PART 2: POWER AND LIGHTING SYSTEMS DESIGN

Amended 09-19-2022, See underlined text

1. SCOPE:

1.1. This part outlines the minimum requirements for the design procedures for the power and lighting systems, for new buildings, and repair and alteration projects for existing buildings on the UMB campus.

2. PRIMARY SERVICE:

2.1. Four (4) 13.2 kV BGE feeders serve a University of Maryland closed ring bus commonly referred to as the North Electric Station (MSS) in West Saratoga Street. The MSS has twenty four (24) circuit breakers to provide a 13.2 kV distribution network throughout the campus. Buildings are typically served by two UMB feeders originating from opposite ends of the ring. Smaller facilities may have a secondary (480V or 208V) service from a larger UMB building or directly from BGE where UMB service is not economical. Conduct an evaluation and provide a report with recommendations at the schematic design phase submission. Where new buildings are added to the University's primary feeders, or a substantial change to an existing structure is made, submit a calculation at the Design Development Phase showing the existing load on the feeder, new load, and feeder capacity.

3. GROUNDING REQUIREMENTS:

3.1. **Structural Steel vs. Poured Concrete Structures and Grounding Electrodes:** Per NEC 250, the grounded conductor of all separately derived systems must connect to the nearest grounding electrode via a conductor that is separate from the equipment grounding conductor of the primary service. For structural steel buildings, either a common grounding electrode riser or the building's structural steel can be used as the grounding electrode. For poured-concrete buildings, only the common grounding electrode riser can be used. As per NEC 250, interior water service piping located more than five (5) feet from the service entrance cannot be used as the grounding electrode. It is UMB's preference to always provide a minimum # 3/0 awg grounding electrode riser in the stacked electric closets to ensure a continuous, low-resistance pathway to earth that doesn't rely on building steel or concrete foundations.

3.2. **Ground Grid Considerations:** Incorporate the following in the building's underground ground grid:

a. Provide a minimum of six (6) 3/4 inch x 10 foot long copperweld ground rods spaced a minimum twenty (20) feet a part. Keep in mind that ground resistance decreases with the quantity of ground rods and as their spacing increases (ref. IAEI Soares' Book on Grounding).

b. Interconnect all ground rods using multiple pathways (i.e. not just a single daisy-chain run around the perimeter) with minimum # 4/0 awg copper and only Cad-Weld type welded connections. The available fault current

from BGE is around 20kA. At 20kA, mechanical connections do not have the temperature rating for use with the # 4/0 awg wire (ref. IEEE Standard 80).

c. Provide direct, independent connections from the 15kV disconnects' ground bus, 600V switchboard ground bus, substation transformer equipment ground, the building's main substation ground bus, tel/data BDF ground bus, emergency equipment room ground bus (if applicable), structural steel UFER ground (if applicable) to the underground ground grid via XHHW insulated, minimum 250kCM copper in two (2) inch PVC 40 conduit and waterproof sleeves. For the main substation ground, provide parallel connections to separate points in the grid for redundancy.

3.3. Lightning Protection Systems: As per NFPA 780, the grounding electrodes associated with a lightning protection system cannot be used in lieu of providing the substation grounding electrode system. Although permitted, it is not UMB's preference to interconnect the two (2) grounds in earth given the potential for stray voltages to propagate onto sensitive low-voltage systems.

4. RACEWAYS, CABLE TRAYS, UNDERGROUND DUCTS, MANHOLES AND HANDHOLES:

4.1. Galvanized steel electrical metallic tubing (EMT) up to four (4) inches in diameter shall be used for feeders, communication cables and branch circuits unless:

a. The NEC requires intermediate (IMC) or rigid galvanized steel conduits (RGSC) because of voltage class; or,

b. There is a risk of physical damage to the feeder and IMC or RSGC is appropriate.

c. Aluminum conduit shall not be used.

4.2. Intermediate (IMC) or rigid (RGSC) galvanized steel conduit shall be used for raceways over four (4) inches in diameter.

4.3. PVC Schedule 40 conduit, fiberglass strut, and NEMA 4X non-metallic junction and pull boxes and conduits shall be used outside buildings, on roofs, in garages (above eight (8) feet) or underground encased in concrete. PVC shall be used with approved expansion fittings in accordance with the manufacturer's recommendations, with a minimum of one fitting between every two fixed points and one fitting for every building joint that is crossed. All Boxes and raceway supports for PVC runs shall be PVC NEMA 4X non-metallic enclosures and fiberglass strut. PVC shall not be used inside HVAC-conditioned spaces.

4.4. Conduit shall not be exposed on the exterior of buildings. Conduit shall not be installed embedded in floor slabs or under slabs below grade unless required by code or expressly permitted by UMB.

4.5. Rigid steel conduit with bonded PVC coating shall be used outdoors, in garages, or in damp/ wet locations where potentially subject to physical damage; i.e. exposed vertical runs below eight (8) feet in garages or any location where it could be struck by a vehicle.

4.6. Size conduits in accordance with the NEC.

4.7. **Branch Circuit Conduit Sizing:** For research building projects, all branch circuit conduits shall be a minimum one (1) inch with no more than six (6) current carrying conductors per conduit. The neutral wire is considered a current-carrying conductor. For office buildings, housing projects, parking garages, and any other non-research space where a high amount of changes are not expected over the life of the space, branch circuit conduit shall be a minimum three quarter (3/4) inch.

4.8. Cable tray (center ladder type with nine (9) inch rung spacing) is preferred for vertical and horizontal telecommunications data, and signal cabling. See further requirements see the Telecommunications Wiring Standards latest edition in Section 5: Appendices of these Design Standards.

4.9. The entrance of cable trays into electrical/telephone rooms or through other fire rated construction shall be via approved fittings designed to use removable pillow type fire stops.

4.10. Conduits for the campus standard combination telephone and data communications outlets shall be a single one (1) inch EMT conduit extending from one (1), four (4) inch square box to above the lay-in ceiling or to the local distribution backboard if gypsum ceilings are used. Provide bushings with pull strings at both ends of conduits.

4.11. Provide a pull line, with two hundred (200) pound minimum tensile strength, in each data/telephone conduit and cable trays.

4.12. All branch circuits for power, telephone, communications, fire alarm, etc. shall be distributed from the same floor which they serve. On each floor, provide disconnects from the main power risers to each distribution panel.

