DIVISION 26—ELECTRICAL

FORMAT
1. Technical Specifications content and numbering system shall be based on CSI Master Format 2004 version.

NOTE ON UTILITY FUNDED ENERGY CONSERVATION MEASURES
1. At the kick-off of each project, the Associate should engage an energy solutions company (i.e. Efficiency Smart) to explore Utility and Government incentives in saving energy with new technologies. Cost analysis should be calculated to determine the amount of energy and costs savings that could be afforded the University.

BASIS OF DESIGN
1. BGSU Construction Standards shall not replace fully developed, project specific technical specifications. The Associate shall utilize the Standards as a minimum, to guide the design and execution in the field. Exceptions to these standards are allowed provided they are approved by Design & Construction department of the University.

2. All submitted substitute products shall be brought to the attention of Design & Construction prior to approval. Provide fully functional samples upon request.

RELATED SECTIONS
22 – PLUMBING
23 – MECHANICAL
27 – ITS COMMUNICATIONS
33 – Utilities
Appendix B – ENERGY CONSERVATION
Appendix D – INFRASTRUCTURE

DETAILS AT THE END OF THIS SECTION:
- Parking Lot Pole Detail
- Pedestrian Light Pole Detail
- Pedestrian Light Pole Apron Detail
- Inground Junction Box Detail
- Power Post Detail

COORDINATION
1. Consult with the University regarding temporary electric service for each individual project, including activation, associated costs, and method of billing. The source should be identified and the voltage and phase specified.

2. All exterior light and pole locations should be staked out by the contractor and approved by the University and/or Associate prior to installation.
GENERAL PROVISIONS

1. Codes and Standards
   a. All work shall conform to the latest edition of the Ohio Building Code and National Electrical Code (NEC) currently adopted by the State of Ohio.
   b. Codes shall be used as minimum requirements, and where the BGSU Construction Standards call for an installation that exceeds and does not violate the code requirements, the Construction Standards shall be followed.
   c. All materials shall conform to the standards of the Underwriter's Laboratories (UL) in every case where such standards have been established for the particular type of material in question.
   d. The complete electrical installation shall comply with all the requirements of OSHA.
   e. All material and equipment shall be UL listed and bear the UL label where such listing and labeling exists.

2. Branch Circuits
   a. All lighting branch circuits shall be separate from power and receptacle branch circuits.
   b. All branch circuits serving computer loads shall have a dedicated neutral conductor.
   c. Refer to Bowling Green ITS standards for describing the use of isolated grounding panelboards and receptacles.

3. Basic Materials and Methods
   a. All boxes, brackets, bolts, clamps, etc., shall be galvanized, electro-galvanized, metalized, or sheradized.
   b. Cast aluminum, stainless steel, and non-metallic materials may be used in specific locations where appropriate for the location.

4. The Campus primary distribution consists of a looped 12.47 KV system with portions that are 4.16 KV. It is the University’s goal to convert the entire system to 12.47 KV. Connect new transformers to the 12.47 kV system. Coordinate with the Office of Design and Construction to determine specific circuits and connection points.

5. The Engineer shall perform a preliminary Fault Current and Coordination Study using a recognized software program to insure that the specified protective devices will properly and safely interrupt electrical faults and overloads and isolate them to the smallest portion of the electrical system to minimize outages. The contractor shall perform a final study to confirm that the installed equipment meets the fault current and coordination study requirements. This final study shall be turned over to the University. Fault Current and Coordination Study shall be provided on any project where a Panelboard is installed New or as a Replacement. Provide PPE labels on all electrical equipment that matches the University standard for layout, style and size.

260513—MEDIUM – VOLTAGE CONDUCTORS
1. General:
   a. Medium voltage cables shall meet or exceed the latest additions ICEA S-93-639/NEMA WC74 (up to 46 kV), ASTM B-8, ASTM B-231, AEIC CS-6 and UL1072.
   b. Cables and assemblies shall be UL approved and listed.
   c. Cables shall be Type MV-105, single conductor shielded, insulated with 133% insulation for use on an ungrounded 15 kV system.
   d. Cables shall be rated 105 deg C for normal operation, 140 deg C for emergency overload operation and 250°C for short circuit conditions.

2. Conductor:
   a. Conductor shall be uncoated soft copper, Class B, stranded compressed concentric round or compact.

3. Conductor Stress Shield:
   a. The strand shield and insulation shields shall be extruded layers of semi-conducting material compatible with adjacent layers of thermosetting compound with a volume resistively not in excess of 10 OHM meters at 90° applied over the conductor.
   b. The shield shall be clean stripping from the conductor and inseparably bonded to the overlying insulation. The thickness of the extruded conductor shield shall be as follows:
   c. Conductor Shield Thickness:

<table>
<thead>
<tr>
<th>Conductor AWG/kcmil</th>
<th>Size Minimum Point (Mils)</th>
<th>Minimum Average (Mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 – 4/0</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>250 – 500</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>600 – 1000</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>

4. Insulation:
   a. Insulation shall be EPR (ethylene-propylene rubber), extruded in triple tandem with the strand shield and the insulation shield.
   b. The insulation shall be flexible thermosetting dielectric based on an ethylene propylene elastomer colored to contrast with black conducting shield. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight of ethylene nor shall the insulation compound contain any polyethylene, both features to limit the degree of susceptibility to treeing experienced by highly crystalline materials.
   c. The minimum average insulation thickness shall be not less than that specified in the following table. The minimum thickness at any cross-section of the insulation shall be not less than 90% of the specified minimum average thickness.
### Table: Insulation Shield Thickness

<table>
<thead>
<tr>
<th>Calculated Minimum Dia. Over Insulation</th>
<th>Insulation Thickness Minimum Point</th>
<th>Shield Thickness Minimum Point (Mils)</th>
<th>Insulation Thickness Maximum Point</th>
<th>Shield Thickness Maximum Point (Mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1.000</td>
<td>24</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.001 – 1.500</td>
<td>32</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.501 – 2.000</td>
<td>40</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.001 &amp; Over</td>
<td>40</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: (1) ICEA S-93-639/NEMA WC74 and UL 1072 do not recognize the 133% insulation level for voltages above 25 kV.

