SECTION 3 ED: ELECTRICAL DIVISION

Latest Update 12-27-11, See underlined text

PART I: GENERAL DESIGN REQUIREMENTS

1. SCOPE:

1.1. This division provides general objectives and criteria for designing electrical systems. It deals with general purpose office, research and instructional buildings; however, principles herein shall be followed, where applicable, for special-purpose buildings. Many of the existing systems serving the UM buildings may not be in compliance with these current standards due to their age. However, it is the intent that all design of both new and renovated systems be done in accordance with these Design Standards. Instances where existing conditions preclude compliance with the standards should be brought to the attention of the UM OFM Project Manager for discussion and resolution.

1.2. The electrical engineering design shall consist of, but not necessarily be limited to, the design of:

a. Power and lighting systems

b. Security systems

c. Fire alarm system

d. Data and voice communication systems.

1.3. The design shall include all work required to provide a complete and operating facility, including the following tasks, as necessary for each system and as applicable to the project:

a. Investigation of field conditions, including existing equipment name plates.

b. Obtaining data from manufacturers.

c. Establishing the levels of the system and equipment reliability required for the design based on consultation with UM, and incorporation of the reliability levels in the design.

d. Field measurements of physical sizes of equipment and spaces, and power, current, voltage, transient voltage, etc. all recorded over sufficient time to establish a trend.

e. Analysis of data and engineering calculations, including preparation of necessary tabulations, graphs, etc.

f. Study of equipment and apparatus operating methods to ascertain the applicability, and comparison of advantages and disadvantages, including maintainability.

g. Preparation of cost estimates and comparisons.

h. Engineering recommendations, listing advantages and disadvantages.

i. Coordination with the A/E team to confirm that the equipment and light fixtures will fit such that the equipment or light fixtures are readily accessible for maintenance and that power sources are provided where needed. Where power sources are installed at remote location, it shall be readily accessible for maintenance.

j. Participation in discussions with UM users, OFM engineers, and other professional consultants in the selection of the various systems, methods, equipment, etc.

k. Preparation of reports, design phase drawings and specifications and construction contract documents.

l. Identification of major installations and/or testing which must be witnessed by UM representatives, and inclusion of these requirements with specific testing criteria in the Specifications.

(1) **Example:** Witnessing of factory testing of synchronizing switchgear for the emergency power system.

(2) **Note:** The purpose is to identify problems as early in construction as possible, so corrections can be made without effecting completion of the building as scheduled.

m. Participation in, and/or the conduct of, a sequence of acceptance tests, to be performed as soon as a system or piece of equipment is installed.

n. Approach to system design, for each system.

(1) Review of current equipment available to accomplish the required function.

(2) Establish the reliability and maintainability required of the system in consultation with UM.

(3) Identify and discuss with OFM the advantages and disadvantages, including impact on cost and schedule, of available types of equipment.

(4) Select in consultation with OFM, and to satisfy reliability and maintainability requirements.

(5) Identify configuration of the system and the type of equipment to best accomplish the proposed function in consultation with OFM.

Justify by reasoning, application, performance, maintenance, reliability and value considerations.

(6) Make calculations to establish the capacity of the system and the size of components, with allowance for future growth.

(7) Establish routing of wiring or other interconnecting requirements, including interface with existing systems.

(8) Prepare drawings, including schematics, wiring diagrams and details that establish and define the installation, and prepare contract Specifications as established by prior consultation with OFM.

1.4. Short Circuit & Coordination Study & Arc Flash Hazard Analysis: A short circuit and coordination study and arc flash hazard analysis study shall be prepared for the electrical over current devices to be installed to assure proper equipment and personnel protection. The complete study and report shall include a system one line diagram, short circuit and ground fault analysis, arc flash hazard analysis and protective coordination plots.

a. Drawing Submission: The 95% Contract Document review submission shall include a short circuit and coordination study and Arc flash hazard analysis study in accordance with IEEE and NFPA. The protective device study shall be prepared by qualified engineers and the study shall be calculated by means of a computer program. The review submission shall include, as a minimum, the following information:

(1) One Line Diagram: On the one line diagram include;

a) All electrical equipment and wiring to be protected by the over current devices installed. Clearly show, on the one line, the schematic wiring of the electrical distribution system.

b) Calculated fault impedance, X/R ratios, and short circuit values at each bus.

c) Breaker and fuse ratings.

d) Generator kW and Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.

e) Voltage at each bus.

f) Identification of each bus.

g) Conduit material, feeder sizes, length, and X/R ratios.

