Modify *Division 26* per the following (deletions are shown struck through and additions are double underlined). Remainder of section is unchanged.

26 00 00 ELECTRICAL

26 00 01 Owner General Requirements and Design Intent

.01 General

A. Service Voltage

1. At University Park, service shall be provided from the 12,470V distribution network whenever possible. The 4,160V network may be used where adequate capacity exists with approval of ES (Engineering Services).

2. At other locations, services may be provided by a local utility or the campus distribution network as appropriate. Details will be provided by Engineering Services.

3. Identify any medium voltage (600V and greater) raceway system within a building by painting it red in its entirety.

B. Building Voltages

1. For loads greater than 750kVA, consider 480Y/277V distribution with 208Y/120V step down transformers for receptacles and other 120V loads.

2. Step down transformers shall be located in rooms with adequate fire ratings and transformers connected for sound isolation using flexible conduit, isolation pads and when supported from the building steel, spring hangers.

C. Utility Demand and Consumption

1. The Design Professional shall complete the Utility Demand and Consumption form on all projects. It is used to inform the University of the impact on the distribution system capacity. Submit to Engineering Services at the Preliminary Design review submission and at the Final Design submission.

Comment [WBM1]: Add link to the form online.

D. Specification Editing

1. Generally, use the “listed manufacturers” option in lieu of “available manufacturers.” Confirm any manufacturer preference with Engineering Services.

2. Note at least 3 manufacturers, unless otherwise approved by Engineer Services. Publicly funded projects require equals unless a formal exception has been granted by the State.

3. Confirm Requirement for extra materials with Engineering Services. Typical items to provide are occupancy sensors, specialty luminaire lenses, fuses, indicating lamps, and enclosure keys.

4. First edit of specifications shall use "strike-through" instead of actually deleting items to be removed. This will allow Engineering Services to see what is to be deleted rather than search for what is missing.

~~4.~~5. Create an Excel spreadsheet list of spare parts, etc. that are to be turned over to PSU at substantial completion (based upon the final contract documents).

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control, Tab stops: Not at 1.63"

E. Mounting Heights

1. Heights are measured to device centerline, unless otherwise noted.

2. Mount switches, card readers, and similar devices at 44" AFF.

3. Mount receptacles and similar wiring devices at 18" AFF.

.02 LEED

Refer to the PSU LEED Policy for our sustainable design philosophy. Refer to the PSU Green Buildings web page for additional information.

.10 Scope (Basis of Design/Application of Systems)

A. Motors

1. Motors less than 3/4 hp. shall be single phase, 115 volts for operation on 120-volt circuits. Motors 3/4 h.p. and larger shall be three phase. Motors operating on three phase, 208V shall be rated at 200V. Motors operating on three phase, 480V shall be rated at 460 volts.

2. On motors 25 hp and above at 480V or 10 hp and above at 208V, discuss the use of soft start and variable speed drives. Voltage sag exceeding 3% on motor start is unacceptable. Download and edit the Variable Frequency Drive specification from

Engineering Services.

3. Where reduced voltage starters of the wye-delta type are used, only closed transition types are acceptable.

B. Elevator Service and Support Circuitry

1. Service:

a. Where required by code, service to elevator machine shall be derived from an alternate source of power, in addition to the normal source. Alternate sources of power, whether generator or dual-primary services, shall be reviewed with Engineering Services ~~for selection~~.

1. If standby supplies more than one (1) elevator, provide a selector switch so that only one (1) elevator can run simultaneously. This reduces yearly PSU testing requirements.

~~b. Provide fusible disconnect switch in the machine room to feed the elevator motor controller.~~

b. Alternate source transfer switch shall contain SPDT contacts for central control system and sufficient number of poles to switch phase wires. Refer to Transfer Switch requirements.