5. Insulation Shield:
   a. The insulation shield shall be an extruded semi-conducting material compatible with adjacent layers of compound with a volume resistively not in excess of 10 ohmmeters at 90°C when tested per AEIC No. CS-6, and shall be clean stripping. The thickness of the extruded shield shall be in accordance with the following:
b. The outer surface of the insulation shield shall be continuously printed with contrasting colored ink - "Semi Conducting - Remove When Splicing or Terminating".

c. Magnetic Drain Shield:
   i. The magnetic drain shield shall be copper tape, nominal 5 mil in thickness with a minimum 12 -1/2% overlap

6. Jacket:
   a. The overall jacket shall be PVC polyvinylchloride. Jacket thickness shall be as shown in the following table.

<table>
<thead>
<tr>
<th>Cable Core Diameter (Inches)</th>
<th>Jacket Thickness Minimum Average (Mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 0.425</td>
<td>45</td>
</tr>
<tr>
<td>0.426 – 0.700</td>
<td>60</td>
</tr>
<tr>
<td>0.701 – 1.500</td>
<td>80</td>
</tr>
<tr>
<td>1.501 – 2.500</td>
<td>110</td>
</tr>
</tbody>
</table>

   b. The minimum jacket thickness at any point shall be not less than 80% of the specified minimum average thickness. The jacket shall be suitable for operation at a rated temperature of 90°C for single conductor cables.

   c. A permanent identifying legend indicating manufacturer, plant number, conductor size, CU, voltage, 100% or 133% insulation and insulation thickness shall be repeated on the jacket at 2'-0" intervals.

7. Field Testing:
   a. Field test cables after installation, using ICEA specified direct-current hi-pot cable test voltages, record results and incorporate into the Operation Instructions Manual.

   b. The cable manufacturer shall furnish recommended D.C. high potential test voltage and corresponding leakage current for field testing after cable installation.

   c. With special approval by the University, Interlocked Armored Cable Assemblies are acceptable in situations that standard conduit/cable installations are impracticable for high voltage conductors.

8. High Voltage Terminations:
   a. All terminations shall be installed by a journeyman experienced in high voltage termination work. Submit qualifications.

   b. Cable terminations for the conductive shielding of the 15 kV conductors shall be made with factory-molded, preinsulated slip-on terminators with rain shields to provide greater tracking distance. Cable terminators shall be 3-M Series 5600 Quick Term II or PLM Adalet FSD. Cable termination lugs shall be long barrel, 2-hole compression type, with the termination end closed to prevent moisture entrance into the cable.
260519—LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS

1. Minimum size wire for lighting and power feeders and branch circuits (20 Ampere) shall be No. 12 AWG copper.
   a. Minimum size wire for control circuits shall be No. 14 AWG copper. All wire shall be stranded.

2. Conductor Types
   a. All conductors for feeders rated at 100A and larger (No. 2 AWG CU and No. 1AWG AL) shall be Type XHHW copper or aluminum alloy (Southwire Stabiloy or equivalent), 600V, insulated with virgin cross-linked polyethylene insulation.
   b. All conductors for feeders rated less than 100A (No. 2 AWG CU) shall be type THHN/THWN, copper, 600V, insulated with virgin PVC compound and shall have an overall extruded nylon jacket.
   c. Conductors shall be insulated with virgin PVC compound and shall have an overall extruded nylon jacket.
   d. Nylon "skim" or "dip" coating IS not acceptable.

3. A green ground wire, sized according to the NEC Table 250-122, shall be installed in each conduit and kept isolated from the white or gray neutral wire.

4. All wire and/or cable shall be delivered to the job site in full factory lengths of 500'-0" minimum. Longer reels may be used where conditions dictate.

5. Factory "shorts", scrap or warehouse and prior job "clean-outs" (leftovers) will not be acceptable.

6. Feeder phase identification from left to right or front to back facing front of equipment shall be one of the following:

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Red</td>
<td>Blue</td>
<td>White (120/208 Volt Feeders)</td>
</tr>
<tr>
<td>Yellow</td>
<td>Brown</td>
<td>Orange</td>
<td>Gray (277/480 Volt Feeders)</td>
</tr>
</tbody>
</table>

7. Wire Connections and Devices:
   a. Taps and splices in all feeder and branch circuit conductors larger than No. 8 shall be made with approved solderless, pressure type bolted connectors.
   b. Splices in conductors No. 8 and smaller may be made with preinsulated Scotchlock or Ideal wing-nut spring tension connectors.
   c. Junctions made in exterior circuits shall utilize setscrew junction connector with three attachment points and a removable gel-filled cap and clamp Raychem Gelcap SL.
1. MC Cable shall be allowed for use as final connection to motors and luminaire power whips. Additionally MC Cable may be used on branch circuits only with approval of the Office of Design and Construction. With approval the University will allow the use of the MC Cable as the final connection on a branch circuit. Conduit shall be provided from the branch panel to a local junction box. From the local junction box to the final device, MC Cable is allowed.