- **a.** **Example:** An electrical panel located on the 3rd floor shall serve only the 3rd floor.

4.13. Romex cables shall not be used.

4.14. Manholes and handholes, both on state property and in the city rights-of-way shall be precast concrete to meet all requirements of Baltimore City DPW.

4.15. All new ductbanks shall be minimum five (5) inch PVC 40 encased in concrete with only long-sweep sixty (60) degree bends. Forty five (45) degree short bends are not permitted. The concrete structure shall be continuous with reinforcing. Top of the ductbank shall be minimum of twenty (24) inches below finished grade. The ductbank shall slope to drain to prevent accumulation of water and

shall not have any low points. A utility marker tape shall be buried twelve (12) inches above each ductbank.

4.16. On projects which allow the use of the MC cable for value engineering efforts, MC cable shall be provided with interlocking steel armor for branch circuit wiring.

4.17. MC cable shall not be used within the electrical rooms, mechanical rooms, janitor's closets, any exposed locations or those typical of RGS applications.

4.18. MC cable shall not be used for feeders. All homeruns shall go to a junction box and/or wire trough, located in the corridor ceiling space, immediately outside the electrical closet in EMT.

5. WIRE AND CABLE, BUSDUCT, POWER CABLE:

5.1. All cable shall have copper conductors. All busduct shall have insulated copper conductors. Aluminum conductors are not permitted.

5.2. 15 kV cable for primary distribution shall be EPR 133% insulated, single conductor cable, rated for grounded system application. The size shall be determined by:

a. Size of existing cables if a tap is to be made.

b. Available duct or conduit size as determined by field survey.

c. In addition, a separate ground cable shall be installed with the three single conductor cables, sized to protect the 15 kV cable shield in the event of a ground fault.

d. Modular splice kits are allowed as needed and must be approved by UMB.

5.3. For 600 volt and under conductors, splices shall be as follows:

a. #12 & #10, solid conductors: wire nuts;

b. #8 and larger conductors shall be by compression type fittings using hydraulic crimpers.

5.4. Not more than one circuit supplied from the same phase shall be installed in the same conduit. No more than six (6) current carrying conductors per branch circuit conduit is permitted. The neutral wire is considered a current carrying conductor.

5.5. Existing 15kV cable which is to be spliced, capped, terminated, or otherwise cut, shall be tested per IEEE 400, Table 5, to establish its condition before performing any work and again before energizing. Similarly, new cable shall be tested according to the IEEE 400 recommendations before splicing, capping, or terminating and then again before energization. See UMB Master Specifications for additional requirements.

6. ELECTRICAL IDENTIFICATION:

6.1. This part defines the general requirements for electrical identification. When working in existing facilities and the existing identification systems are found to vary from the following requirements, bring any differences to the attention of UMB for direction.

6.2. Power feeders shall be identified in accordance with a scheme which relates the voltage of the feeder and the source of the feeder as well as number of that feeder.

a. **Example:** 480V-1-5 which would indicate a 480V feeder from switchboard number one (1) which is designated "Number five (5) feeder".

b. The identification scheme should be tailored to the distribution system and may be simple for a building with one switchboard but must be appropriately sophisticated for a building with emergency and normal systems along with varieties of configurations and numbers of substations. Consult with UMB for final approval of identification scheme.

6.3. Substation and switchboard identification shall match with power feeder identification.

6.4. The panelboard name must identify whether it's on emergency power; what type of load is served; the internal buss voltage; the building floor being served; and a sequential number or address.

a. **Example:** Panel 'ELP232' is an emergency lighting panel serving 208V/120 loads on the 3rd floor.

b. **Legend:** Use the following legend in developing the building's panelboard naming scheme:

1) **'E':** First letter to be included if on emergency power; leave blank if not on emergency power.

2) **'LP':** Lighting Panel

3) **'RP':** Receptacle and small loads panel.

4) **'LAB':** Emergency panel dedicated to a lab module or suite. Where 'LAB' is used there is no need to include the letter 'E' to identify emergency. These are normally fed from the 'ATS-LAB' emergency power riser in the building.

5) **'ELAB'**: Emergency panel dedicated to a lab module or suite. Newer buildings may use ELAB labels. These may be fed from either a 'ATS-LAB' power riser or other standby electrical power source.

6) **'EQ':** Emergency Equipment Panel. Mechanical Division Loads, pumps, fans, ATC, fume hoods, etc. on emergency power that must stay in service during a loss of power. These are normally fed from the 'ATS-EQ' emergency power riser in the building.

7) **Emergency Distribution Panel (EDP):** Typically used for the distribution panel in the electric closet on each floor that subfeeds the local 'LAB' panels in the research space areas.

8) **First Number in Series: '**2' designates 208V/120; '4' designates 480V/277.

9) **Second Number in Series:** Identifies which Floor the Panel is located on.

10) **Third Number in Series:** Assign a sequential number regardless of whether there is only one type/purpose or more than one. When working within an existing building, pick up the numbering sequence from the last existing panel.

6.5. Power system identification shall be shown on all risers, plans, and substation details and schedules.

6.6. Identify all equipment and low-voltage feeders with phenolic tags with white backgrounds and black lettering. Identify high-voltage feeders with phenolic tags with red background and white lettering. Attach tags to switchboards and equipment enclosures via self-tapping screws or rivets; attach to low and high-voltage cabling via weather-resistant plastic tie wraps. 13.2 kV panels shall be identified with phenolic tags with red backgrounds and white lettering.

6.7. Data and telecommunications riser cabling and backboards shall be identified using principles similar to those described for power. All cables and backboards shall be identified on each floor and the drawing riser diagrams shall be labeled to match. See further requirements see the Telecommunications Wiring Standards latest edition in Section 5: Appendices of these Design Standards.

6.8. The panel directories of all panels which are affected by this work shall be brought up-to-date with every circuit, new and existing, identified correctly. The directory shall be updated in UMB formatted spreadsheet. UMB shall provide spreadsheet file to A/E and Contractor, which shall be returned as part of the as-built documents to UMB.

6.9. Each circuit breaker shall be numbered and marked with proper markers in the spaces made available by the manufacturer of the panelboard. Panel schedule shall be in approved UMB format. Contact UMB for spreadsheet templates.

6.10. Each receptacle shall be neatly marked on the face of the cover plate with a printed label identifying the panel and breaker from which it is fed.

