1 enclosure for standard installations. For special locations, the enclosure shall be rated for the specific condition and code requirements for the space.

The hardware shall connect to the Supervisory system (currently Siemens Insight) via BACNet IP or Siemens P2 Ethernet protocols.

The hardware shall include the capability to connect directly via the Secondary Network (FLN) via BACNet MS/TP, MODBUS RTU or Siemens P1 protocols. The selection of the specific protocol for a project shall be approved by Florida State University. The specific details for integration of devices are detailed in the Control System Integration Requirements Appendix to the Control Design Guidelines.

Hardware – Devices

As a general rule, Florida State University does not want to use IP based devices to connect with the Building Automation System (BAS). Devices include, but not limited to, flow meters, temperature sensors, variable speed drives, and lighting control panels.

The design engineer is expected to select devices in the most basic form. For example, if a temperature sensor is offered as a networked sensor versus a traditionally wired sensor, the designer shall provide justification acceptable to the Director of Utilities & Engineering Services.

Additional guidance regarding the connectivity requirements of devices to the Siemens Apogee control system is provided in the Control Systems Integration Requirements Appendix to the Control Design Guidelines.

Supervisory System

All primary field panels shall be able to connect with the existing Siemens Insight supervisory system. No non-Siemens hardware shall be connected directly to the Siemens Automation Level Network (ALN).

Addressing

Florida State University has a variety of addressing schemes that have developed over the past 30 years. Due to the complexity, the point addressing, building naming convention, and other addressing details shall be discussed with the Utilities & Engineering Services team and Siemens prior to the design.

Scheduling

The default schedule for all new buildings shall be Monday – Friday from 7 am – 6 pm. Other schedules based on customer requirements may be considered on a case by case basis. All schedules other than the default schedule must be approved by Utilities & Engineering Services prior to implementation.

Control Schemes

All controls schemes must be approved by Utilities & Engineering Services prior to system design. Suggested sequences and drawings can be made available upon request.

Commissioning

The primary intent of commissioning is to assure that the system conforms to the design and that the function is sufficient to meet the design requirements. Due to the high volume of unusual testing requests, the Commissioning Agent shall present a specific functional testing plan to the Utilities & Engineering Services team prior to starting the testing process. More specific commissioning guidance is available via the Commissioning Design Guidelines.

Data Collection / Trending

Data collection and trending, if improperly executed, can create a burden on the Building Automation System (BAS). Prior to design, the Controls Contractor and Design Engineer shall present a data collection and trending plan for approval by Utilities & Engineering Services.

Alarms

Florida State University requires several different types of alarming schemes for the control system.

1. Systems impacting entire campus – If the failure of a specific device has the potential to create a major impact on the entire campus, alarms should be sent to the Central Utilities Plant control room and key Utilities and Engineering Services staff shall be notified via the Remote Notification System (RENO).
2. Systems impacting a specific building – If the failure of a specific device has the potential to create a major impact in a specific building, alarms should be sent to the Central Utilities Plant control room and key Maintenance and Building staff shall be notified via the Remote Notification System (RENO)

Plans and Submittals

No construction shall commence until the plans and submittals are received and approved by Utilities & Engineering Services.

Control Contractor – Design Review

Siemens Industry, Inc., Tallahassee Factory Branch, the Controls Contractor, has primary responsibility to review the proposed design by the EOR with conformation to the specific requirements of the campus Building Automation System (BAS) as well as Florida State University requirements. Where there is disagreement between the Controls Contractor and the EOR, the Utilities & Engineering Services team will mediate the dispute. The final solution shall be approved by Utilities & Engineering Service prior to implementation.

Control Devices (valves, actuators)

All control devices shall be approved by the Utilities & Engineering Services team prior to inclusion in a campus project. Control devices shall be simple and reliable.

Sensors

IP based sensors shall not be used unless specifically required by the project and approved by Utilities & Engineering Services. Sensors requiring periodic calibration are discouraged. When a sensor requiring periodic calibration is selected, the EOR shall provide a written calibration plan.

Laboratory Controls

Laboratories are designed to meet specific research requirements. Due to laboratory complexity, the specific project requirements shall be discussed with the user groups, EH&S, and Utilities & Engineering

Services prior to design. Poor lab designs typically use more energy and offer the researchers a much lower margin of safety.

All laboratory controls shall be designed in such a way as to minimize the use of air in excess of the requirements by the code and EH&S. Siemens blade style air control devices shall be used for both supply and exhaust system.

All laboratories shall be able to be operated in an occupied and unoccupied mode. Use of variable volume systems is encouraged if there are significant offsetting energy or safety benefits. In all cases, the designer should be able to document any benefits via life cycle analysis of constant, two position, and variable volume for review.

Testing & Balancing

Testing & Balancing work shall be coordinated with the Controls Contractor to insure that accurate functional testing can be performed. Opposite season testing shall be a requirement for all testing & balancing projects.

Seasonal Switching

The Controls Contractor and the EOR shall ensure that the system is able to operate in all seasons without additional program or device modification. During the first year of operation, the system performance shall be verified by the testing & balancing contractor. Data shall be provided to Utilities & Engineering Services.

Graphics

The graphics standard is under review. All proposed graphics shall be included with the controls submittal and approved by Utilities & Engineering Services.

Construction Server

All panels added to the Siemens Apogee system must be managed via an existing construction server in order to minimize impact on the overall campus control system. When the completed project has been approved by Utilities & Engineering Services, the panel may be connected to the primary system.

During construction, the Controls Contractor shall provide alarms as required by the Florida State University Project Manager to key stakeholders.

Energy Conservation Strategies

All controls shall be configured in the most basic form to meet the space requirements while minimizing the consumption of energy. Complex controls schemes to save energy shall be prohibited unless the EOR can provide financial justification acceptable to Utilities & Engineering Services.