260526—GROUNDING & BONDING

1. Flexible connections to motors shall be jumpered with a No. 14 green equipment grounding conductor, or per National Electrical Code Table 250-122.
2. Install a green bonding jumper between the outlet box and the receptacle grounding terminal on all flush mounted receptacles.
3. An insulated ground wire shall be installed in all feeder, branch circuit and lighting circuit raceways. Ground wire shall be sized in accordance with N.E.C. Article 250.
4. Grounding bushings shall be utilized on each conduit which is not bonded to a grounded enclosure by means of properly installed conduit nuts, one on each side of the enclosure panel and properly tightened such as to cut through the panel paint and make bare metal to metal contact.
5. Ground all step down transformers in accordance with N.E.C. Article 250-30 for Grounding Separately Derived Alternating Current Systems.
   a. The bonding jumper shall be directly connected to a grounding electrode.
   b. Transformer case shall be bonded to the grounding electrode conductor, but shall not be used as the grounding electrode.
   c. Grounding electrode conductor shall be protected within rigid metallic conduit.
6. Install grounding bonding jumper across all building expansion joints, conduit, busway, and cable tray expansion fittings.
7. Install a building grounding electrode system in accordance with N.E.C. Article 250 and as required by the local inspecting authority.
   a. The building framework, metal siding, underground metal water piping, natural gas piping, concrete encased electrode and other made electrodes shall be sufficiently bonded together to form the grounding electrode system.
   b. Connections to the metal underground water piping system shall be made on the line side of the water meter.
   c. Natural gas piping shall not be utilized as a grounding conductor.
   d. It shall be the Contractor's responsibility to provide a grounding system acceptable to the local inspecting authority.
8. Buildings with steel framework shall have a ground loop (counterpoise) installed around the perimeter of the building and connected to the steel
columns at every corner and intermediate points 60 feet on center. Use #4/0 tinned copper buried at least 18" below finished grade. Provide ground rod connected to loop at each corner and 60 feet on center. Connect all lightning downleads to loop. Ground rods shall be ¾” X 10’ copperclad steel.

9. Provide at least one ground test well for each service at the ground rod closest to the service entrance. Use bolted and clamped type connections between conductor and ground rod.

10. The Contractor shall demonstrate by testing that the electrical service grounding system to earth resistance value is 10 Ohms or less, utilizing a "clamp-on" or 3 point fall of potential tester.

260533—RACEWAY AND BOXES

1. Minimum conduit size shall be 3/4 inch for power and lighting circuits.
2. Provide three (3) spare 1-inch conduits up to 24” above finished ceiling and one (1) down.
3. All rigid conduit and electrical metallic tubing shall be hot-dipped galvanized, sheradized, metalized, or electro-galvanized. Use of aluminum conduit is not permitted.
4. Conduit in stud partitions, concealed above ceiling, or above the bottom chord of bar joists may be electrical metallic tubing.
5. Conduit for circuits 100V to ground or greater in mechanical equipment rooms, electrical equipment rooms, chases, and areas subject to physical abuse shall be exposed rigid galvanized steel or intermediate grade conduit below six feet from floor.
6. Conduit for circuits below 100V to ground in mechanical equipment rooms, chases, and areas subject to physical abuse shall be electrical metallic tubing.
7. Conduit on exterior block walls, or exposed exterior shall be full weight rigid galvanized steel.
8. Buried Conduit:
   a. Exterior conduit below grade shall be minimum 1”.
   b. Conduit buried in concrete pours shall be Schedule 40 PVC, Schedule 80 PVC, or electrical non-metallic tubing.
   c. Conduit buried beneath building slabs shall be Carlon Schedule 40 or Schedule 80 PVC.
   d. Exterior conduit below grade shall be Carlon Schedule 40 or Schedule 80 PVC.
9. Feeder conduits for 5 kV and 15 kV systems installed below grade shall be encased in red concrete for their entire length.
10. Flexible galvanized steel conduit shall be used for "make-up" connections to rotating machinery equipment or flush lighting fixtures. Flexible conduit in damp or wet locations shall be liquid tight. Flexible conduit at exhaust fans shall allow hinged access into the exhaust fan.
11. Conduits installed surface mounted shall utilize one-hole or two-hole type straps.
12. Pull and Junction Boxes:
   a. All pull boxes shall be galvanized sheet steel, minimum No. 14 gauge.
   b. Pull boxes shall not be installed in inaccessible locations.

260539—UNDERFLOOR RACEWAYS

1. Under floor cell duct shall be used only in large open areas where power data/communication and/or Audio/Visual outlets are impractical.
2. All elbows and stub ups in firewalls shall be rigid galvanized steel. Elsewhere, elbows and stub ups not exceeding 24" above grade may be Carlon Schedule 40 or Schedule 80 PVC. All joints and terminations for PVC shall be made according to manufacturer's recommendations using "Carlon Solvent Weld Cement" to insure all joints are watertight.
3. All outlets shall be mounted in recessed activation kits with flush doors and wire management blocks.
4. The Use of flush outlets is highly discouraged. Allowance shall be determined on a project by project basis.
5. The Use of recessed floor systems is highly discouraged. Allowance shall be determined on a project by project basis.
   a. When floor boxes are necessary, utilize only types with outlets mounted in boxes with flush doors and wire management blocks.
   b. Floor outlets "dog houses" or "monuments" are not acceptable.