6.11. Where the receptacles cannot have a label on the face of the cover plate due to architectural reasons in public areas, receptacles shall be neatly marked on the inside of the cover plate with indelible marker identifying the panel and breaker from which it is fed.

6.12. All panels, safety switches, motor controls, switchboards/gear, etc., shall be correctly identified as to the feeder, motor or circuit controlled with white, black phenolic nameplates with minimum 1/2 inch high etched black letters and beveled white trim.

6.13. Emergency power outlets and their cover plates shall be red in color. Any special outlets that are not available in red shall be equipped with red cover plates.

6.14. Color code insulated grounding conductors in accordance with NEC 210.

6.15. Color code current carrying conductors (except control and instrumentation conductors) as follows:

a. 208/120 Volt System:

1) Phase A: Black

2) Phase B: Red

3) Phase C: Blue

4) Neutral: White

5) Ground: Green

b. 480/277 Volt System:

1) Phase A: Brown

2) Phase B: Orange

3) Phase C: Yellow

4) Neutral: Grey

5) Ground: Green

c. No. 12 thru No. 6 conductors shall have continuous insulation color.

d. Color code conductors larger than No. 6 which do not have continuous insulation color by application of at least six inches of colored tape on each conductor at all points of access including junction boxes.

6.16. Number code all control and instrumentation wiring at all points of access including junction boxes.

6.17. Identify all circuits, branch or feeder, at junction boxes. This may be done by labeling the conduits entering the box where exposed.

6.18. Identify systems wiring by painting each junction box using the following schedule:

a. **Fire Alarm:** Red

b. **Emergency:** Orange

c. **Telecommunications:** Green

d. **Security:** White

7. VARIABLE FREQUENCY DRIVES:

7.1. **General:** Provide complete variable frequency drive (VFD) units of capacity, quantity and characteristics for fan and pump applications in a single enclosure, and suitable for use with both standard and high efficiency three (3) phase motors as follows:

a. For motors above 175hp, specify twelve (12) pulse or greater units for each motor. Each unit shall be of the same manufacturer. Smaller six (6) pulse not permitted for the larger hp motors.

b. For motors 175 hp and smaller specify six (6) pulse units for each motor. Each unit shall be of the same manufacturer.

c. Coordinate the size of drive with the equipment manufacturer.

7.2. **Standards:** All VFD's shall comply with the latest applicable standards of ANSI, IEEE and NEMA. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430.

7.3. **Acceptable Manufacturers**: Subject to compliance with ANSI, IEEE and NEMA requirements, and unless otherwise indicated, all VFD's shall be products manufactured by one (1) of the following:

a. Siemens Technology,

b. Eaton Electrical Inc.

c. Square D.

d. Danfoss

e. Yaskawa

7.4. **VFD Design:** All VFD's shall be of the pulse width modulated (PWM) design converting the fixed utility voltage and frequency to a variable voltage and frequency output via a two (2) step operation. VFDs utilizing a 3rd power section are not acceptable. Efficiency shall exceed 96% at 100% speed and load. Line side displacement power factor shall exceed (0.95) regardless of speed and load. The VFD shall be rated for 110% current for one (1) minute for variable torque loads and 150% current for one (1) minute for constant torque loads.

7.5. **VFD Enclosure Requirements:** Each drive, including its accessories, shall be mounted in a single cabinet. VFDs shall be designed to be installed indoors unless it is not possible. VFD enclosures shall be suitable for both indoor and outdoor applications as follows:

a. **Indoor Applications:** Provide single NEMA 12 metal enclosure, including transformer, line filters, line reactor, PWM, etc., with manufacturer's optional exhaust fan package that does not require an air filter. Provide additional cooling and/or exhaust as required to ensure enclosure ambient temperature satisfies manufacturer requirements. Assume a room ambient temperature of 104^0F (40^0C).

b. **Outdoor Applications:** VFD's located outdoors on rooftops, in parking garages, at grade, etc: Provide a single non-metallic NEMA 4X enclosure and an independent heating and cooling system to maintain manufacturer's ambient operating conditions.

7.6. **Drawing Requirements:** The following information shall be included in the construction documents:

a. Incorporate the University's standard VFD specifications and details into project contract documents.

b. All design work shall be coordinated between electrical, mechanical and UMB.

c. Show VFD locations on mechanical plans. Ensure adequate mounting space and floor area including service access. VFD preferred location is adjacent to and within the same room as equipment served.

d. The 50% Contract Document review submission shall include specifications and details for VFD's.

e. For projects where the VFD load exceeds 0.1% of the forecasted building load then the 50% Contract Document review submission shall include harmonic calculations made in accordance with IEEE 519 Standards showing the specified THVD, line notching and the specified THCD limits are met. Calculations shall assume worst case system conditions. The review submission shall include, as a minimum, the following information:

1) All input data and assumptions.

2) Explanation of method used to perform the analysis.

3) All calculations and computer printouts used in the analysis, including input documentation.

4) A system impedance diagram based on the electrical one-line diagrams.

5) All calculations shall be in accordance with IEEE 519 with all drives at 100% speed. The point of common coupling shall be the secondary connection of the transformer supplying that group of devices. These calculations shall be done with the transformer loaded to no more than 70% of its nominal capacity. These calculations shall also be done with all twelve (12) pulse or greater drives running as well as the smaller drives running.

8. SERVICE ENTRANCES AND SUBSTATIONS (MEDIUM VOLTAGE):

8.1. Primary electrical service is available from the University 13.2 kV distribution system.

8.2. Available fault current at the master switching station (MSS) bus is 19,200A/500 MVA phase to phase and 18,900A/500 MVA phase to ground at 13.2 kV.

8.3. The UMB 13.2 kV distribution system shall be used unless use of the BGE distribution system has been specifically allowed by UMB.

8.4. Typical primary service is via two feeders, two air load interrupter switches and one fuse compartment. The fuse compartment is key interlocked so that both switches must be open in order to gain access to the fuses.

8.5. 100% spare fuses are required.

8.6. Typically, two transformers with a secondary tie breaker are used, although UMB may elect to serve garages and small office or academic buildings with a primary selective (dual feeder) single-ended substation. Automatic transfer may be required as directed by UMB depending on the reliability designated

8.7. Voltage surge protection shall be applied in the primary switches.

8.8. B.I.L. rating is 95 kV.

8.9. All bus and coils shall be copper.

8.10. The whole substation assembly shall be on a housekeeping concrete pad at least four (4) inches above the room floor.