Diagnostics

Automated system diagnostics shall be performed at the field panel level via PPCL and in a separate program. The Siemens Apogee system has significant data traffic limitations that inhibit our ability to transfer large volumes of data to a central or 3rd party system.

Hardware Warranty

All hardware shall be warranted by the Controls Contractor for 1 year for both parts and labor. All control valves shall be warranted by the Controls Contractor for an additional 4 years for parts only.

Program Warranty

All programming shall be warranted by the Controls Contractor for 5 years. Hard lockouts of HVAC devices via PPCL shall be prohibited without approval of Utilities & Engineering Services. During the program warranty, Florida State University shall make no changes to the program without prior discussion with the Controls Contractor and the approval of the Director of Utilities & Engineering Services. Changes to system under warranty that are not approved by the Controls Contractor can only be approved by the Director of Utilities & Engineering Services.

Compliance Manager

All new systems shall be equipped with software that creates approval levels for the commanding of points.

Audit / Compliance Systems for Research

Audit and Compliance systems for the support of research departments are beyond the scope of the Controls Design Guidelines. Systems that integrate with the Building Automation System (BAS) and are designed to meet specific research requirements are generally funded directly by the research departments. Since each system has unique requirements, any of these types of systems will require additional review and approval by the Director of Utilities & Engineering Services.

Lighting Controls

All lighting controls must provide a set of dry contacts on each motion detector for each controlled room to be connected to the appropriate Building Automation System (BAS) controller. Prior to submitting a bid, the Lighting Contractor must coordinate with the Controls Contractor regarding the integration of systems and produce a written agreement regarding the control scheme. The agreement must be approved by Utilities & Engineering Services.

Lighting systems requiring scene control must be able to integrate with classroom audio visual systems. Specific requirements for these systems are included in the Classroom Design Guidelines.

Florida State University prohibits the use of whole building lighting systems. Lighting control systems shall control localized sections of the building and integrated, where financially feasible, with the Building Automation System (BAS).

The use of an addressable lighting system (such as DALI) is prohibited unless specifically required for scene control or if there is a significant energy savings. All addressable lighting control systems must be approved by the Director of Utilities & Engineering Services.

SECTION 16000 – Electrical

Part 1 - General

Introduction

The Florida State University Electrical Design Guidelines were created to assist the design professional in the development of projects that meet the specific needs of the University. In general, the guidelines are not fully descriptive of all electrical design. In fact, the intent is that engineers from the Utilities & Engineering Services team will be involved in the project from program development through commissioning. The team will work closely with the A/E team assigned to the project to assist in the development of a conceptual design that satisfies both the details specified in the Design Guidelines as well as a review of other design elements. The conceptual design will be reviewed for compatibility with other University priorities such as reliability, maintainability, and energy conservation.

The design review process, as provided by the Utilities & Engineering Services team will primarily review project documents for compliance with agreed upon design concepts. It is expected that the A/E team will be fully responsible for ensuring that the designs meet applicable codes. In the spirit of cooperation, the Utilities & Engineering Services team will willingly share any advice or recommendations that may simplify or enhance the final design.

Process Simplification

Building Design has become unnecessarily complex over the past several years. Some of the reasons noted by design professionals are that compliance with LEED, the Florida Energy Code, and/or other initiatives necessitate the complexity. The reality of modern building design is that many of the challenges to MEP designers are more effectively resolved in the architectural design phase. The expectation is that the architectural design should facilitate a simple MEP design. The MEP design should have the minimum amount of complexity to meet the building performance requirements.

1.1 Scope of Section

This section contains the requirements relating to the design and installation of all 15kV and below university electrical systems. Protection of existing electrical equipment, utilities procurement, utility disconnects and locates are included in Division 1- General Requirements.

1.2 Overview

A. Coordination Meeting: There shall be a utilities coordination meeting during the Design Development process between Utilities & Engineering Services, FSU Project Manager and the consultants. At the time of the meeting the design team should have documentation prepared to include the anticipated square footage of the facility, anticipated loads and a basic understanding of the existing utility infrastructure around the project location.

B. Connection to Existing Utilities: All utility work shall be approved by Utilities & Engineering Services. Drawings shall clearly call for the contractor to request permission for all outages or switching arrangements a minimum of 5 working days in advance of the required outage, unless an emergency arises.

C. Electric Consumption During Construction: The Contractor, through the Project Manager, shall pay for all electric energy consumed during construction as part of the project General Conditions. Construction power shall be metered by FSU Utilities, see Metering section 3.7(B). Service will not be energized until meters are installed. The Contractor shall obtain the Utilities Procurement Procedures from the Project Manager. Requirements for establishing service are as detailed. Drawings shall clearly call for the Contractor to take such action.

D. Dedicated Electrical Rooms:

1. The project shall have dedicated electric rooms as required to accommodate all major electric equipment including, but not limited to main switchgear, panels, transformers, automatic transfer switch(es), and disconnect devices.
2. The Life Safety emergency switching equipment shall be in a separate room with outside accessibility. See also generator emergency power off requirements, section 3.6(G).
3. No other type utilities that are not specific to the electric system shall be allowed to occupy any space in the electrical rooms. This is including, but not limited to ductwork and piping passing through the rooms.
4. In multiple floor buildings where additional electrical rooms are required for each floor, the electrical rooms shall be ‘stacked’ to facilitate the installation of feeders required to provide service to the floors.
5. Provide a minimum of (2) 2.5” empty conduits from the main electrical room to each of the sub electrical rooms for future.
6. A scaled drawing (minimum of ¼” = 1’) of each electric room shall be included as part of the electrical design to ensure the room is of adequate size to accommodate all electrical equipment and provide NEC mandated clearances for all equipment.
7. The main electrical room and all sub electrical rooms shall be sized such that there is 50% clear wall space (60” minimum) for future equipment remaining at the completion of the project. Conduit shall be routed so that it does not interfere with the dedicated future wall space.