260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

1. Nameplates should be provided on all major equipment, including the following:
   c. Primary Switches
d. Circuit Breakers & Switches in Distribution Panels
e. Disconnect Switches
f. Panels
g. Motor Starters
h. Motor Controls
i. Transformers
j. Contactors

2. Nameplates shall be plastic laminate, white face with black engraved letters, numbers, etc. for normal power; red face with white letters, numbers, etc for emergency power, attached with stainless steel screws.
3. Warning/Sense tape with metal backing shall be installed 12" above exterior below grade feeders.
4. Provide ‘arc flash warning’ and ‘PPE ratings’ (as defined by NFPA 70E) signage on all switchgear, switchboards, motor control centers, distribution panels, panelboards and similar equipment as defined in section 26 05 74 Arc Flash Program.
260574 – ARC FLASH PROGRAM
1. Each project shall have a Short Circuit Study, Protective Device Evaluation Study, Protective Device Coordination Study and Arc Flash Analysis for new and existing electrical distribution system as described in a scope narrative and/or show on the one-line drawings.
2. The study shall include Arc Flash Hazard Warning labels specific to each individual piece of electrical equipment.
3. IF the construction documents DO NOT include this specification section, notify the Office of Design and Construction immediately.
4. Refer to BGSU’s specification in Appendix F - Arc Flash Program for further information.

261200—MEDIUM VOLTAGE PAD MOUNTED TRANSFORMER
MEDIUM VOLTAGE TRANSFORMER
1. The University preference for Medium Voltage Transformers is utilize Exterior Pad Mounted Transformers. However, since the existing infrastructure includes substations installed within the buildings, with approval from the University indoor type medium voltage transformers will be allowed.
2. Common Transformer Characteristics:
   a. Primary Voltage: 12,470V
   b. Secondary Voltage: AS required for the project
   c. Tap Changer, one center, two 2.5% above and two 2.5% below.
   d. Surge Arrestors on the primary with load break elbows.
   e. Bay-O-Net type primary fusing.
   f. 55/65 Degree Temperature Rating
   g. 60K BIL Rating
   h. Construction coil material can be copper or aluminum.
   i. Compliance with IEEE/ANSI C57, NFPA 70, UL, and NEMA.
   j. Minimum energy efficiency ratings of the transformer shall meet DOE 2010 requirements.
3. Pad Mounted Transformers shall include R-Temp or Enviro-Temp seed oil based insulating oil.
4. Indoor type medium voltage transformers shall be dry-type or oil filled type. Building construction type shall determine transformer construction type restrictions. Oil filled indoor type medium voltage transformer shall include R-Temp or Enviro-Temp seed oil based insulating oil.
5. Dry-type indoor medium voltage transformers shall be allowed. Dry-type transformers shall include temperature monitoring and cooling fan kits. Transformer shall be encapsulated in resin coating. Transformers shall have a maximum audible sound level of 65 dBA while self-cooled.
7. Bay-o-net type primary fusing.

261300—MEDIUM VOLTAGE PAD MOUNTED SWITCHGEAR
1. G&W PVI series pad mounted combination unit, with two (2) SF-6 puffer main
interrupters and up to four (4) breaker taps. Pad lockable, dead front-quick change bushings, front access painted Munsell green.

2. Typical PVI 62-376-12-62F switch unit; two (2) main interrupters rated 600A, 15.5 kV Class with four (4) vacuum breaker taps. Taps are SMU-20 fuse (type “E” breaker curve settings), 12,000A interrupting and 19,200A momentary. The following accessories are required; pressure gage, viewing windows, control power from integral CT’s, grounding lugs and approval of Bowling Green Municipal Utility Electrical Engineering Department.

262200—LOW-VOLTAGE TRANSFORMERS

1. Dry-type transformers are permitted to convert 480 volt emergency power to 120/208V-3PH-4W emergency power. Any exterior transformer and larger than 112.5kVA transformers shall not be utilized unless approved by the University.

2. Transformers 30 kVA through 112.5 kVA shall be 115ºC rise with 220ºC insulation. Transformers larger than 112.5 kVA shall be 80ºC rise.

3. Dry-type transformers shall be two winding, copper, indoor type arranged for floor, Trapeze or wall mounting.

4. Dry type transformers shall be NEMA TP -1 energy efficient type.

5. Provide K-rated transformers where substantial non-linear load is served and where defined by the Bowling Green ITS standards.

6. High voltage rating shall be 480 volts with two 2-1/2% full capacity taps above normal and four 2-1/2% full capacity taps below normal voltage. Low voltage rating shall be 120/208 volts wye. Double lugs shall be provided on low voltage side at the transformer locations if required.

7. All transformers 30 kVA and larger shall be mounted on vibration mounts and be connected by using at least 6" of seal-tite flexible conduit on the primary and secondary.

8. All floor mounted transformers shall be mounted on a 4” high concrete house keeping pad.

262413 - SWITCHBOARDS

1. Low voltage switchboards (<600 VAC) shall be dead front, self supporting, NEMA 1 enclosures that are front accessible, front and rear aligned. Switchboards shall be fully rated for the short circuit current available at the terminals. Series rated equipment is not acceptable. The associate shall include short circuit analysis on the construction documents.


3. Typically, switchboards shall be located indoors in locked, dedicated rooms and bolted to a 4” high concrete housekeeping pad.

4. Service voltage shall be 480/277 VAC, 3 phase 4 wire, or 208/120 VAC, 3 phase, 4 wire with ground.

5. Bussing shall be fully rated tin plated copper, Neutral bus shall be 100% rated; ground bus shall be provided and run full length of switchboard.
6. Main Device:
   a. Draw out circuit breaker.
   b. Bolted pressure switch.
   c. Insulated case power circuit breaker, 100% rated.
   d. Fused switch (less than 1000A main).
7. Feeder Devices:
   e. Circuit breaker.
   f. Fused switch.
8. Microprocessor trip on all units 400 A and above.
9. Mains greater than 1000 A (480/277VAC systems): provide integral GFP.
10. Switchboards shall be designed with 20% spare physical and electrical capacity.
12. Panels shall be designed with 20% spare capacity (physical and electrical capacity).