(2) Short Circuit Study:

a) Systematically calculate the fault impedance to determine the available short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.

b) The study shall be calculated by means of a computer program. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.

c) Present the data determined by the short circuit study in a table format. Include the following:

1) Device identification.

2) Operating voltage.

3) Protective device.

4) Device rating.

5) Calculated short circuit current.

(3) Coordination Curves:

a) Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet.

b) The following specific information shall also be shown on the coordination curves:

1) Device identification.

2) Voltage and current ratio for curves.

3) Three (3) phase and single (1) phase ANSI damage points for each transformer.

4) No-damage, melting, and clearing curves for fuses.

5) Cable damage curves.

6) Transformer inrush points.

7) Maximum short circuit cutoff point.

c) Develop a table to summarize the settings selected for the protective devices. Include the following in the table:

1) Device identification.

2) Relay CT ratios, tap, time dial, and instantaneous pickup.

3) Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.

4) Fuse rating and type.

5) Ground fault pickup and time delay.

d) The arc flash hazard analysis shall be performed in accordance with the IEEE 1584 equations that are presented in NFPA70E-2009 Annex D.

e) The arc flash hazard analysis shall include recommendations to correct any conditions showing the incident energy level in excess of 40 calories/sq cm or 167 joules/sq cm.

2. DESIGN SUBMISSIONS:

2.1. The A/E shall submit design document, proposals, drawings, sketches, calculations, specifications, etc. at various stages in the design process. For electrical requirements of each submission, refer to this division and the UM Procedure Manual for Professional Architectural and Engineering Services for UM Construction and UM Service Centers, latest edition.

3. CODES, STANDARDS AND REGULATIONS:

3.1. **Codes:** The design shall comply with the codes, standards, and regulations listed in Section 2: General Design Standards of these Design Standards, and at a minimum, with the most recent edition of all the codes that have been adopted by the State of Maryland. The technical requirements of these codes shall supplement all other standards, codes and regulations imposed by the University which may be initiated subsequent to the program preparation. The Office of Environmental Health and Safety (EHS) is the appointed campus Occupational Safety and Health Coordinator and the University Fire Marshal and as such will review all design documents. When a specific project warrants variance from the governing codes and regulations, a request shall be submitted in writing to UM at the Schematic Design Phase. Unless otherwise noted the latest edition of the codes in effect at the time the design contract is awarded will be used throughout the design and construction of that project.

3.2. Standards and Regulations: In addition to those codes, referenced above, the basis for electrical design shall also include amendments and revisions, of the following standards and regulations:

a. National Electrical Manufacturers Association (NEMA),

b. Institute of Electrical and Electronics Engineers (IEEE),

c. Edison Electric Institute (EEI),

d. Electronic Industries Application (EIA),

e. Insulated Power Cable Engineers Association (IPCEA),

f. Certified Ballast Manufacturers Association (CBM),

g. American National Standards Institute (ANSI),

h. American Society of Mechanical Engineers (ASME),

i. American Concrete Institute (ACI),

j. Underwriters Laboratories, Inc. (UL),

k. Illuminating Engineering Society of North America (IES),

l. Rules and regulations of the Baltimore Gas and Electric Company,

m. Regulations of agencies having jurisdiction over State of Maryland construction, such as the EPA, ADA and OSHA.

4. COORDINATION:

4.1. Electrical Design: The electrical design must be coordinated with the civil, architectural, structural, mechanical, fire protection, and specialty designs to permit the A/E submissions and reviews by UM to be made effectively.

4.2. Exterior and interior exposed electrical items shall be indicated, and coordinated, with the A/E team. The items involved shall be identified, along with their physical characteristics, including clearances, finish materials, etc. Coordination with all disciplines shall include location and sizes of electrical devices with accommodation of other equipment, furnishings, finishes, etc.

a. Example: Equipment and devices, such as security hardware, which require electrical power or electrical trade work shall be coordinated for requirements and specifically indicated in the construction documentation.

4.3. Site Visits: On a renovation or alteration project, the architect shall make necessary visits to the site to ensure coordination with existing conditions and to make certain that there is adequate space and service clearance for the

proposed layout and equipment. The engineer shall not rely solely on original construction document or earlier renovation drawings, as they may not represent the actual existing conditions. The A/E team shall check building dimensions to confirm the accuracy of archived record drawings.

5. ECONOMICAL DESIGN:

5.1. General: Electrical systems shall be designed to permit acceptable competitive bids. Equipment and systems shall be efficient and economical for construction and maintenance.