E. Exterior Equipment Enclosures:

1. **Required:** All medium voltage switches, pad mounted transformers, exterior site lighting panels, generators and generator accessories shall be enclosed in a protected equipment yard.
2. **Clearance:** The enclosure shall have a minimum 4' clearance, or greater as required by code, around all sides of all pad mounted equipment.
3. **Equipment Yard:** The equipment yard shall contain no vegetation. The yard shall be lined with weed barrier fabric and filled with rock 2" deep.
4. **Equipment Pads:** Shall be a minimum 4" above finished grade and shall provide 18" clearance, or greater if required by equipment manufacturer, around all serviceable sides of the equipment.
5. **Maintenance:** Future servicing or replacement of equipment shall be a top priority when selecting the equipment enclosure locations. Final approval of medium voltage equipment locations shall be by Utilities & Engineering Services.
6. **Lighting and Outlets:** Provide adequate lighting, minimum one fixture per wall, in the equipment yard that is controlled by a switch located at the entrance to the enclosure. Provide a minimum of two NEMA 5-20 receptacles on opposing walls in the yard. Lights and receptacles shall be connected to either normal or emergency power depending on what equipment is located in the yard.

F. Fault Current and Arc Flash Calculations, Time-Current Coordination Studies and Breaker Settings:

1. The Engineer of Record (EOR) is responsible for preparing fault current and Arc flash calculations, performing time-current coordination studies for both normal and emergency systems and establishing settings for all adjustable circuit breakers.
2. The required calculations and studies shall be included in the project specifications and submitted with the 100% construction documents. Construction documents will not be approved if the calculations are omitted.
3. The EOR is required to perform an on-site inspection to ensure that all adjustable breakers are properly set per the results of the approved time-current coordination studies prior to any equipment being energized.
4. For projects that are remodeling in nature and do not encompass the whole electric system, only the electric systems that are added as part of the remodeling will require the calculations and studies noted above.
5. At the conclusion of the project as part of the close-out documents the EOR shall send the power system software electronic files (ex. SKM files) to Utilities & Engineering Services via the FSU Project Manager.

G. Arc Flash Boundaries and PPE requirements:

1. New electrical equipment shall be clearly marked with appropriate warning signage to indicate the appropriate PPE as calculated by the EOR per the requirements outlined in NFPA 70E.

2. See example of the university preferred Arc Flash and Shock Hazard warning signage in the Utilities & Engineering Services technical library appendix.
3. Signage shall be permanently affixed on the front cover of all electrical equipment as required by NFPA 70E.

H. As-Built Drawing Requirement: Record Drawings that accurately reflect the actual installed conditions shall be furnished at the end of the project. Consult with the Project Manager for details of this requirement.

I. Systems Observation/Training: An authorized representative(s) of the Owner shall witness an operational demonstration of completed systems. Representative(s) shall be completely instructed in the operation and maintenance of installed equipment. Representative(s) shall sign and date a statement that confirms they have received proper, comprehensive training. A manufacturer representative shall be required to provide necessary specified training on all specialized equipment supplied by the manufacturer.

Part 2 – Materials

2.1 General Material Requirements

A. All electrical materials and equipment shall be UL or ETL listed. CSA is not considered an equivalent.
B. All materials and types of construction shall meet or exceed the requirements of UL, ANSI, NEMA, IEEE, and the NEC as well as conform to manufacturer's written recommendations.

2.2 Raceway

A. Exterior:
1. Raceway buried below grade shall be a minimum size of 1".
2. Use of flames or hairdryers to fabricate bends of PVC conduit is unacceptable.
3. PVC shall be converted to rigid metallic conduit where the raceway transitions from below grade to above grade. Buried metallic raceway must have a minimum of two coats of bitumastic or have factory applied PVC coating.

B. Interior: All EMT connectors and couplings shall be steel, compression. No set-screw or zinc connectors or couplings shall be used. All connectors (EMT, flex, seal-tight, etc) shall be insulated throat type.
C. Empty Conduit: All empty conduit shall have a 200-pound test pull cord installed.
D. Conduit shall be manufactured in the United States.

2.3 Conductors

A. Conductors: All conductors shall be copper with insulation Type THHN/THWN-2.

B. Minimum power conductor size: #12AWG.

1. **Sizing:** Power conductors shall be sized for maximum 5% voltage drop from source to point of utilization.
2. **Wire Type:** In general, conductors #10 and smaller shall be solid, unless the application specifies stranded wire. Conductors larger than #10 shall be stranded.
3. **Neutral Conductors:** All 120 and 277 volt circuits shall have a dedicated neutral conductor. Multi-wire branch circuits, that share a neutral, shall not be allowed.

C. Control conductor sizes and color-coding shall be as governed by approved wiring diagrams or schematics.

2.4 Conductor Connections

A. Conductors connected to main electric service equipment, utilizing factory or field installed bus bar, sizes 4/0 and larger shall employ copper to copper 2-hole, compression lugs (long barrel only) using ½" bolts, 2 flat washers, and 1 split lock washer. All bolts and hardware shall be grade 5 cadmium plated steel or bronze (equal to Burndy Durium style). Lugs shall be rated for copper only. Copper clad connectors will be acceptable. No all-aluminum connectors shall be used in any application.

B. Conductors may be spliced 'in line' to facilitate circuit extensions and/or new installations. Wire sizes 4/0 and larger shall employ in line compression sleeves with appropriate insulated covers. Cold shrink insulation sleeves may be used in lieu of 'heat shrink' insulation.

C. Connections made to breakers that are furnished with factory installed mechanical connectors will be allowed. For mechanical connectors, factory recommended installation procedures shall be employed (connector torque settings, the use of oxide inhibiting compound, etc).

2.5 MC Cable and Manufactured Modular Wiring

A. All conductors shall be installed in conduit or where applicable, tray-rated cable in cable trays. MC cable and modular wiring shall not be used without a campus design guideline waiver signed by Utilities & Engineering Services.