8.11. The following items shall be furnished with each substation:

a. Hotstick with voltage tester

b. Two (2) sets of three-phase grounding clamps and associated "welding cable" to permit grounding of primary switches; and

c. One line riser diagram of the complete electrical system framed and covered in plexiglass.

d. A gang box style storage cabinet for tools and equipment.

e. Remote racking mechanism.

8.12. Water piping and drain piping shall not be permitted in substations and or electric rooms. The only exception to this requirement will be the piping required for the fire protection system.

9. SWITCHBOARDS AND SWITCHGEAR (LOW VOLTAGE): [Start Here]

9.1. Double-ended substations are to be employed, the mains and ties shall be metal enclosed, draw-out air, or draw-out insulated case circuit breakers with automatic throw over and manual operation, depending on the application.

9.2. Feeder circuit breakers shall be draw out type and shall either be molded case, or insulated case depending on application. Microprocessor based trip units shall be used in all switchgear.

9.3. Copper bus is standard.

9.4. Feeder lugs shall be copper and UL approved and meet the temperature rating for the feeder served.

9.5. All spaces in the switchgear or switchboard shall be occupied with a circuit breaker. Circuit breakers not serving a load shall be provided with variable and adjustable rating trip devices.

9.6. All circuit breaker trip devices shall be coordinated.

9.7. All circuit breaker trip devices shall be set, in accordance with the coordination study, by the contractor before placing the feeder in service.

9.8. Circuit breaker trip operation shall be tested and adjusted as required to comply with the coordination study by an independent electrical testing company.

9.9. Computer/laboratory power should be separated from mechanical and lighting systems where possible.

9.10. Service entrance main switchgear shall have transient voltage surge suppression installed.

9.11. All switchgear shall be ANSI/IEEE type 2 arc resistant.

9.12. All associated metering equipment shall be installed in an isolated separate compartment to facilitate service while gear is energized including shorting blocks, disconnect for meter power, etc. Fused disconnect used only for voltage inputs to meter equipment only.

9.13. Provide copies of all PLC Programs on a thumb drive and paper copies for each station. Provide PLC program software.

9.14. Install a laminated copy of Switchgear Sequence of Operations including Instructions on how to Operate Gear on front of gear.

10. ELECTRICAL METERING:

10.1. Square D metering equipment is the UMB standard for the following applications:

a. Building Service Entrance and/or Switchboard/gear Main Circuit Breakers

b. Building Sub-metering for Separating Self-support Occupancy Loads

c. **Generator Alarm and Fuel and Auto-Transfer Switch Status Monitoring:** Tie the genset "common alarm," "running," and "low fuel" alarm outputs; Main fuel and genset day tank's "high level," "low level," and digital fuel monitor's 4-20mA analog outputs; and the auto-transfer switch's "emergency mode" and "normal mode" switch status outputs to the UMB electrical metering system via the meters described above.

d. **Metering EP Circuit:** Put all electrical metering equipment control power inputs on a dedicated 120V emergency power circuit derived from the 'Life Safety' emergency power riser in the building (i.e. Do not use the 'LAB' or 'EQ' Risers). Do not simply tap the 'A' phase PT input terminal. Backup the 120V emergency power circuit with a 750VA UPS with "low battery" and "replace battery" contact outputs that are tied to a local meter with I/O capability. Provide a shelf for the UPS with a pad lockable strap to keep the UPS secure. Recommended vendor and part information is the APC Smart-UPS 750VA USB & Serial 120V UPS with a relay I/O smart slot card (APC Part # SUA750 with Part #AP9610). In addition to the UPS, provide a Liebert 120V power distribution unit, rack-mountable, and with bypass switch (Liebert part # 2U POD). Verify model number or equivalent with UMB.

e. **3 Phase 4 Wire (3P4W) Applications:** For 3P4W applications, provide four (4) CT's and three (3) PT's. For 3 Phase 3 Wire (3P3W) applications, provide three (3) CT's and two (2) PT's. Do not provide two (2) CT and three (3) PT installations for 3P3W. Both CT and PT's shall be 0.3% revenue metering class accurate with CT's also having a 133% rating factor.

f. **High Voltage Applications:** For high-voltage applications, do not 'piggy-back' the electrical metering onto the same CT's used for the overcurrent

relays. Relaying CT's come with a higher rating factor (i.e. to avoid saturation problems during fault conditions) which degrades their accuracy performance to +/- 10% even with a light burden on their secondary circuit. Provide dedicated CT's for the metering that are revenue metering class accurate.

g. **Blocks and Fuses:** Provide CT shorting blocks and PT fuse blocks for each installation.

h. **Technical Support:** Through Square D, provide two (2) years of powerlogic technical support for the UMB electrical metering system.

10.2. For each new building project, provide a dedicated ethernet switch (consult UMB for latest part number information), backup UPS with battery alarm contact output connected to either the building automation and/or electrical monitoring system, and a bypass switch.

a. **Rack Mount Installations:** For rack mount installations specify an APC smart UPS 750VA USB & serial 120V (part #SUA750RM1U) with an APC smart slot triple chassis (part #AP9604), APC network management card (part #AP9616), and an APC relay I/O smart slot card (part #AP9610). Connect the "replace battery" contact output from the smart slot card to the local building automation system panel and connect the network management card to the local ethernet switch. In addition to the UPS and expansion chassis, provide a Liebert 120V power distribution unit, rack-mountable, and with bypass switch (Liebert part # Micro POD MP2-115A). Verify part numbers with UMB.

b. **Metering Network Switch:** For the metering network switch specify a Cisco switch, part number WS-2960-24PC-L. Verify part numbers with UMB.

10.3. If required, additional metering system modules shall be included with the building construction scope of work to accept the metering input.

11. TRANSFORMERS:

11.1. 13.2 kV primary transformers shall generally be 115^0C temperature rise ventilated dry, cast-coil type with copper coil and of the appropriate voltage secondary. For single-ended substations provide liquid-filled transformer with an insulator that has a high fire-point rating for indoor applications and containment wall/curb for greater reliability and overload capacity.