262416 - PANELBOARDS
1. The panelboards shall be not more than 92" high and shall be fully rated for the short circuit current available at the terminals. Series rated equipment is not acceptable.
2. Distribution panelboards may be circuit breaker or fusible switch type.
3. Neutral bus shall be fully rated and isolated from the ground, except as service rated equipment.
4. Bus bars shall be extended to the maximum standard height in each section.
5. Sections of distribution panels shall be bussed with full capacity, three-phase, four- wire copper.
6. Equipment supplied with vertical bus sized to accommodate only the branch feeders supplied will be rejected.
7. All panelboard circuit breakers shall be bolt-on type.
8. Panelboards shall be designed with 20% spare capacity (physical and electrical capacity).
9. Panelboards shall be dead front type and equipped with thermal magnetic molded case circuit breaker units, as indicated.
10. Cabinets shall be galvanized, code gauge, sheet steel and shall be minimum of 17" wide and 5-3/4" deep.
11. Provide adequate wiring and gutter space and a means for circuit identification.
12. Provide a glazed, typewritten circuit directory.
13. Breakers shall be common trip, bolt on type, rated a minimum of 10,000 amperes for 208v and 22,000 amperes for 480v interrupting capacity. Breakers shall be rated for the load connected.
14. Provide flush doors with lock and keys. Provide two (2) keys for each panel. All locks shall be keyed alike and match the University Standard.
15. Computer grade panelboards (UL rated for non-linear loads) shall be installed where required by the Bowling Green ITS standards.
   a. Neutral bus rated 200%.
   b. Integral TVSS.

262419—MOTOR-CONTROL
1. Motors 1/3 HP and smaller shall be 120V or 208V, single-phase.
2. Motors 1/2 HP and larger shall be 208V or 480V, three-phase, depending upon voltage of building power.
3. Motors that are an integral part of packaged equipment may vary from the above to meet manufacturing standards.
4. Motor Starters:
   a. All motor starters and associated controls shall be provided with engraved laminated plastic nameplates.
   b. All single speed starters for motors smaller than 1/2 horsepower shall be manual starters complete with overload and pilot light.
   c. All starters and fusible combination magnetic starters for motors 1/2 horsepower and larger shall be magnetic motor starters. Starters shall be full voltage, non-reversing single-speed, NEMA 1 enclosed with overload heaters in each line. Starters shall be complete with 120 volt fused and grounded control transformer and heavy duty H-O-A selector switch mounted in the cover unless otherwise noted. A red pilot light, indicating motor running, shall be installed in the cover of each starter. Starters shall be as manufactured by Square D, General Electric, Siemens or Cutler-Hammer.
   d. Furnish the University ten percent spare fuses of each type and rating of sizes installed, but not less than three (3) of each type, upon completion of the project. Furnish fuse pullers for each size of fuse provided.
   e. Furnish a 16-gauge sheet metal enclosure with hinged cover of sufficient size to house the spare fuses and pullers.
5. Mount the enclosure near the load where practical.
6. Where motors are grouped reasonably close together, motor control centers should be used.
7. The minimum size combination starter shall be NEMA No. 1.

262713—ELECTRICITY METERING
1. The building electrical system shall be monitored by a multi-function (V, A, kW, kVAR, PF, kWH) digital meter at each service entrance transformer secondary. Meters shall be networked into the campus system. There shall be no deviations to this University standard Manufacturer, E-mon D-mon.

262726—WIRING DEVICES
1. Switches:
   a. Wall switches shall be 20A, industrial heavy duty Specification
grade, nylon toggle, brass binding screws and shall be:
   i. Cooper 2221 Series
   ii. Hubbell HBL1221 Series
   iii. Leviton 1221 Series
   iv. Pass & Seymour PS20AC1 Series
b. All wall switches shall be gray unless other colors are approved by the University on a specific project basis.

2. Dimmer switches shall be modular, fully compatible with electronic dimming ballasts for compact and linear fluorescent lamps.
   a. Control: continuous slide type with positive 'off', single or three way.
   b. Audible and electromagnetic noise filters.

3. Receptacles:
   a. Duplex receptacles shall be industrial heavy duty specification grade 20A, side and back wired, solid brass mounting strap, fiberglass reinforced housing.
      i. Cooper 5362 Series
      ii. Hubbell HBL5362 Series
      iii. Leviton 5362 Series
      iv. Pass & Seymour 5362 Series
   b. Duplex receptacles connected to emergency power shall be red. All other duplex receptacles shall be gray unless other colors are approved by the University on a specific project basis.
   c. GFCI type duplex receptacles shall be feed-thru type.

4. Coverplates:
   a. Switch and receptacle plates shall be Type 302 stainless steel, Hubbell 97000 Series or approved equal by Cooper, Leviton or Pass and Seymour.

5. Installation:
   a. Feed thru wiring devices shall be pig-tailed.
   b. Wiring devices shall not be split wired.
   c. Circuit numbers shall be indicated on the inside face of the coverplate.

262813—FUSES
1. Low voltage fuses shall be as manufactured by Bussmann, Ferraz Shawmut or Littelfuse.
2. All fuses 0 to 600 amps shall be Type R rejection series.
3. All fuses shall be of the current limiting type as follows:
   a. 0 to 90 amps dual element, time delay Class RK-5; Bussmann FRN-FRS, Ferraz Shawmut TR-R TRS-R or Littelfuse FLN-R/FLS-R.
   b. 100 to 600 amps dual element, time delay, Class RK-1; Bussmann LPN-LPS, Ferraz Shawmut A2D-R A6D-R or Littelfuse LLN-RK/LLS-RK.
   c. Above 600 amps time delay, Class L; Bussmann KRP-C, Ferraz Shawmut A4BQ, 601 to 2000 amps, and A4BY above 2000 amps or Littelfuse KLP-C.
d. Motors shall be protected by dual element, time delay fuses.
e. Where circuit breaker panels are protected by fuses, they shall be fast acting, current limiting type.