Part 3 – Equipment

3.1 Panelboards

A. Identification: Panelboards shall be identified using permanently attached machine engraved phenolic nameplates.
1. Standard color shall be white letters on black background.
2. Emergency panels shall have white letters on a red background.

B. Bussing: Panelboard bussing, including equipment ground bar, shall be copper.

C. Rating: Lighting and receptacle panelboard neutral bus shall be 100% rated.

D. Sizing: Panelboards shall be sized for minimum 25% spare ampacity above calculated diversified demand loads.

E. Enclosure Cover: Cover shall be the hinged front type.

F. Breakers:
1. Circuit breakers shall be bolt-on construction.
2. Devices shall be rated for the bolted fault current available as calculated by the fault current study.
3. Circuit breakers shall not be used for typical on/off switching.
4. Breaker handle ties shall not be employed.

G. Acceptable panel manufacturers: Square D, Siemens, and Cutler-Hammer

3.2 Surge Protective Device (SPD)

A. Required Features:
1. UL 1449, Type 2 (TVSS)
2. Stand Alone Device
3. Internal Fusing
4. EMI/RFI Filtering
5. Full Mode Protection (ex. 3ph, 5 wire service = 10 mode)
6. Minimum 15 year warranty

B. Required Locations:
1. Main Service Distribution Panel
2. All Panels and Busducts 400Amps or larger
3. Separately Derived Systems served by a 30kVA or larger transformer
4. Other equipment deemed necessary by the EOR or End User.
5. Mount device as close to its breaker as possible.

3.3 Switches and Receptacles

A. Required Features:
1. Specification Grade, rated minimum 20 amperes
2. Stainless Steel Coverplates

B. Emergency receptacles:
1. Devices assigned to the emergency system shall be distinctive in color: red is considered standard unless another color code has already been established in the facility.
2. Cover plates shall be stainless steel and engraved with panel name and circuit number.

C. Receptacle spacing:
1. Vending areas shall have GFI receptacles mounted no further apart than 48" on center. Each receptacle shall be on a dedicated branch circuit.
2. Hallways shall have outlets spaced 40 feet on center, maximum.

D. Wet and Damp Locations: 20 Amp, 125 Volt and 250 Volt non-locking receptacles in wet or damp locations shall be 'Weather-Resistant', GFI receptacles with 'WR' clearly marked on face.

E. In Use Covers: 'In Use' covers employed on exterior receptacles shall be 'die-cast' construction. Plastic covers shall not be used.

F. Building Exterior: NEMA 5-20R outlets shall be provided on the exterior of facilities located so that their spacing does not exceed 100 feet on center.

3.4 Motors, Disconnect Switches and Starters

A. Motors: Shall be high efficiency and have an operating power factor of 90% or greater. Provide reduced voltage starters or variable speed drives for all motors 15 horsepower or larger.
1. Variable speed drives shall be connected to the Building Automation System (BAS). See Control Design Guidelines for requirements.
2. **Acceptable Manufacturers of VFDs and Reduced Voltage Starters:**
   a. **VFDs:** Yaskawa; ABB; Danfoss (under 125 HP); Trane.
   b. **Reduced Voltage Starters:** Square D, Siemens, Cutler Hammer and SAF
3. **Disconnect Switches:** Shall be heavy duty type.
4. **Across-the-line starters:** Shall be minimum NEMA size 1.
5. **Acceptable manufacturers of Disconnect Switches and Across-the-Line Starters:** Square D, Siemens and Cutler Hammer (Eaton).

3.5 Dry Type Transformers

A. Windings: Dry type transformers shall be constructed using aluminum windings.

B. Temperature Rise: Dry type transformers shall have 80 degree C temperature rise rating.

C. Installation: Transformers sized 30kVA and larger shall be floor mounted on concrete housekeeping pad. Wall mounting or trapeze mounting will not be acceptable.

D. Acceptable Manufacturers: Square D, Siemens, and Cutler-Hammer (Eaton).

3.6 Power Generation

A. Emergency Power Source: Where required for life safety per NFPA-101 and/or for continuity of function in certain facilities, provide a standby rated emergency generator set. Utilizing unit equipment to meet NFPA-101 exit/egress requirements is highly discouraged.

B. Reference Standard: Generator shall conform to ISO-9001; have Class H insulation, and permanent magnet excitation for production of 300% of rated full load current for ten seconds.

C. Engine Generator Set: Shall be diesel fueled unless so small that diesel prime mover is not commercially available. Natural gas and LP fueled sets are unacceptable. 'Full tank' shall be defined as 7/8 tank capacity and shall provide 36 hours of continuous operation at full load. Larger tanks may be required to serve facilities where continuity of function is mandatory. The operation and fueling requirements for those types of facilities will be handled on a project-by-project basis as design criteria through the Project Manager.

1. **Acceptable Manufacturers:** Engine generator sets shall be Caterpillar or Cummins/Onan. All other manufacturers are unacceptable.

D. Generator Set Location:

1. There are numerous locations on campus where terrain or geometry of adjacent structures may require that the generator set be installed in a sound attenuating enclosure with a rated sound attenuating silencer. This requirement will need to be discussed during initial design meetings and the actual level of attenuation determined early in the design process.
2. Generator sets shall be installed on building exteriors except possibly for locations such as energy/utility plants.
3. The location of the generator set shall be coordinated with the relative location of the fresh air intake for the building to eliminate the intrusion of the generator's exhaust fumes into the building fresh air intake system.
4. Unit shall be located and physically protected in such a manner as to reduce the vulnerability to damage by vehicles, severe storms or hurricanes.
5. See Exterior Equipment Enclosures section 1.2(E).

E. Generator Sizing: Shall be for minimum 25% spare above calculated diversified demand loads. Greater than 25% spare capacity may be required. Consult with FSU Project Manager for percentage spare capacity.