11.2. Characteristics & Features:

a. Hot spot temperature gauge with output for remote monitoring.

b. 5.75% impedance 7.5% tolerance.

c. 95 kV B.I.L. primary; 10kV B.I.L. secondary

d. NEMA standard sound level; and,

e. Two 2-1/2% taps above rated voltage and two 2-1/2% taps below rated voltage.

f. Provide forced air cooling.

g. Provide transformer temperature monitor for remote recording of transformer winding temperatures.

11.3. Primary and distribution transformers shall be grounded to the building's substation grid in addition to any NEC requirements.

11.4. 600V Class Transformers' Energy Efficiency Standards – Shall comply with NEMA TP-1

12. PANELBOARDS:

12.1. All new panel boards for power distribution, lighting, and branch circuits shall use bolt-on circuit breaker protective devices. Fused switches shall not be used. Plug-in circuit breakers may be used only when connecting to existing panels that accept only plug-in breakers.

12.2. Provide additional spare conduits from flush mounted panels stubbed out above the lay-in ceiling for future use. The number of conduits should be half the number of one-pole spaces left for the future to maximum of six (6).

12.3. All panels installed in electrical rooms and mechanical rooms shall be surface mounted.

12.4. All panels shall be copper bus and breakers and shall be door in door enclosure type. Both the internal and outer doors must be hinged. Providing hinges for the outer cover is typically an optional item so it must be clearly stated.

12.5. All new branch panels shall be either forty two (42) pole or eighty four (84) pole with a min. 225 amp (208V) or 250amp (480V) bus rating. The potential savings by using a thirty (30) pole versus a forty two (42) pole panel is quickly lost after several small renovations and a new branch panel is required because a twenty four (24) pole or thirty (30) pole was previously specified. Also, the bus bars in most 100 amp or 150 amp panels are already 225 amp (i.e., 'NQOD') or 250 amp (i.e., 'NF'). Where special circumstances require the panel to be 100 amp or 150 amp, then require the panel to be "ready to be assembled" in the field instead of "factory assembled." When 100 amp or 150 amp panels are "factory assembled," the nameplate will reflect the engineer's required amperage when they are actually a derated 225 amp or 250 amp panel. In contrast, "ready to be assembled" panels will reflect the actual rating of the bus bars regardless of what the engineer required them to be. In addition, "ready to be assembled" panels have a much shorter lead time (1-2 weeks vs. 4-6 weeks) and are less expensive.

12.6. All new 'I-Line' type distribution panels shall have a minimum ninety nine (99) inches of breaker mounting space (i.e. the combined vertical mounting space on both left and right sides) and with the minimum breaker capacity or prepared spaces for installing 400A and/or 600A branch circuit breakers in the future. Distributors do not size these panels based upon required poles but on the required amount of breaker mounting space. They also may still provide the largest panel possible but then shorten the internal bus bars, so the extra mounting space is useless.

13. EMERGENCY AND STANDBY ELECTRICAL POWER SYSTEM:

13.1. Emergency Generator Permitting: Per MD COMAR Rule # 26.11.02.10 Part E, all new emergency generator installations with an output greater than or equal to 500 brake horsepower or 373 kW must first receive a 'permit to construct' from the Maryland Department of the Environment (MDE). However, prior to receiving MDE approval, the MD Public Service Commission (PSC) must issue a Certificate of Public Convenience and Necessity (CPCN) Exemption for the generator and, prior to the PSC issuing the CPCN waiver, BGE must provide a CPCN 'Relief Letter.' As soon as the design team is confident the generator size will exceed the MDE 373 kW limit, work with the designated UMB Representative to generate the above permit and CPCN waiver applications. For the BGE application, provide a one-line diagram of the building project's proposed emergency power distribution system that confirms the genset will comply with a MD PSC 'Type I' application meaning it will only be used during a loss of utility power and not 'Type II' where it could be used for paralleling with utility power.

13.2. Buildings shall have a source of emergency and standby electrical power, typically one (1) or more natural gas and/or diesel generator set(s). Where identified in the program, the EPS/SEPS may be used for electrical demand peak shaving or load curtailment. For small loads, UMB may elect to use a battery/inverter system. EPS/SEPS would be sized based on the following typical loads:

a. Emergency Power Loads:

1) Life safety requirements including all fire alarm and fire protection (fire pump), emergency, exit and egress lighting loads, and ventilation loads as required by the authority having jurisdiction.

2) Generator accessories including fuel pump, enclosure louver activators, ventilation, and miscellaneous controls.

3) Security, access control, telephone and data communications systems

4) Electrical substation, generator room, Tela/Data BDF and IDF closet(s), and server equipment room(s) lighting and convenience power to facilitate quick restoration of normal power and voice/data communications.

5) Elevator cab lights, control communication and signal systems.

6) ATC Panels.

b. Standby Electrical Power Loads:

1) Fume hood exhaust where loss of exhaust could create a hazard.

2) Elevators, typically through use of a sequencer so that only a single elevator runs at a time, with consideration for additional capacity for a service elevator.

3) A generous amount of laboratory convenience and equipment power. In some critical medical research laboratories, up to 100% of convenience receptacles are connected to the SEPS. Equipment load may include freezers, centrifuges, walk-in cold rooms, etc.

4) Other unique loads as required, i.e., data centers, NMR's, some server farms, etc.

5) Reasonable growth and future expansion, typically 20% - 50%, according to facility. However, given the conservative inrush magnitudes and multipliers programmed into most genset vendors' sizing software and the end-user's high diversity factored in during planning there is usually plenty of spare capacity realized with building occupation and use.

13.3. In addition, generators must be sized using as a criteria motor starting with 15% maximum voltage drop at the motor.

13.4. The engine generator day tank shall have a sight glass or an electronic display to show fuel levels.

13.5. Where applicable, provide a double-wall, sub-base day tank for each genset.

13.6. Provide local fuel gauges for both the main fuel tank and genset day tank. In addition, provide digital fuel monitors for both the main fuel tank and genset day tank with a min. of two (2) 4-20mA signal outputs from each fuel monitor. Tie one (1) of the signal outputs from each of the tanks' digital fuel monitors to the UMB electrical metering system for remote recording of tank liquid levels. In addition, tie the 'high' and 'low' liquid level digital output alarms from the fuel tanks to the UMB electrical metering system. The other signal output will go to the local BAS/ATC monitoring panel.

13.7. All engine generator transfer switches and engine sensing devices for correct system operation shall have contacts for remote monitoring. The contacts shall be for common alarm, anticipatory high coolant temperature, and low oil pressure.