**262818—DISCONNECTS**

1. Motors located remote from the combination starters shall have a lockable disconnect in the power feeders, not a lockout stop in the control circuit.
2. Disconnects for exterior equipment and similar applications shall be rain tight, NEMA 3R.
3. All disconnect switches shall have interlock defeaters for maintenance purposes.
4. Fusible switches shall have rejection type fuse clips.
5. Disconnect switches shall be heavy duty type as manufactured by Square D, General Electric, Siemens or Cutler-Hammer.

**263213—ENGINE GENERATORS**

1. A natural gas engine driven electric generator with automatic transfer switch(es) shall be installed in all new buildings and in additions to existing buildings to power, at a minimum, emergency lights, EXIT lights, fire alarm system, security, basic telephone and data communications, heating and cooling as noted (and elevators where Code required). Engine generator shall meet NFPA Level 1, Type 10 starting requirements.
2. A diesel fuel driven electric generator shall be utilized where the transfer time cannot be accomplished by a natural gas drive generator or if required by the authority having jurisdiction.
3. Emissions: comply with EPA “TIER” requirements.
4. Location of generator requires consideration of air intakes, exhaust, visibility, high profile areas, maintenance access, and proximity to classrooms, dorms, and offices.
5. Consider serving more than one building from a single engine generator set.
6. Quality Assurance:
   a. Comply with NFPA 37, 54, 58, 70, 70E, 110.
7. The generator shall be provided with voltage, amp, frequency, and other necessary meters and all controls necessary for complete and reliable operation.
8. Silencers shall be minimum “residential” grade.
9. Generators located outdoors shall be housed in a sound attenuated, vandal-proof and fully weatherproof enclosure, wind resistant up to 100 mph.
10. Coordinate design/ installation of Natural Gas service with the Mechanical Engineer.
11. Generators shall be installed on reinforced concrete pads which extend 12” beyond enclosure in any direction and 6” above grade.
12. The generator will also have the necessary excitation control circuitry to
prevent the lose of excitation on fault conditions allowing quick return to full voltage and power to normal and faulted circuits.

13. Remote generator annunciator with audible alert shall be located near fire alarm annunciator.

14. Emergency Lights:
   a. All emergency lights shall be provided and installed in accordance with the National Electric Codes and O.B.C. Provide at least one light connected to the emergency generation system in each mechanical room, electrical room, receiving room, and toilet room. Install a red dot (1/4” diameter) on the frame of emergency light fixtures.

15. Emergency Receptacles:
   a. Provide at least one duplex receptacle connected to the emergency generation system in mechanical and electrical rooms.

16. Heating and Cooling:
   a. Circulation pumps associated with chilled or hot water distribution shall be connected to emergency power. The HVAC system for the BDF Rooms shall be connected to emergency power.

17. Elevators: as required by O.B.C. and NFPA.

18. Smoke control or pressurization fans as required by O.B.C. or NFPA.

263513—CAPACITORS

1. Capacitors shall be Myron Zucker Inc., Calvault VL with blown fuse indicating lights; or equal by Cornell-Dubilier, Cutler-Hammer, Sprague, General Electric, or Square D.

2. Furnish and install banks of three-phase capacitors on all listed motors, 10 HP and larger. Motors with reduced voltage solid-state starters shall be provided with isolation contactor to connect the capacitor bank to the system with motor run signal.

3. Capacitors shall be located adjacent to motors where practical. An alternate location is above the motor control center. Capacitors shall be connected to the load side of the overload heaters. Overload heaters of motor starters shall be sized according to reduced current of motor nameplate amps due to addition of capacitors.

4. If motors are other than 1,800 RPM, the size shall be adjusted per RPM of the motor.

5. Capacitors shall only be installed on any central refrigeration unit, elevators or any variable speed motor with owner’s approval.

6. Where motors are grouped reasonably close together, motor control centers should be used.

7. The minimum size combination starter shall be NEMA No. 1.

264113—LIGHTNING PROTECTION

1. The University shall determine on a project by project basis if to include a lightning protection system. If determined to be part of a renovation or new
building, it shall be manufactured and installed in complete accordance with Underwriter's Laboratories Pamphlet No. UL96A Master Labeled "Lightning Protection Systems", NFPA 780, and LPI -175.
2. The Contractor shall be listed with UL for lightning protection installation.
3. Upon completion, the Contractor shall furnish the University with the Master Label Certificate.

264313—TRANSIENT-VOLTAGE SUPRESSION
1. Surge protection devices shall be provided on each main distribution, and sub-distribution switchboard or panelboard. Surge protection devices shall be provided on branch panels that serve sensitive electronic loads (i.e. computers).
2. TVSS units shall comply with UL 1449, 2nd edition.
3. TVSS units shall be modular in design and replaceable without interrupting power to the switchboard or panelboard. Provide with non-fused switch or circuit breaker disconnect.
4. The protection levels shall be:
   a. 200 kA (L-N, L-G, L-L, N-G) MDP
   b. 100 kA (L-N, L-G, L-L, N-G) SDP
   c. 60 kA (L-N, L-G, L-L, N-G) Branch Panel

265000—LIGHTING
1. The wiring system for interior lighting shall utilize conduit and wire. Modular type systems shall not be permitted, except in Master/Satellite systems where a ballast in the Master Luminaire also controls lamps in the Satellite luminaire.
2. Illumination levels shall be as described in the latest edition of the IESNA Lighting Handbook.
3. Voltage for lighting fixtures shall not exceed 277 volts to ground unless approved by the University.