F. Generator Grounding: See Service and Distribution Grounding section 3.7(C).

G. Emergency Power Off and Signage: Provide an exterior EPO button as required by NFPA 110. Provide a second EPO button near the entrance in the main electrical room. Coordinate with local Fire Marshal whether additional interior EPO buttons are required. Provide signage on the entrance door to the main electrical service equipment and on the main service equipment enclosure indicating a second source of power as required by NFPA 110. If a single generator serves two or more buildings then each building shall have an interior EPO button that will only shut down the emergency service to its respective building.

H. Generator Start: Generator set shall be started electrically using its own properly rated and sized batteries. Air start is unacceptable.

I. Generator Cooling: Generator set shall be cooled with self-contained coolant and radiator system. Remote coolers are unacceptable.

J. Fuel tank location/Platform: Fuel tank shall be above ground and approved by EPA. If fuel tank is of such dimension that the top of the mounting skid is 24" or greater AFG, then a substantial maintenance platform shall be constructed that allows for adequate access to both sides and generator controls (if controls are mounted on the end of the generator). Platform shall be in full accordance with all applicable OSHA safety standards for handrails, etc.

K. Remote Annunciator: A generator annunciator panel shall be located within the building in a constantly attended location. If a single generator serves two or more buildings then an annunciator panel shall be located in both buildings.

L. Connection to Building Power Distribution: Engine generator set shall connect to building power distribution system through coil and contactor operated automatic transfer switch(s) (ATS). "Walking Beam" switches are unacceptable.

M. Automatic Transfer Switch:

1. Transfer switch shall have an integral, field adjustable automatic exerciser clock that is capable of providing a twenty second pre-transfer signal prior to transferring from normal to emergency and vice versa.
2. If a four pole ATS is employed, the neutral switching operation shall be a 'make before break' on transfer to emergency power and re-transfer to normal power.
3. The transfer switch that is identified as the Life Safety switch shall have Siemens DEM series 2000 meters installed to monitor the emergency feed from the generator. The switch shall also be provided with a set of dry contacts that can report any general alarm to the Building Automation System. Provide a 1" conduit from the switch to the nearest BAS control panel. Coordinate with the controls contractor.

4. Acceptable manufacturer: Emerson Network Power ASCO 7000 Series (Life Safety and Legally Required) or ASCO 4000 Series (Optional Standby)

N. Number of Automatic Transfer Switches:
When 'Standby Emergency' power is required, there shall be a minimum of two Automatic Transfer Switches installed. The switches and associated panels shall be labeled and identified as 'Life Safety' (LS) and 'Optional Standby Emergency' (OS). In a facility where a legally required standby system is required then there shall be a minimum of three Automatic Transfer Switches installed. The switch and associated panels for the legally required system shall be labeled and indentified as 'Required Standby Emergency' (RS).

O. Minimum Emergency Services: In addition to other requirements, the generator set shall have the capacity to serve, as a minimum, one elevator, building access control panels, all building data gathering panels used for HVAC control and management systems, steam condensate return pumps, and sump pumps.

P. Load Bank Testing: Generator set on-site acceptance testing shall be performed in accordance with NFPA-110 at 80% and 100% power factors.
1. The acceptance test shall be a minimum of 4 hours at 80% PF utilizing a resistor/reactive load bank device.
2. Generator Shop Supervisor shall be notified of the test schedule a minimum of 72 hours in advance so that they may attend.

Q. Acceptance Testing and Code Conformance: On site testing of the entire emergency power supply system shall be witnessed by the Engineer of Record and a representative from FSU Utilities & Engineering Services, FSU Generator Shop and FSU EH&S for the test to be valid. It is the contractor's responsibility to make arrangements for the test procedure and witnesses. This testing shall include all building control systems (BAS, lighting, etc.) that could be affected during a real power outage or during normal maintenance and testing. A manufacturer's representative shall be available to demonstrate the system's control functions.

R. Fuel: The contractor shall furnish a full tank of fuel at the completion of all testing. Full tank shall be defined as 7/8 tank capacity.

S. Maintenance Manuals: Equipment supplier shall supply two operation and maintenance manuals. Deliver one to the Project Manager and one directly to the Generator Shop Supervisor.

T. Warranty: All systems shall have a minimum five-year warranty. Additional warranty may be required on a project-by-project basis.

3.7 Service and Distribution

A. Electric Service:

1. **On Campus:** Buildings and facilities on campus will normally be served from FSU's 15 KV (12,470V) medium voltage distribution system. Coordinate all utility infrastructure requirements with Utilities & Engineering Services.
   a. **Emergency Power Off and Signage:** Coordinate with the local Fire Marshal to determine, depending on the location of the main disconnection means, whether an EPO button is required at the entrance to the electrical room. Provide signage on exterior electrical room door to indicate main service disconnecting means is located within.
2. **Off Campus:** Coordinate service requirements including emergency and failure-to-pay shut off requirements with the local utility company.
3. **Demand Capacity:** Service to buildings shall be supplied from pad-mounted transformers. The transformers, service entrance conductors or bus, and main electrical panel or gear shall be of adequate size for the demand expected in the facility and to allow for future growth of 25% based on calculated diversified demand.

B. Metering: A watt-hour meter with a demand register shall be provided at a minimum for each building. Coordinate building metering requirements with Utilities & Engineering Services through the FSU Project Manager.

1. **Approved Meter:** Siemen's DEM series 2000
2. **Meter Locations, minimum required:**
   a. **Main Switchgear:** Gear shall be provided with a separate metering compartment in the main circuit breaker section of the gear. Metering compartment shall include a terminal block to connect meter PT leads.
   b. **Main Panelboard:** Provide a C/T cabinet with plywood backboard next to the main distribution panel. C/T cabinet shall include a terminal block to connect meter P/T leads. The panelboard shall include a 15A/3 pole breaker for the meter P/T leads.
   c. **Generator:** See Automatic Transfer Switch section 3.6(M)(3).
   d. **Raceway:** Provide an empty 1" conduit with pull string from the metering location to the nearest BAS control panel. Coordinate with the controls contractor.
   e. **Temporary Construction Power:** Contractor shall provide the meters for temporary power and turn over to FSU Utilities after temporary power is no longer needed.