13.8. Additional alarm contacts shall be provided:

a. Generator called on to start,

b. Mode switch not in "Automatic",

c. Over speed,

d. Over crank,

e. Battery alarm,

f. Transfer switch in emergency position,

g. Transfer switch in normal position,

h. Ventilation fan on/off,

i. Louver closed/open,

j. Fuel pump for day tank malfunction,

k. Engine heater not working.

13.9. The generator set shall be natural gas and/or diesel fueled with automatic start and transfer upon loss of normal power. Automatic transfer switches shall have manual by-pass switches to permit maintenance and repair of automatic switches without interrupting the load being served.

13.10. Each engine-generator set shall have a local start/stop switch at each unit.

13.11. Engine generator sets should be located close to the normal power switchboard as appropriate to permit paralleling with the normal power substation for demand peak-shaving and curtailing load operations. Provide a tie circuit breaker and tie feeder between the emergency power bus and the appropriate substation secondary.

13.12. The contractor shall fill and ‘top off’ all fuel tanks within forty eight (48) hours of final acceptance.

13.13. The emergency power system shall have a status monitoring system with annunciation at the building automation system (BAS). In addition, several summary alarms as well as fuel level indication will be transmitted to the campus BAS.

a. Example of parameters are as follows:

1) Common Alarm

2) Run Status

3) Mode switch in other than automatic

4) Coolant temperature

5) Oil pressure

6) Over speed

7) Over crank

8) Battery voltage status

9) ATS status

10) L.V. main circuit breaker status

11) Reverse power

12) Fail to synchronize

13) Engine running

14) Low fuel level

15) Ground fault

13.14. Bridge Power Distribution Systems: The A/E shall coordinate with UMB to determine whether the need exists for providing a bridge power riser and/or distribution system for supporting the following critical systems during the eight (8) to twelve (12) second source transfer from normal power to emergency power:

a. Tela/Data systems including network switches that support VOIP.

b. Building automation system network panels and all low-voltage power supplies.

c. Fire Alarm, access control, intrusion detection system panels.

d. Provide monitoring points connected to the BAS for:

1) Common Alarm

2) Bypass

3) Inverter On Load

e. The bridge power riser will consist of a separate distribution system fed off the standby emergency power service that ties into a central UPS via receptacles and/or disconnects. In sizing the UPS, consider 100% spare capacity with a run-time capability of only fifteen (15) minutes (the UPS will only need to run for a maximum of fifteen (15) seconds). Consider dedicating the riser to the stacked tel/data closets with branch circuit taps to the local floor's electric and/or 'energy management' closets for supporting the building management system loads.

14. INTERIOR LIGHTING

14.1. General: Lighting levels shall be in accordance with I.E.S standards, IESNA (Illuminating Engineering Society of North America) Lighting Handbook latest edition; maintained levels.

14.2. All lighting fixtures shall be of LED light source type that are approved as "Efficient Lighting Systems". Review LED luminaires to evaluate glare control, flicker rates, and color rendering capabilities.

14.3. Building designs shall take maximum advantage of day lighting. Ambient light sensors, dimmers and programmable controllers are to be used where standards and codes require them. The type of photo sensors used shall be coordinated with the lighting control system.

14.4. To take the advantage of the day lighting, where applicable the lighting fixtures shall be placed perpendicular to the exterior window to achieve maximum control.

14.5. Where sufficient day lighting is achieved and requires to turn-off or reduce the overhead lighting level, task lighting shall be provided for supplemental lighting.

14.6. Automatic Lighting Control: Up to 60% of a building's lighting load is wasted or unused. As UMB becomes more aware of the potential energy savings through lighting control and the efficient use of lighting, the proper design of lighting control system(s) for a building becomes ever more important. The design of the lighting control system shall be in accordance with the latest IECC code and ASHRAE standards. In developing lighting control system(s) for a building, please incorporate the following: the buildings lighting control system shall include the following:

a. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1) Monitoring: On-off status.

2) Control: On-off operation.

b. Occupancy/ Vacancy Sensors: Provide sensors for all public spaces, lobby areas, corridors, vending areas, waiting rooms, bathrooms (ceiling-mounted only), etc. Vacancy sensors shall be used in offices, classrooms

and conference rooms. Classrooms and conference rooms may be integrated into the building lighting control system for more complicated occupancy requirements. The occupancy sensors shall be multi-technology type.

c. **Central Lighting Control Panels:** Centralized lighting control panels for interior lighting should be used for special purpose applications such as auditoriums, theaters, seminar and conference rooms where manual control of the lighting is critical to the successful use of the space.

d. **Wireless Lighting Controls:** If wireless technology systems are proposed, consult UMB for requirements of wireless lighting controls. Requirements will be dependent on building and location.

e. **Electronic Timer Switches:** Provide electronic timer switches in all utility rooms/spaces with a display that counts down the time remaining) and with a time frame of up to eight (8) hours. All timer switches in utilities rooms/spaces shall be equipped with an override, if timer switches with overrides are not available, manual on/off switches shall be used. Electronic Timer Switches shall not be installed in substations or electrical rooms. Manual on/off switches shall be installed in those spaces.

f. **Safety Exceptions:** Exceptions to these requirements may be taken where there is impact to safety or security of the space. Consult with UMB for specific requirements.

g. **Preferred Manufacturers:**

1) Lutron

2) Acuity Controls Light

3) Siemens

4) Leviton

14.7. **Lighting Calculations:** Perform all lighting calculations in accordance with the latest edition of IESNA Lighting Handbook. Submit hard copies and electronic files of the calculations to UMB for review and comment during design phase. Submissions shall include the following:

a. Calculations at a minimum shall include:

1) Room name,

2) Room number,

3) Fixture type chosen for the room,

4) Actual and delivered LED lumen outputs used,

5) Color temperature (UMB Standard - 3500° K, minimum CRI of 80),

6) Light loss factor,

7) Required illumination level (IESNA),

8) Calculated illumination level,

9) Calculated illumination level statistics,

10) Power density statistics,

11) Lighting fixture schedule, and

12) All light loss and reflectance assumptions used.

b. Calculations indicated shall be submitted as part of construction design documents.

c. Calculations for most interior spaces may be performed using the zonal cavity or point-by-point method. Perform and submit point-by-point calculations for areas of greater architectural or luminous complexity. Perform and submit point-by-point calculations for laboratory designs.

d. Calculations for exterior spaces, including parking structures, shall be point-by-point.

e. Calculations shall include demonstrated compliance with energy conservation measures. Allowed Lighting Power Density (LPD) figures shall follow ASHRAE 90.1.