265100—INTERIOR LIGHTING
1. Luminaires shall be of specification grade. Residential grade and contractor grade luminaires shall not be utilized.
2. The illumination levels for the campus shall meet the recommendations of the latest edition of the IESNA Lighting Handbook, Education Facilities Illuminance Recommendations; Table 24.2. Lighting levels shall meet the vertical, horizontal, and uniformity targets. Visual Age of Observers used for the recommended levels shall be “25-65”. Example illumination levels are as follows:
   a. Lecture Hall (Audience): 50fc Ave-H, 20fc Ave-V, 3:1 Ave:Min
   b. General Classrooms: 50fc Ave-H, 20fc Ave-V, 3:1 Ave:Min
   c. Corridors: 20fc Ave-H, 7.5fc Ave-V, 3:1 Ave:Min
d. Offices: 50fc Ave-H, 20fc Ave-V, 3:1 Ave:Min

e. Lounges: 20fc Ave-H, 10fc Ave-V, 3:1 Ave:Min

f. The above list is only a sample of area types and lighting levels. Areas and subsets of areas shall follow the recommended levels in the IESNA Lighting Handbook. Review specific lighting levels of each area with the University and users during the design.

3. The University’s preferred illumination source is LED. However, fluorescent luminaires shall be allowed to be utilized with prior University approval.

4. Incandescent lamps shall NOT be utilized.

5. Compact fluorescent lamps shall NOT be utilized.

6. High Intensity Discharge Lamp including metal halide, high pressure sodium, and mercury vapor shall NOT be utilized.

7. High bay lighting shall utilize LED lamping technologies. Fluorescent T8 or T5 based luminaires shall not be used.

8. Downlights shall use LED sources only.

9. Fluorescent lamps shall be “T8” or “T5/T5HO”, 4100K color temperature, CRI 85 minimum, low mercury content, 30,000 hour rated minimum, and standard wattages.

10. Solid state based luminaires, LED, shall be 4000K to 4100K color temperature, CRI 85 minimum, 50,000 hour rated for LED modules, and 50,000 hour rated drive.

11. Fluorescent ballasts shall be Program Rapid Start design with the Class A sound rating, 10% or less harmonic distortion, ballast factor of 0.85 minimum, and EMI/RFI emission within F.C.C. guidelines.

12. The University’s preferred classroom luminaires are volumetric style luminaires 2x2 or 2x4 with dimming capabilities within the luminaires. Alternate luminaires can be considered, but will only be allowed with prior approval from the University.

13. Lighting power density levels shall meet the Ohio Energy Code levels.

14. Luminaires with acrylic lenses shall be “A12” pattern and a minimum thickness of 0.125”.

15. Emergency egress lighting shall be provided by generator power where available. Where a generator is not available, individual battery units with LED heads shall be utilized. The emergency luminaires shall include Ni-Cad battery packs, solid state charger, and self-diagnostics.

16. Interior lighting shall be 120V or 277V.

**LIGHTING CONTROLS**

1. All projects shall provide ASHRAE 90.1 compliant lighting controls as part of
the current adopted Ohio Energy Code.

2. The University is interested in Day-Light Harvesting control systems. Due to budget constraints these type systems will be reviewed with the University on a project basis.

3. Classroom Lighting Controls:
   a. Include a minimum of two zones of lighting; (1) lights at the front of the room near video displays and (2) the body of the classroom.
   b. Include present levels; (1) 100%, (2) 50%, (3) 25%, and off.
   c. Preset recall stations shall be placed at the entrance of the classroom and near the instructor station.
   d. Lighting control shall be integrated into the classroom AV system, when available.
   e. Slider dimmer controls in addition to preset level controls can also be considered.
   f. Occupancy sensor override capabilities shall be included in the room.

4. Classroom Lighting Controls:
   a. Include a minimum of two zones of lighting; (1) lights at the front of the room near video displays and (2) the body of the classroom.
   b. Include present levels; (1) 100%, (2) 50%, (3) 25%, and off.
   c. Preset recall stations shall be placed at the entrance of the classroom and near the instructor station.
   d. Lighting control shall be integrated into the classroom AV system, when available.
   e. Slider dimmer controls in addition to preset level controls can also be considered.
   f. Occupancy sensor override capabilities shall be included in the room.

5. Classroom Lighting Controls:
   a. Include a minimum of two zones of lighting; (1) lights at the front of the room near video displays and (2) the body of the classroom.
   b. Include present levels; (1) 100%, (2) 50%, (3) 25%, and off.
   c. Preset recall stations shall be placed at the entrance of the classroom and near the instructor station.
   d. Lighting control shall be integrated into the classroom AV system, when available.
   e. Slider dimmer controls in addition to preset level controls can also be considered.
   f. Occupancy sensor override capabilities shall be included in the room.

6. Unless warranted otherwise, ceiling mounted occupancy sensors are the University's preferred type.

7. Wall type occupancy sensors shall be used in single person toilet rooms and janitor closets only.

8. Digital Time Switches shall be used in other non-occupied, enclosed areas.

9. Occupancy sensors shall be dual technology, IR and Ultrasonic/Microphonic. Sensors shall be ceiling mounted opposite of the door. Sensor coverage shall be contained within the room. Provide a six feet whip connected to the sensor to allow for relocation.