C. Service Entrance:

1. **Testing:** All service entrance cables shall be megger tested prior to terminating. Testing shall be witnessed by FSU BCA and Utilities & Engineering Services. Provide a minimum 3 day advanced notice to the FSU PM prior to testing.
2. **Identification:** The service raceway path shall be readily identified with both marking tape and a layer of flowable fill with red dye. The flowable

fill layer shall come to within one foot of finished grade or, if under a paved area, to the bottom of the asphalt base or concrete pavement.

3. **Additional Requirements:** See Conductor Connections section 2.4(A), 15kV Transformer Connections section 3.7(F)(7), Metering section 3.7(B) and Grounding section 3.7(D) for additional service entrance requirements.

D. Grounding:

1. **Required Resistance:** Grounding for all building main electrical services (grounding electrode system), standby generators, medium voltage switches, manholes and utility transformers shall achieve a ground resistance that measures 10-ohms to ground or less using the three-point test method.
2. **Ground Resistance Test:** The three-point test shall be performed with the ground system that is being tested to be completely separated and isolated from any other grounded or grounding system.
3. **Grounding System Verification:** Testing shall be witnessed by FSU BCA and Utilities & Engineering Services. Provide a minimum 3 day advanced notice to the FSU PM prior to testing. A written record of the test results shall be prepared and signed by the contractor and campus electrical engineer. This record shall be submitted to the Architect/Engineer and supplied to the University with the O&M manual upon the completion of the project.
4. **Connectors:** All grounding electrode conductors shall be connected to ground rods by either (1) an approved exothermic welding process as manufactured by Erico or (2) a compression system as manufactured by Burndy known as 'Hyground'.
5. **Electrodes:** All grounding electrode conductors at the service entrance shall connect to the neutral bus using long barrel copper compression lugs, 3/8" or larger nut and bolt, (2) flat washers and (1) lock washer. All connection hardware shall be grade 5 cadmium plated steel or bronze equal to Burndy Durium type.
6. **Separately Derived Systems:** Buildings with 480Y/277V services shall be provided with a common grounding electrode conductor, minimum size #3/0, from the main service grounding electrode system to each electrical room in the building. The common grounding electrode conductor and separate services grounding electrode conductors shall terminate with compression lugs as described in section 3.7(C)(5) onto a 12"x4"x1/4" copper ground bar with insulated standoffs mounted on the electrical room wall.

E. 15kV Circuit Coordination: It is the responsibility of the Engineer to ensure the proper electric circuit coordination.

1. All new circuit and transformer installations shall be properly coordinated with the existing electric distribution on campus. The Engineer shall furnish circuit coordination parameters including relay/fuse settings, time-current characteristic curve plots, and verification that all settings have been made.

2. Existing substation breaker settings and available fault current data (at FSU's substation) will be made available, upon request, from FSU's Utility Department.
3. The Engineer must produce coordinated time current curve characteristic plots of his proposed settings for review and approval by FSU Utilities Section prior to energizing.

F. Pad-Mounted Transformers:

1. **Base Capacity Rating:** In order to provide better circuit coordination in the University's electrical system, a service transformer's base rating shall not exceed 2000 KVA. If additional capacity is required the design professional must consider either multiple transformers or specifying units that are dual temperature rated and equipped with forced air-cooling.
2. **Grounding:** See Service and Distribution Grounding section 3.7(C).
3. **Location:** See Exterior Equipment Enclosures section 1.2(E).
4. **Basic description, features, accessories:**
   - **a. Insulating fluid** – Envirotemp FR3
   - **b. Winding Material** – Copper or Aluminum
   - **c. Primary Voltage**, 12470 delta – 95 KV BIL
   - **d. Taps** – 2 @ 2 ½ % above and 2 @ 2 ½ % below normal
   - **e. Configuration** – Dead front, radial feed
   - **f. Primary Bushings** – Three Wells, 15 KV, 200-amp
   - **g. Inserts** – Feed through
   - **h. Secondary Bushings** – Spade Terminals
   - **i. Fusing** – Bay-O-Net oil immersed in series with ELS-P
   - **j. Impedance** – NEMA Standard with standard tolerances
   - **k. Color** – Bell Green
   - **l. Standard Features**:
     - **i.** MOV arrestors
     - **ii.** Provisions for bushing mounted CT's
     - **iii.** Stainless steel grounding pads in HV and LV compartments
     - **iv.** Removable neutral ground strap
   - **m. Standard Accessories**:
     - **i.** 1" fill plug
     - **ii.** 1" drain valve and sampling device in HV compartment
     - **iii.** Dial type thermometer.
     - **iv.** Liquid level gauge
     - **v.** Pressure vacuum gauge
     - **vi.** Pressure relief valve.
7. **Secondary Conductor Connections:** All secondary conductor connections to padmounted transformers shall be installed using 2-hole copper compression lugs, ½" bolts, (2) flat washers and (1) lock washer for wire size 4/0 and larger. All connection hardware shall be grade 5 cadmium plated steel or bronze equal to Burndy Durium type.
8. **Acceptable Manufacturers**: Cooper – Waukesha, Wisconsin; Howard– Laurel, Mississippi; or General Electric – Shreveport, Louisiana.