~~c.~~

~~d.~~c. Provide combination fused disconnect/Shunt Trip operator unit. Equipment shall include three (3) Class J dual-element time delay fuses (sized appropriately for motor HP), 100VA CPT, 10 amp 120VAC Fire Safety Switch interface relay, key to test switch, green pilot light all mounted in a NEMA 1 enclosure. Unit shall be equal to the Bussmann "Elevator Power Module" PS series, Eaton "Elevator Control" ES series, Little Fuse LSP series, or Ferraz Shawmut ES series.:

~~1) Where required by code, elevator service shall include a self-contained, fusible shunt trip machine disconnect, Bussman Powermodule, or approved equal, installed in machine room as required by code.~~

~~2~~1) Where elevator machine service includes an alternate source transfer switch, ~~and shunt operator is required,~~ the shunt trip circuit shall originate from a normal/ emergency circuit. Shunt trip normal / emergency circuit shall include a voltage-sensing, time delay on release (off) relay,

Formatted: Indent: Left: 2", Outline numbered + Level: 4 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 2.63" + Tab after: 2.88" + Indent at: 2.88", Tab stops: 2.25", List tab + Not at 2.88"

Formatted: Indent: Left: 1.69", No bullets or numbering

Formatted: List Paragraph, No bullets or numbering

field set for seven (7) second delay to off. Relay shall include NC contact for tie-in to fire alarm panel to annunciate "trouble". ~~Discuss optional methods of alarm with Engineering Services w~~Where tie-in to fire alarm system is not possible, provide a stand-alone fire alarm system with the control panel in the machine room.

2. Support Circuitry:

a. Cab lighting: Dedicated 20A Life Safety circuit shared only with emergency telephone consolidator. Fuse the cab lighting disconnect at 20A, slow-blow fuse. ~~Coordinate dual~~Each additional cab requires its own dedicated lighting circuit.~~requirement with Engineering Services~~.

b. Emergency Phone Consolidator: Dedicated 20A Life Safety circuit shared only with elevator cab lighting. Direct the contractor to tap the line side of the cab lighting disconnect and provide a single red receptacle with red cover at the consolidator. Engrave the receptacle cover to read "FOR EMERGENCY PHONE USE ONLY".~~Fuse emergency phone disconnect at 5A, fast-acting fuse~~. Request further emergency phone installation design requirements from Engineering Services.

c. Pit Sump Pump: Dedicated circuit and devices as required by load.

d. Pit lighting and GFI receptacle: Dedicated 20A normal circuit for GFI receptacle(s) and required lighting fixtures. Provide two (2) 3-lamp 48 inch shallow depth (4 inches or less) lensed T8 luminaires in the pit. Luminaires may be mounted horizontal. Provide 3-way switching for pit luminaires at the top and bottom of and within reach of, pit ladder. Mount all devices in the pit higher than 24 inches AFF.

~~d.~~e. Hoistway lighting~~ and GFI receptacle~~: Dedicated 20A normal circuit for ~~GFI receptacle(s) and~~ required lighting fixtures. Provide ~~two~~ one (2) 2-lamp 48 inch shallow depth (4 inches or less) lensed T8 luminaires ~~in the pit and one~~ at each landing above the pit at a maximum distance of 10 feet center-to-center. Mount luminaires vertically in a corner~~, except pit luminaires may be horizontal~~. Provide separate 3-way switching for hoistway luminaires (in pit and top of shaft)and 4-way switches at each access point into the hoistway (elevator door)- mount

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: Font: (Default) Courier New, 10 pt

Formatted: Font: (Default) Courier New, 10 pt

Formatted: Font: (Default) Courier New, 10 pt

switches 48″ above landing floor level and within reach of access opening. ~~Mount all devices higher than 24 inches AFF in the pit.~~

f. Machine Room lighting and GFI receptacle: Dedicated 20A ~~standby power~~ circuit for GFI receptacle ~~and lighting~~. ~~Connect~~ Provide minimum of one (1) 3-lamp 48″ luminaire on a switched standby power circuit. Connect lighting and related control on line side of GFI receptacle.

g. Provide two (2) emergency stop switches, one (1) at the entrance to the pit and one (1) at the bottom of the pit ladder in the pit. Switch shall be similar to Square D #SKR9R05H13, 2-position, maintained pull, mushroom head with "PUSH EMERGENCY" engraved on the unit. Connect switches to the elevator controller(s)

C. Building Automation Systems (BAS)

1. Coordinate the monitoring of certain electrical equipment with the design of the BAS system. Equipment to be monitored shall include, but not be limited to:
   a. Arc Flash Reduction Maintenance switches on service entrance equipment (when applicable)
   b. Occupancy sensors for HVAC setback
   c. Exterior lighitng circuits including building-mounted exterior luminaires
   d. Engine Generators (when applicable)
   e. Automatic Transfer Switches
   f. UPS's (when applicable)

~~e.~~2. Provide a dedicated circuit or circuits to BAS equipment, from the appropriate branch of power. Not every piece of BAS equipment requires a 20A circuit, they may be combined when appropriate. Require that the EC field coordinate with the BAS vendor exact locations and provide a single receptacle for their UPS.