14.8. Lighting Fixture Schedule: Provide a Lighting Fixture Schedule on the drawings, separate from the specifications.

a. The Lighting Fixture Schedule shall state at a minimum:

1) Fixture designations used on the plans,

2) Lighting fixture description,

3) LED lumen type,

4) LED driver type,

5) Wattage per fixture,

6) Three manufacturers and complete catalog numbers for each fixture

7) Voltage

8) Mounting type

b. For site lighting fixtures include catalog numbers for pole and mounting height.

14.9. Lighting Design: Lighting design includes the following:

a. Laboratory: See paragraph 16 for requirements.

b. Non Laboratory Areas: The A/E shall make recommendations applicable to specific project. UMB standard recommended fixtures for general lighting areas (2x4, 2x2, and 1x4) are as manufactured by H.E. Williams – AT1, Lithonia – BLT and Cooper Lighting Metalux – RD1.

14.10. Lighting Schemes: Provide at least two (2) proposed lighting schemes for special or architecturally unique areas such as: Lobbies, Atriums, Conference Rooms and other special use areas identified in the project program or as directed by UMB. Layouts shall vary in design and materials such as fixture layout, fixture type, lamps, louvers, reflectors, etc. to enable UMB to select the best scheme to suit project goals and budget requirements.

14.11. Excluded Fixtures: Do not use fixtures with "wrap-around" lenses.

14.12. LED Lighting:

a. Provide LED luminaire as a complete luminaire consisting of housing, reflector/lens, LED module, driver and dimming driver. LED luminaires from different manufacturers which have similar housing, lumen output, input wattage, and optical system may have different photometric performance. A/E shall review all important performance parameters to assure a minimum of three domestic manufacturers are producing equivalent equipment.

b. Utilize LED luminaires when operating at or below temperatures of 32°F. LED luminaires perform well in cold weather. Do not specify LED luminaires for environments that exceed 122°F, unless LED luminaires are certified, listed and warranted by manufacturer for such environment. Verify with manufacturer that performance and warranty are not altered.

c. LED driver must be determined in conjunction with luminaire, lamp source, and controls. Utilize 0-10V dimmable power supplies as basis of design. LED power supplies must be field accessible.

14.13. Exit Signs: Exit signs shall be LED type with a uniform illumination of RED letters over the entire face.

a. UMB Standard Exit Sign Basis of Design: Lithonia EXR-LED-M6RAD

14.14. Battery Backup Fixtures: Battery Backup Fixtures shall be LED type. When battery backup fixtures are required; specify maintenance free type fixtures self-diagnostic test feature.

15. EXTERIOR LIGHTING:

15.1. General: The University goals, for an attractive institutional identity within its urban setting, as well as a high priority for security and safety requires open spaces and the exterior of buildings be well-lighted. Except in locations where it may be necessary to relocate or remove, and approval of Baltimore City is obtained, the city street lighting grid utilizing a high pressure sodium (hps) or LED source on twenty four (24) foot or thirty (30) foot masts shall remain in place. This lighting shall be supplemented by University projects to raise the overall minimum on pedestrian walks to five (5) foot candles. Provide LED light source fixtures. Review LED luminaires to evaluate glare control, flicker rates, and color rendering capabilities.

15.2. Building and Site Lighting: Building and site lighting, including steps and ramps, shall be provided by each project. Entrances and service areas, such as loading docks, shall be provided with ten (10) foot candle lighting level. Alleys and incidental spaces such as interior courtyards, etc. shall be provided with a minimum of five (5) foot candles and a uniformity ratio of three (3) to one (1). Highlighting of architectural features may be recommended for major capital projects which have a significant impact on the campus setting and institutional identity. Landscape lighting has not been employed on campus, but may be proposed for unusual conditions. In general, utilitarian direct source fixtures such as “wallpacks” should not be used on facades or areas facing the public streets. “Walpack’s” may be used in spaces outside direct public view such as alleys with agreement from UMB.

15.3. Sidewalk Lighting: Sidewalk lighting shall be provided as a private lighting system powered from the project. The standard fixtures are:

a. Type 1 Fixture: Pedestrian Walkway:

1) Model: Louis Poulsen Model # ALBEERTSLUND-MAX1-LD-GREY FINISH-ALB MAX PT/LED/120 277/GREY/T DRA 5.3”

2) Lamp/LED: CCT - 4000K, WATT- 82, LUMEN – 4996, LIGHT SOURCE 82WLED 4000K, GREY, INSULATION CLASS 1, EFFICACY 61. LED driver in fixture head.

3) Mast: Louis Poulsen #DRA-5”.3”, 10’-BR ALU (BRUSHED ALUMINUM)

4) Base: Cast aluminum cover w/ tamper proof screws.

5) Pedestal: Site cast air-entrained concrete, top 2” above finished sidewalk elevation with four (4) galvanized anchor bolts,

engineered for wind and impact loading. Sidewalks are usually brick or paver type. Poulsen pole detail is available on the UMB website.

b. Type 2 Fixture: Surface Parking Lot:

1) Model: Beacon Viper VP-L series

2) LED Engine Watts – Provide as necessary to provide required illumination for the area/parking lighting

3) LED Color – 4000K

4) Voltage – UNV

5) Optics – Provide Optics to suite illumination requirements.

6) Provide house side shield options as required.

7) Provide Bird Deterrent

8) Provide with rectangular arm for round pole mount.

9) Fixture Finish – Metallic Titanium Textured

10) Pole – Round Straight Aluminum Beacon Smooth, 25', Metallic Titanium Textured finish. Pole shaft and thickness shall be determined per ASCE 7-05 wind map EPA Load Rating

c. Type 3 Fixture: Plaza Lighting:

1) **Model:** Selux Saturn Cutoff LED # SACL-1-LG4700 (700Ma/65W)-40-8'-BRUSHED ALUMINUM -120 OR 277-DS-HS(AS REQUIRED)

2) **Lamp/LED:** CCT - 4000K, LG4700 (700mA/65W)

3) **Pole:** Round Straight Aluminum A35 -8' -BRA (BRUSHED ALUMINUM FINISH)

4) **Base:** Two-piece cast aluminum

5) **Optics:** Provide optics to suite illumination requirements

15.4. Exterior Lighting Control: Control all exterior lighting via the local building automation system through an mechanically held latching type lighting contactor with a mechanical override switch.