G. Pad Mounted Medium Voltage Switching Equipment:

1. **Specifications:** The switch shall consist of manually operated load interrupting, SF6 insulated, 630A linear puffer switches and manually operated, electronically controlled fault interrupters. Number of ways and configuration shall be as directed by Utilities & Engineering Services.
2. **Grounding:** See Service and Distribution Grounding section 3.7(C).
3. **Location:** See Exterior Equipment Enclosures section 1.2(E).
4. **Identification:** Provide engraved labels for each way. Coordinate with Engineering Services for exact verbiage for each label. Identification on the exterior of the switch enclosure shall be by FSU personnel.
5. **Warning Label:** Affix warning label on the exterior of the switch enclosure. Label shall be a minimum of 10"x7" and shall read "Danger – High Voltage – Keep out".
6. **Basic description, features, accessories:**
   a. **Bushings:** Shall be 600A quick-change field replaceable.
   b. **Fault Interrupter:** Shall be a Type 2 Electronic Vacuum Interrupter Control in a NEMA 4X enclosure for overcurrent protection.
   c. **CT:** Internal 1000:1 current transformer.
   d. **Enclosure:** Shall be tamper resistant incorporating hinged access doors with pentahead locking bolts and provisions for padlocking.
   e. **Spare Ways:** Provide deadbreak protective cap with static discharge wire for all unused bushings.
7. **Cable Grounding:** The ground braids and static discharge wires for each feeder and spare ways static discharge wires shall all terminate in a single hole, long barrel compression lug and connect to the switch ground boss.
8. **Gas Bottle:** A 35 lb bottle of SF6 gas shall be supplied with all new sectionalizing switch installations
9. **Overcurrent Coordination:** The fault interrupter device simulated in the SF6 switch must be compatible with the campus 15kV feeder breakers in order to achieve proper circuit coordination. See 15kV Circuit Coordination section 3.7(E).
10. **Manufacturer:** G&W shall be the only acceptable manufacturer.

H. Medium Voltage Cable:

1. **Specification:** Medium voltage cable shall be copper, 105 degrees C rated, EPR with 133% insulation.
2. **Size**:
   a. Feeders: Cable size shall be 350 KCMIL for feeders.
   b. Transformers: Transformer feeder cable, from switch to transformer, shall be 2/0, 1/0 or #2 (minimum).
3. **Acceptable Manufacturers**: Cable shall be manufactured by The Okonite Company, The Kerite Company or General Cable Corporation.
4. **Proof-testing:** All new 15KV cable shall be proof tested according to manufacturer's recommendations prior to being energized.
5. **Installation:** Fire wrap all exposed cables in manholes, medium voltage switches and transformers separately with 2 hour fire rated tape. Tape shall be Scotch series 77W or equal.

I. Duct Bank Systems: All 15 KV cable shall be installed in duct bank system as follows:

1. All ducts shall be encased in at least 3" concrete on all sides, top and bottom.
2. Ducts may be EB-35, or schedule 40 PVC conduit. Conduit shall be parallel and separated by appropriate spacers. Conduit shall be sized as required for the project but not less than 4".
3. Duct banks shall have sufficient number of conduit for the project plus a minimum of two spares. Conduits from 15 KV switches to transformers will require only one spare.
4. Duct banks shall be a minimum depth of 36" to the top of concrete. Where duct banks are less that 36" or in locations that require protection, a layer of 'flowable fill' with red dye shall be installed over the duct bank. The flowable fill layer shall come to within one foot of finished grade or, if under a paved area, to the bottom of the asphalt base or concrete pavement.
5. A #4 Rebar shall be installed in the duct bank on each corner of the flowable fill for all 2-duct wide banks. If deemed necessary by the engineer of record, on wider duct banks, more #4 Rebar shall be installed in the middle of the top and bottom of the duct banks.
6. A 4/0 copper ground loop conductor shall be installed with all duct banks, regardless of number of ways. The ground loop conductor shall be located in the center of the top of the concrete encasement. To prevent corrosion of the ground conductor, the conductor shall be insulated and all cadweld splices shall have heat shrink or cold shrink insulation.
7. All duct bank installations shall be inspected by the Engineer of Record, FSU BCA and FSU Utilities & Engineering Services prior to encasing in concrete.
8. If a duct bank is within 8' laterally or crosses a steam line, coordinate with FSU Utilities & Engineering Services to ensure sufficient additional heat barrier insulation is installed to prevent damage to the duct bank and electric cables.

J. Manholes:

1. **Characteristics:** Manholes shall have the following basic physical description:
   - **a.** Inside dimensions of 8'-0" octagonal made from minimum 2500 PSI concrete.
   - **b.** Duct entrances supplied with end bells.
   - **c.** Minimum clearance from centerline of lowest duct entrance shall be 2'-0" to floor.
   - **d.** Minimum 6" thick walls, minimum 8" thick ceiling and floor for sump.
   - **e.** Duct face at corners a minimum of 18" wide.
2. **Cabling Supports:** Cable racks shall be heavy duty, galvanized, with porcelain cable saddles. Pulling irons fabricated from hot-dipped galvanized steel bars shall be provided in walls opposite duct entrances. Cables shall loop manhole prior to exiting on through-pulls and shall pass by two adjacent complete faces, as a minimum, on angle pulls.

3. **Covers:** Conform to Specification RR-F-621 with vent holes and, minimum, two pick holes. Pick holes shall be minimum ¾" diameter. Cover shall be approximately 32-½" diameter. Manufactured by U.S. Foundry, or equal.
4. **Ground Loop Cabling:** Each manhole shall contain a 4/0 ground loop, mounted 18" above the floor, connected unspliced to the manhole ground system. The manhole ground system shall be an array of ground rods, quantity as required, to achieve a ground resistance that measures 10 ohms to ground or less, see Ground Resistance Test guidelines (3.7 (C)(2)). Manhole ground loop shall bond all non-current carrying conductors in each manhole and shall be bonded to the ground conductor routed with the duct bank systems. Bonds shall be by exothermic means or compression using a Burndy "Hyground" system. No other compression system is acceptable.

Part 4 – Lighting Systems

4.1 General

A. Lighting system designs shall comply with the current edition of the Illuminating Engineers Society (IESNA) standard.

4.2 Emergency Lighting

A. Power Source: The emergency egress lighting system shall be powered by an emergency generator system. Battery powered emergency lighting shall not be used unless there is no emergency generator associated with the project.