.20 Definitions

A. CCS: Central Control System that monitors all Building Automation Systems at University Park campus.
B. Provision(s): Electrical space that is built for installation of future overcurrent device without the requirement of any additional parts.
C. Night Lighting: CCS term for exterior lights mounted to the building. These "Night" lights are usually controlled by the campus master photo cell. "Night" Lighting does not include exterior lighting for walkways, roadway or parking, or egress lighting to the Public Way.
D. Site Lighting: CCS term for exterior lighting covering free standing walkway lights and "shoebox" roadway or

Formatted: Font: (Default) Courier New, 10 pt

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: Indent: Left: 0.88", Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 1 + Alignment: Left + Aligned at: 1.13" + Tab after: 1.38" + Indent at: 1.38", Tab stops: 1.25", List tab + Not at 1.38"

Formatted: No bullets or numbering

Formatted: Indent: Left: 1.25", Hanging: 0.38", Outline numbered + Level: 2 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 1.63" + Tab after: 1.88" + Indent at: 1.88", Tab stops: 1.63", Left + Not at 1.88"

Formatted: Numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 1 + Alignment: Left + Aligned at: 0.88" + Indent at: 1.13"

parking lots. These "Site" lights are typically controlled by the campus master photo cell. "Site" Lighting does not include exterior lights mounted to the building or egress lighting to the Public Way.

.30 Submittals

A. Design Calculations

The University requires that the Design Professional submit calculations for all projects, including:

1. Illumination
2. Short Circuit
3. Voltage Drop

B. Construction Submittals

1. Engineering Services has the right to request any submittal for review, but it is the sole responsibility of the Design Professional to approve or reject that submittal. Do not mark any item "Approved As Noted – Pending PSU Review" (or similar). Discuss any questions or concerns with Engineering Services prior to returning the document to the contractor.

2. Require all submittals in PDF format so that they may be shared electronically.

3. Provide a submittal schedule to ES and include ES on any transmittal of review comments.

4. Contact ES regarding which, if any, submittals should be transmitted for review. Again, this review shall be simultaneous to that of the Design Professional.

D. As-Built Submittals

1. Utilize the spreadsheet list of spare parts to be turned over to PSU at substantial completion. Require that the contractor provide documentation of each product turned over and note on spreadsheet when PSU received the materials and who accepted it.

~~4.~~ 2. Refer to the Lighting section for additional As-Built submittal requirements.

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: No bullets or numbering

.40 Standard of Quality/Quality Assurance (reserved)

.50 Coordination (reserved)

26 01 00 Operation and Maintenance of Electrical Systems

.01 General

A. It is the goal of PSU to design systems that are safe, robust, and easy to maintain. At University Park, all major electrical equipment is inspected, tested, and maintained on a yearly basis.

26 05 00 Common Work Results for Electrical

26 05 10 Electrical Acceptance Testing

A. The Design Professional shall consider utilizing the information below to create a separate "Electrical Acceptance Testing" specification. It is acceptable to include these testing requirements within other specification sections, but these requirements are often overlooked by the contractor. A separate section clarifies the requirement to hire an independent testing agency for all electrical testing.

.01 Electrical Acceptance Testing

A. Testing shall be performed on electrical equipment and systems to assure that equipment and systems are operational and within applicable standards and manufacturer's tolerances. Testing should verify that equipment and systems are installed in accordance with design specifications. All testing shall occur at the building site.

B. Testing shall be performed by an independent organization that is professionally independent of the manufacturers, suppliers, and installers of the equipment or systems being evaluated. The name of the proposed testing organization shall be submitted to Engineering Services for approval.

C. Qualified technicians who are trained and regularly employed for testing services shall do all testing. Submit technician qualifications.

D. The testing organization shall conform to the general guidelines of section 5 of the latest NETA Acceptance Testing Specifications, in their entirety. This includes the following:

1. Safety and Precautions
2. Suitability of Test Equipment
3. Test Instrument Calibration
4. Test Report

E. Provide report in the Megger “Power DB” program. Furnish one (1) original, editable electronic (.mdb format), one (1) electronic PDF copy, and Four (4) paper copies of the completed report to Engineering Services. Have the testing firm contact Engineering Services to procure PSU standard Power DB testing forms.