5.2. Equipment Selection: Equipment specified should be nonproprietary, except where no other source is available to meet performance requirements. Where a proprietary selection is deemed necessary, a request shall be submitted in writing to UM early in the design stage. Materials selected shall be suitable for the application and shall be coordinated with other aspects of the project.

6. GENERAL DESIGN CONSIDERATIONS:

6.1. Electronic Drawing Files: The A/E shall prepare electronic drawings, utilizing the UM standard drawing templates, in accordance with the requirements in Section 4 of these Design Standards. The UM standard drawing templates can be accessed through the UM web page address included in Section 2 of these Design Standards

6.2. General Project Files: Non CAD type project files such as fee proposals, studies, reports, cost estimates, calculations, and specifications shall be submitted to UM on a CD-R as part of the project closeout document requirements. For additional requirements see Section 4 of these Design Standards.

6.3. Floor Plans and Details: Full size floor plans shall be drawn to a minimum scale of 1/8 inch per foot. Floor plans for mechanical equipment rooms, main electric room, electric rooms, BDF & IDF rooms, server rooms, emergency generator room, fire command center and all other areas where space conditions are such that close coordination between all disciplines is necessary shall be drawn to a minimum scale of 1/4 inch per foot. Where scaled details are necessary to indicate coordination between materials and equipment utilize a minimum scale of 1/2 inch per foot. Drawings shall be coordinated with the respective trades, and cross-sections and elevations provided. All floor plans shall include room numbers as indicated on the architectural drawings.

6.4. Sustainability and Green Building Policy: In accordance with the UM Green Building Policy outlined in Section 1 of these Design Standards, UM encourages the integration of sustainable and green building practices in the design of all renovation and new building projects, regardless of the intent to meet LEED™ certification requirements. The A/E team is encouraged to investigate and recommend the use of innovative and state-of-the-art use of materials, equipment, systems, and design approaches that hold promise for increases in energy efficiency, resource reuse and recycling, reduced energy consumption, and improved indoor air quality, operational efficiencies, and thermal

performance of the project space. Where the intended use of such design practices conflicts with these Design Standards, the A/E team shall notify the UM OFM Project Manager during the Schematic Design phase, or as soon as possible thereafter, so that a discussion of the issues can be held and resolution can be reached. The engineer shall explore opportunities for the integration of discipline specific initiatives for sustainable design in the project as the design effort progresses. Specific design initiatives in the area of the electrical design could include, but are not limited to, use of recycled and salvaged materials and equipment, use of recyclable materials, use of occupancy sensors for lighting and HVAC control, daylighting techniques, local switching to accommodate varying occupancy schedules within the space, use of smart breakers, use of flywheel and fuel cell technology for special power needs, and integration of raised floors for future flexibility and ease of utility routing. In addition, the A/E shall include requirements for recycling of demolition and construction waste materials in the construction documents.

6.5. Interferences: Coordinate the design with the structural and architectural system components to avoid interference and conflicts. Particular attention shall be given to avoidance of structural components, including beams, columns, bracing, column caps and concrete reinforcement, and to ensure that all equipment and distribution systems fit adequately above intended ceiling heights. Coordinate the routing of all systems with all work of other disciplines. Consider space required for access for maintenance and repair of equipment.

6.6. Foundation Drawings: If construction of a foundation is to proceed in advance of completion of the superstructure drawings, separate working drawings of foundations are required. These drawings shall show:

a. Electrical work that cannot be installed later. This includes piping and conduits below or through foundations, slabs, etc.

7. SPECIFICATIONS AND SUBSTITUTIONS:

7.1. General: In addition to the requirements in this section see UM Procedure Manual for Professional Architectural and Engineering Services for UM Construction and UM Service Centers, latest edition.

7.2. Electrical Specifications:

a. A project specification incorporating sections for electrical work shall be prepared, coordinated with drawings, and submitted. UM has developed a complete set of master specifications for mechanical and electrical divisions, and selected architectural sections, and general requirement sections. The A/E shall review the UM master specifications table of contents, included in Section 5: Appendices of these Design Standards, and select from the UM web page all appropriate specification sections necessary to suit the current project scope. The A/E shall edit the UM master specification sections to suit the requirements of the project. The A/E shall utilize their own specifications and/or other resources only in those cases where the UM master specifications do not include the required equipment, materials, or construction procedures to suit the

current project. The UM master specifications can be accessed through the UM web page address included in Section 2 of these Design Standards. All text in the header, footer and body of each specification section shall be "Times New Roman, Size 12".

b. For UM design projects that do not require a full set of electrical specifications, UM has a condensed version of electrical specifications that should be used for these projects. The UM condensed specifications can be accessed through the UM web page address included in Section 2 of these Design Standards.

c. **Inspection Certificates:** For major projects, include in the project specifications the following:

(1) The builder is required to provide an electrical certificate from an independent electrical inspection agency approved by the Maryland State Fire Marshal.