10. Wall type occupancy sensors shall include adaptive technology and a 180 degree field of view.

265300—EXIT SIGNAGE & EMERGENCY LIGHTS

1. Exit signage shall be scratch resistant high impact thermoplastic with no visible knockouts, diffuse “LED” type with RED lettering. Exit signs in Residence Halls shall be wall mounted and have a clear protective vandal-resistant shield.

2. Existing signs and emergency lighting units with internal battery packs shall comply with UL924.

3. Buildings with a generator shall power egress lighting and exit signage from the generator system. When required for lighting control, emergency relays shall comply with UL924.

4. In buildings without a generator, the egress lighting and exit signage shall be provided with Ni-Cad battery packs with solid state charger and self-diagnostics.
265600—EXTERIOR LIGHTING

1. Refer to the following details at the end of this section:
   a. Parking Lot Pole Detail
   b. Pedestrian Light Pole Detail
   c. Pedestrian Light Pole Apron Detail
   d. Inground Junction Box Detail
   e. Power Post Detail

2. Exterior lighting shall be controlled via a master photocell. The photocell shall be “turn-lock” type, Tork 50015-2223 or equal. The photocell shall be mounted facing north on the roof or wall mounted on the building at 10'-0”.

3. The illumination levels for the campus shall meet the recommendations of the latest edition of the IESNA Lighting Handbook and the following minimum requirements:
   a. Pedestrian walkways shall be an average level of 2.0 fc with a minimum of 1.0 fc on the pathway between luminaires.
   b. Parking lots shall be an average level of 2.4 fc with a minimum of 0.6 fc and a uniformity ratio of 4:1 within the parking lot.

4. Consideration of an existing building’s “Historic Nature” shall be considered and discuss with Design & Construction at the beginning of a project.

5. Exterior building mounted luminaires below 15'-0” shall have full cut-off optics and shall be “Dark Sky” complaint. Exterior building mounted luminaires mounted 15'-0” may be cut-off, adjustable flood, or wall-pack with frontal illumination. The use of the adjustable flood and wall-pack style luminaires shall be approved by the University on a per incident basis. Adjustable type luminaires about 15'-0” shall be installed in a manner to achieve “Dark Sky” principals.

6. Exterior luminaires shall be as follows:
   a. Pedestrian poles shall use the Cree Edge Round Spider Mount luminaire for standardizing and style consistency across campus, unless an approved exact comparable style becomes available. The luminaire shall include type V distribution with LED module count as determined to achieve lighting levels based on the current offering from Cree. The LED drive current shall be 700mA when possible (the use of 525 mA drive current is acceptable, the use of 350 mA drive current should be avoided.) The LED color temperature shall be 4000K with a CRI of 70 minimum. The finish shall be dark bronze and shall match the pole finish.
   b. Parking lot poles shall use the Cree Edge Square series or the Lithonia DSX series luminaires. The luminaires shall include distribution types and LED module counts as required to meet illumination level minimums. The LED drive currents shall be 1000 mA (the use of 700 mA and 525 mA drive currents shall be used when lower module counts are not available to meet illumination levels.) The LED color temperature shall be 4000K with a CRI of 70 minimum. The finish shall be dark bronze and shall match the pole finish.
c. Ground based accent lighting products for signage and façade lighting shall be LED based products with all illumination and electrical components above grade. Products shall be cast aluminum with tempered glass lens. The LED color temperature shall be 4000K with a CRI of 70 minimum. The finish shall be dark bronze.

d. Building mounted luminaires shall be LED based products. The LED color temperature shall be 4000K with a CRI of 70 minimum. The finish shall be dark bronze; however alternate finishes may be used as appropriate to match building finishes.

7. The University has a discount pricing agreement with CREE for the parking lot and pedestrian pole lighthouse. This agreement expires in 2017 Verify with Design & Construction at the beginning of the project.

8. Pedestrian walkway poles shall be round straight aluminum, 14'-0" H x 5' Dia with dark bronze finish and cast aluminum base cover.

9. Area and parking lot poles shall be round tapered steel (it is strongly recommended poles be seamless, extruded aluminum for durability and longevity) with dark bronze finish and cast base cover. Pole heights shall be 25'-0" to 40'-0". Where applicable, based on circuit counts, poles that are used for the main feeder to an area shall include a transformer base for a junction box.

10. Concrete pole base shall be formed with a chamfered edge. Grinding to create the chamfer shall not be permitted. Concrete base shall be rubbed smooth. Finish coatings shall not be applied. Concrete forms imprint shall not be cast into the concrete base.

11. Concrete pole bases shall be 27" above grade when in parking areas. Concrete pole bases shall be 4" above grade when adjacent to sidewalks with pole apron for detail at end of electrical section and when 5'-0" or greater from a parking lot.

12. Each light pole shall contain a #6 AWG ground conductor and a 5/8" x 8'-0" ground rod.

13. Maintain FAA compliance with all lighting poles. Verify the compliance with Design & Construction during the design.

14. Each leg of the feed to lighting poles shall be fused in the pole handhole. The fuse holder shall be in-line, non-breakaway, copper crimp terminal, weather resistant, one connector IN/OUT; Bussman HEB series.

15. Lighting contactors shall include hand-off-auto control mounted in the face of the contactor.

16. Each building supplying power to an exterior lighting branch circuit shall have one hand hole (12" x 24" Tier 5) in the grass area within 10'-0" of the building’s exterior wall. Inground junction box shall have a tapered side wall to prevent heaving out of the ground.

17. Exterior lighting shall be 208V.

EMERGENCY POWER

1. All Communication Room, HVAC, Power and Lighting shall be on the emergency power.
End of Section