B. Control: To conserve energy the emergency egress lighting should be switched with the normal lights in each space.

4.3 Interior Lighting

A. Standard Non-dimming Systems: The standard lighting system shall utilize fluorescent T8, 80+ CRI, 4100K lamps with instant start electronic ballasts having a total harmonic distortion (THD) of 10% or less.

1. **Lamp Standard:** Interior systems shall employ 25W lamps where ambient temperatures and other conditions are suitable for their application.

B. Dimmable Systems: Fixtures whose light levels will be controlled either manually or electronically shall utilize LED technology. LED's shall be controlled with a dimmable LED driver having a THD of 20% or less.

4. **Manual Control:** Dimmer controller shall have separate dimming control and on/off control such as a slide dimmer switch with push button.
5. **Electronic Control:** Each space that requires dimmable fixtures shall have a stand-alone, dedicate digital lighting control system. Entire building or whole floor lighting control systems are not acceptable.

6. **Emergency Switching:** All dimming systems shall employ switching relays that will return emergency lighting fixtures to full brightness upon loss of normal power.

C. Fixture Whips: All fixture whips shall have #12 wire minimum.

D. Automatic light controls shall comply with "Chapter 13, Energy Efficiency", of the Florida Building Code. Coordinate all lighting control schemes with the controls contractor. See also the Lighting Controls section of the campus Control Design Guidelines.

E. Stairway Lighting: Shall be above the landings and not above the steps.

F. Re-lamping: No lighting fixtures shall be installed that require scaffolding for re-lamping. High ceiling facilities such as auditoriums and gymnasiums shall be analyzed to determine the feasibility of providing catwalks above ceiling for maintenance of all MEP systems.

G. Classroom Lighting: Classroom lighting shall comply with DOE requirements. Lighting in classrooms and lecture halls with seating capacity greater than 25 people shall be equipped with dimming systems. For detail requirements for dimming and occupancy sensor systems refer to Appendix E, Design Criteria and Requirements for Classrooms at Florida State University.

4.4 Exterior Lighting

A. General: Outdoor lighting on the FSU campus shall be attractive and in keeping with the standards set forth in this section. The lighting plan shall be energy efficient while maintaining appropriate light levels as prescribed in the latest edition of the NFPA codes and IES handbook for high activity facilities. The campus is currently undergoing a conversion from traditional HPS lamp technology to high lumen output LED technology. All new exterior lighting fixtures shall be LED technology.

B. Integrated Design: All new site lighting designs shall include all existing site lighting fixtures that are located within a 100' from the perimeter of the proposed site. Required information for existing fixtures shall include lamp type and wattage, building from which fixture(s) are fed, general condition, etc. The new design and fixture selections shall match or blend in with the existing fixtures around the new site.

C. Retrofit: The conversion of existing HID fixtures to new LED technology shall only be done by either replacing the existing fixture or retrofitting the existing fixture with a retrofit kit manufactured by the original fixture manufacturer. All retrofit kits shall have a five year warranty and shall continue the UL listing of the fixture.

D. Lamp Access: No lighting fixtures shall be installed that require scaffolding for re-lamping. Pole mounted parking lot and walkway lights shall be a

maximum of 30’ above finished grade so that fixtures are bucket truck accessible.

E. Lighting Control: Pedestrian and parking lot lighting fixtures shall be controlled by a photoelectric cell and contactor with a manual override for maintenance. All new fixtures installed shall be fed from either an existing or new lighting panel located in the nearest electrical equipment yard. Coordinate panel location and control requirements with Utilities & Engineering Services.

F. Aesthetics: Outdoor lighting shall be period style fixtures, pole mounted where possible. Refer to Utilities & Engineering Services technical library appendix for examples of approved poles and fixtures.

G. Pedestrian Fixtures:

1. **Luminaires:** 3000K LED light source with universal voltage, 0-10V LED dimming driver, glass acorn shaped globe and black fluted cast aluminum post top fitter and finial.
2. **Poles:** Black straight fluted cast aluminum 12’ tall ornamental pole mounted on a concrete base a minimum of 6” above finished grade. Concrete base construction requirements (size, depth, etc) shall be specified by the EOR.
3. **Installation:**
   - **a.** Pedestrian walk paths, sidewalks, green spaces, etc.
   - **b.** Luminaire and pole shall be separate items, combination fixtures are not allowed.
   - **c.** Provide an open bottom, concrete handhole with traffic rated cover (ex. Quazite) next to each fixture for branch circuit.

H. Area Fixtures:

1. **Luminaires:** 3000K LED light source with universal voltage, 0-10V LED dimming driver, architectural style black die cast aluminum head, optic type as required by application.
2. **Poles:** Black square straight steel of appropriate height mounted on a concrete base a minimum of 30” above finished grade. Concrete base construction requirements (size, depth, etc) shall be specified by the EOR.
3. **Installation:**
   - **a.** Parking lots and roadways
   - **b.** Luminaire and pole shall be separate items, combination fixtures will not be acceptable.
   - **c.** Provide an open bottom, concrete handhole with traffic rated cover (ex. Quazite) next to each fixture for branch circuit.

4.5 Parking Deck Lighting

A. Automatic light controls shall comply with "Chapter 13, Energy Efficiency", of the Florida Building Code.

B. The EOR shall present a control system design to the FSU Project Manager and Utilities & Engineering Services no later than the conceptual design phase.

C. Due to the ever changing technology in lighting systems, different systems may be employed in new parking garage projects. Any new system design must be evaluated by the design professional and have approval of Utilities & Engineering Services.

Part 5 – Miscellaneous Systems:

5.1 Lightning Protection Systems

A. New Construction: All buildings/structures shall have appropriate lightning protection systems designed and installed in accordance with NFPA-780.

B. Existing Construction: Expansions and renovations of existing facilities shall upgrade the existing lightning protection system as required to obtain or maintain a Master Label for the envelope.

C. Certifications: Installer shall be LPI certified. Installed system shall bear a Master Label.

END OF SECTION 16000