(2) The electrical contractor shall file with the approved inspection agency prior to the start of construction so that adequate rough-in inspection may be made during the course of construction.

(3) The builder shall be responsible for all fees associated with this inspection.

7.3. Substitutions: For specification sections provided by the A/E that are not based on the UM Master Specifications, the specification sections shall include the names of at least three manufacturers for every product. The engineer shall ascertain that every manufacturer listed is acceptable to UM, and that every manufacturer listed can provide a product that is acceptable in terms of performance, quality, size, service access and orientation. Even though the engineer may identify one manufacturer's product as the design basis, the other manufacturers' products will not be viewed as substitutions, but as approved equals. In addition, other manufacturers' products which are not listed, but can be considered as approved equals, shall not be viewed as substitutions. Only manufacturers' products which are not approved equals because of a deficiency in one or more significant aspects of the product will be considered to be substitutions. The design shall include sufficient space and service clearance such that all equal products can be used.

8. ACCESSIBILITY:

8.1. Access to Machines and Equipment: Clearance shall be provided around machines and equipment to remove parts for repair or replacement. Door or window openings, removable panels in building walls, and corridors shall be arranged so that large machines or equipment parts can be removed or replaced without structural changes or movement of other equipment. The engineer shall arrange with the architect to provide openings and passageways of sufficient size so that standard equipment can be used. Particular attention shall be given to equipment such as high voltage switch gear, motor control centers and transformers. Accessible utility core spaces shall be provided for all major

mechanical and electric utilities. Access through full-size man doors shall be provided. These spaces shall have adequate clearance for maintenance and future replacement of the equipment, risers and conduits with a minimum of three (3) feet between equipment and structural components or as in compliance with manufacturer's recommendations. Adequate space must be provided for possible future additional duct and pipe risers, conduits and equipment. Provide adequate clearance for maintenance and repair. Designs which indicate the routing of piping, ductwork, and conduits across the floor within the path of travel for service or maintenance personnel will not be acceptable to UM, nor shall piping, ductwork, and conduits be designed which would create a low clearance hazard. There shall be a minimum of seven (7) feet vertical clearance within the path of travel. Where the path of travel is not obvious, or where directed by UM, indicate the path of travel around all equipment requiring service access on the construction drawings. UM reserves the right to require a total or partial redesign of equipment layouts, at no additional cost or time delay, where the submitted design is, in the opinion of UM Facilities Management, not in the best interest of UM. Coordinate with the electrical engineer to provide adequate lighting levels in all electrical spaces for service and maintenance.

8.2. Demonstration of Access: The 50% submission shall show sketches demonstrating that at least three manufacturers' equipment is accessible and will fit with adequate clearance, as deemed acceptable by UM.

9. BUILDING OPERATION:

9.1. Except for selected shutdown holidays, UM campus buildings are open to the public for business from 7:00 am to 6:00 pm, Monday through Friday, but many of the buildings on campus are occupied to a lesser extent at all hours of the day and night, seven days per week. In buildings where public spaces and/or research spaces adjacent to the project area require other hours of operation, the design shall identify construction phasing that has the least impact on the adjacent occupied areas. The design shall include requirements for off hour work as required for work involving the shut down of systems or equipment serving the occupied areas.

10. DEMOLITION:

10.1. A/E shall include all necessary provisions for demolition in the construction documents. Demolition documents shall clearly define the limits of the demolition work including the disconnection and removal of all equipment and distribution systems serving the project area. A list of all equipment and systems intended for demolition, and those to be reused in the project design shall be submitted to UM for approval. The A/E shall request from UM OFM Project Manager a list of equipment to be identified as salvaged material to be turned over to the University.