15.5. Exterior Lighting Calculations: Perform all lighting calculations in accordance with the latest edition of IESNA Lighting Handbook. Submit electronic files of the

calculations to UMB for review and comment during design phase. Submissions shall include the following:

a. Calculations at a minimum shall include:

1) Site plan

2) Fixture type chosen for the site

3) Number and type of lamps to be used

4) Locations and mounting heights

5) Required illumination level (IESNA)

6) Calculated illumination level

7) Calculated illumination level statistics

8) Power density statistics

9) Lighting fixture schedule

10) All light loss

11) Reflectance assumptions used

b. Calculations indicated and submitted as part of construction documents are also accepted.

c. Calculations for exterior area lighting, side walk lighting; parking lot lighting and parking structure lighting shall be point-by-point method.

d. Calculations shall include demonstrated compliance with energy conservation measures. Allowed Lighting Power Density (LPD) figures shall follow ASHRAE 90.1 or IECC.

15.6. Lighting Fixture Schedule: Provide a Lighting Fixture Schedule on the drawings, separate from the specifications. The Lighting Fixture Schedule shall state at a minimum:

a. Fixture designations used on the plans,

b. Lighting fixture description,

c. LED lumen type,

d. LED driver type,

e. Wattage per fixture,

f. Three manufacturers and complete catalog numbers for each fixture

g. Voltage

h. Mounting type

16. LABORATORY ELECTRICAL DESIGN FOR NEW AND/OR RENOVATION PROJECTS:

16.1. Design Intent: The intent of the laboratory electrical design is to standardize the use of materials, equipment, and systems for all new laboratory installations and all laboratory renovation projects. The A/E shall discuss with UMB the selection of all material and equipment prior to proceeding with the design.

16.2. General Laboratory Requirements: Standard laboratory requirements shall include but not be limited to the following:

a. Electrical Services: Electrical services shall include normal power, emergency power, and standby emergency power for laboratory equipment and lighting for each laboratory space.

b. Emergency Power Outlets: Red with red face plates with circuit number indicated on the back of the cover plate and on the face plate.

c. GFCI Outlet: GFCI and indicator within six (6) feet of wet areas.

d. General Lighting: Unless otherwise directed by UMB, provide 1x4 LED source fixtures in laboratories located over the laboratory benches. Lighting shall be designed in accordance with IES standards, IESNA handbook, most recent edition. Wherever feasible, use natural light as the primary daytime light source. Review LED luminaires to evaluate glare control, flicker rates, and color rendering capabilities.

1) Provide 1- foot x 4-floot recessed LED lighting fixture with acrylic lens, installed above the edge of the lab bench. UMB standard laboratory fixtures are:

a) LED – Lithonia – BLT, H.E. Williams – AT1, Cooper Lighting Metalux – RD1.

e. Special Receptacles: Coordinate with UMB for special type of twist-lock receptacles or other type of special receptacle requirements in the laboratories and equipment spaces.

16.3. Special Laboratory Requirements: Special laboratory requirements shall include but not be limited to the following:

a. **Biological Safety Level 2 (BSL-2) Laboratories:** Ultra violet lighting shall be provided only as plug-in equipment with integral switch as directed. Provide warning sign. All fixtures shall be vermin proof.

b. **Biological Safety Level 3 (BSL-3) Laboratories:** A/E design team must coordinate the designs for biological safety level 3 areas with UMB.

c. **Animal Biological Safety Level 3 (ABSL-3) Laboratories:** A/E design team must coordinate the designs for animal biological safety level 3 areas with UMB.

d. **Surgery Laboratories, Survival:** In laboratories used for survival surgery, in addition to standard laboratory requirements provide a ceiling mounted surgery light fixture and explosion proof outlets. Also lighting fixtures shall be watertight and vermin proof, and switches and receptacles shall be watertight. Surgery lighting fixtures shall be structurally engineered for installation in each space.

e. **Surgery Laboratories, Non - Survival:** In laboratories used for non - survival surgery in addition to standard laboratory requirements provide a ceiling mounted or floor mounted surgery light fixture and explosion proof outlets. Also lighting fixtures shall be watertight and vermin proof, and switches and receptacles shall be watertight. Surgery lighting fixtures shall be structurally engineered for installation in each space.

f. **Animal Holding Rooms:** In rooms used to hold animals, all lighting fixtures shall be watertight and vermin proof, and switches and receptacles shall be watertight. Fixtures shall be rated for clean room application.

g. **Photo Dark Rooms:** In dark rooms provide traditional red filter work lighting with exterior warning light with interlocked switches for alternative general lighting. Consult with UMB for specific requirements.

h. **Administrative Support Areas:** In administrative support areas include standard power, data, and lighting.

i. **Equipment Rooms:** In equipment rooms include standard power, emergency power for equipment, and lighting.

j. **Laboratories with Low Flow Chemical Fume Hoods:** In laboratory areas with low flow chemical fume hoods, consult with UMB to determine requirements if flammable or explosive chemicals will be used. For normal use low flow chemical fume hoods, in addition to standard laboratory requirements provide power for the fume hood and emergency power for incubators and other equipment and data outlets as directed by UMB.

k. **Laboratories with Existing Standard Chemical Fume Hoods:** In laboratory areas where the existing standard chemical fume hoods are to

be reused from another location, consult with UMB to determine requirements if flammable or explosive chemicals will be used. For normal use low flow chemical fume hoods, in addition to standard laboratory requirements provide power for the fume hood and emergency power for incubators and other equipment and data outlets as directed by UMB.

l. Laboratories without Chemical Fume Hoods: In laboratories without chemical fume hoods, in addition to standard laboratory requirements provide emergency power for incubators and other equipment and data outlets as directed by UMB.

m. Tissue Culture Laboratories: In tissue culture laboratories in addition to standard laboratory requirements, provide emergency power for incubators and other equipment and data outlets as directed by UMB.

n. Prosthetic Dental Laboratories: In prosthetic dental laboratories provide standard power, emergency power, data and lighting as directed by UMB.

END OF CHAPTER 3 ED - PART 2