10.2. The A/E shall include a phasing plan in the construction documents that indicates a method by which the work in the occupied building can be accomplished with the least possible disruption to the occupants of surrounding and adjacent spaces. The plan shall include provision for all temporary power, equipment and systems necessary to provide HVAC and plumbing services to all occupied areas

interrupted by the construction work. The plan shall also include the requirement for off hour work for all outages and disruption of all services to the occupied areas. The plan shall utilize, to the extent possible, the change of seasons in the calendar year to lesson the impact of system outages, performing work on heating systems in the summer months and performing work on cooling systems during the cold weather months. The plan shall consider the anticipated disruption to adjacent occupied areas that will be caused by work that involves the generation of excessive noise, dust, and vibration**.**

11. ELECTRICAL EQUIPMENT ROOM LAYOUTS:

11.1. General: The engineer shall work with the architect at the outset of the project to identify the sizes, shapes and locations of required spaces as dedicated mechanical and electrical equipment rooms. These rooms shall be arranged as penthouse mechanical and electrical rooms and lower level mechanical and electrical rooms to accommodate the building plumbing, HVAC, and electrical equipment and associated pipe and duct distribution systems. Lower level mechanical and electrical rooms shall be located either on grade or below grade with sufficient access to loading docks and/or public streets to facilitate the removal/replacement of equipment.

11.2. Room Design: All electrical rooms shall be designed to accommodate the required equipment in accordance with the manufacturer's operating and service clearance requirements, and in accordance with the accessibility requirements of these Design Standards. Provide a telephone outlet in each mechanical room. Coordinate the locations with the A/E team and UM.

11.3. Separation of Mechanical and Electrical Rooms: Separation of mechanical and electrical rooms shall be maintained, with appropriate physical barriers to prevent flow or migration of fluids from mechanical to electrical spaces.

11.4. Equipment Room Stacking and Vertical Relationship to Main Electric and Tela/Data BDF Rooms: It is UM's preference to stack all electric rooms and Tela/Data BDF closets in vertical alignment with their respective basement and/or penthouse level main electric rooms and between floors to facilitate the routing of wiring and conduit and to minimize cross-connect runs in the basement or penthouse level.

11.5. Electric Room Cooling: See Section 3 MD of these Design Standards for cooling requirements. Connect the mechanical equipment to the emergency power source.

11.6. Tela-Data BDF and IDF Centralized Cooling: See Section 3 MD of these Design Standards for cooling requirements. Connect the mechanical equipment to the emergency power source.

11.7. Future Equipment Space: When directed by UM, or as required by the project program, provide space for future equipment such as chillers, pumps, and cooling towers. For future roof mounted equipment the design shall include the necessary structural supports and roof penetrations for piping and conduits.

12. FIRE STOPS AND SMOKE SEALS:

12.1. Provide fire stops and smoke seals for all electrical conduits that pass through floor slabs, utility shaft walls, and roof levels. Coordinate with the A/E team and UM to ensure all code requirements are complied with.

13. ELECTRIC MOTOR REQUIREMENTS:

13.1. For power factor requirements for each motor (10 hp or larger) or motor driven equipment, see Section 3 MD of these Design Standards.

14. EMERGENCY POWER REQUIREMENTS:

14.1. In addition to the life safety equipment and/or systems required by Code, include the following equipment and systems in the design of the emergency power distribution system that may apply to the project unless otherwise directed by the UM OFM Project Manager:

a. Preheat pumps and system.

b. Process cooling water pumps

c. Fire pump

d. Fume hood exhaust fans.

e. General exhaust fans.

f. AHU supply air fans as needed for make up air for smoke evacuation Systems.

g. Atrium smoke evacuation systems.

h. A/C units, dry coolers and pump packages serving computer rooms, data rooms, IT closets, elevator machine rooms, electric rooms, Tela-Data, BDF, and IDF rooms.

i. Stair pressurization systems.

j. Controlled environment rooms.

k. Foundation sump pumps.

l. Fire alarm systems.

m. Domestic water booster pump package

n. ATC controls for the above equipment and systems, including but not limited to, cabinets, TEC's, transformers, and ATC air compressor. Coordinate with UM for additional requirements.

o. One (1) building elevator.

15. COMMISSIONING:

15.1. The A/E team shall include the requirement for commissioning of all mechanical, electrical, and appropriate building systems by an independent commissioning agent to be hired by UM or the CM, as directed by the UM OFM Project Manager. The design specifications shall include all descriptions, commissioning forms, reports, and procedures required to completely test and demonstrate the operation of systems provided by the project. The testing and demonstration of each system shall include, at a minimum, normal operation and control sequences, failure modes, monitoring and control systems, life safety operations, security operations, and all remote monitoring and notification.

END OF SECTION 3 ED - PART I