F. Notify Engineering Services at least seven (7) days in advance of any testing. A representative of Engineering Services shall witness testing.

G. Inspection and testing of all applicable electrical equipment listed below shall be done in accordance with the latest version of NETA ATS. This will include all tests marked optional unless waived in writing by Engineering Services.

1. Switchgear and Switchboard Assemblies
2. Transformers: Air Cooled and Liquid Filled
3. Cables: Low and Medium Voltage
4. Air Switches:

    a. Low Voltage
    b. Medium Voltage, Metal Enclosed
    c. High and Medium Voltage, Open

5. Oil Switches: Medium Voltage
6. Vacuum Switches: Medium Voltage
7. Low Voltage Circuit Breakers:

    a. Insulated Case/Molded Case (100 amp frame and larger)
    b. Power

8. Medium Voltage Circuit Breakers:

    a. Air
    b. Oil
    c. Vacuum
    d. SF6

9. Circuit Switchers
10. Network Protectors
11. Protective Relays
12. Instrument Transformers
13. Metering
14. Grounding Systems

15. Ground Fault Protection Systems
16. Motors: AC and DC
17. Generators: AC and DC
18. Motor Starters: Low and Medium Voltage
19. Motor Control Centers: Low and Medium Voltage
20. Adjustable Speed Drive Systems

21. Direct Current Systems:

    a. Batteries
    b. Battery Chargers

22. Surge Arresters

    a. Low Voltage Surge Protection Devices
    b. Medium Voltage Surge Protection Devices

23. Capacitors and Capacitor Control Devices
24. Outdoor Bus Structures
25. Emergency Systems:

    a. Engine Generator
    b. Uninterruptible Power Systems
    c. Automatic Transfer Switches

26. Automatic Circuit Reclosers and Line Sectionalizers
27. Fiber Optic Cables

.02 System Function Tests

A. Perform system function tests upon completion of equipment tests as defined in 26 05 10.01. It is the purpose of the system function tests to prove the correct interaction of all sensing, process, and action devices.

B. Verify the correct operation of all safety devices for fail-safe functions in addition to design function.

C. Verify the correct operation of all sensing devices, alarms, and indicating devices.

.03 Thermographic Survey

A. Perform a thermographic survey on all current carrying devices. Perform the survey during periods of maximum possible loading and prior to expiration of warranty or bond period.

B. Imaging equipment shall be capable of detecting a minimum of 1-degree Celsius at 30 degrees Celsius.

C. A level 2 certified thermographer shall perform the survey.

D. A report shall be submitted to Engineering Services which includes the following:

1. Description of equipment tested
2. Discrepancies
3. Temperature difference between area of concern and reference area
4. Areas inspected
5. Load conditions at time of inspection
6. Provide photographs and/or thermograms of deficient areas
7. Summary which includes recommendations for corrective actions.

.04 Electromagnetic Field Testing

A. Determine the vector-valued quantity of magnetic flux density for power frequency magnetic fields over a predetermined space or area, as designated by Engineering Services.

B. Testing shall be done in accordance with the latest version of NETA ATS.

~~B.~~C. This test is only necessary for specific labs, confirm with Engineering Services prior to adding to the specifications.

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

.05 Voltage Drop Testing

A. A voltage test shall be made at the last receptacle of each branch circuit of each Panelboard. Total voltage drop shall not exceed 3% of the initial voltage measured at the end of that branch circuit. The test shall be made using a 12A load attached to the furthest receptacle. Contractor is responsible to correct any installation with a voltage drop of greater than 3%. If a branch circuit fails the test, all other branch circuit on that panel shall be tested. Submit all test results to Engineering Services.

B. Documentation of the results shall be provided to Engineering Services.

C. Any non-conforming branch circuits shall be corrected.

.06 Fire Alarm Testing

A. All connected fire alarm devices are to be tested for operation, proper programming, and verified to meet proper sequence of operation. Printout of full system test showing test of all devices and interconnected systems shall be provided. Test is to include all

sprinkler flow sprinkler tamper devices, all duct detectors and associated fan shutdown, any smoke evacuation sequence, elevator recall, magnetic door hold or door closer devices, any fire alarm sub-system interconnection, etc. Final fire alarm testing is to be completed in the presence of a representative from the Office of Physical Plant – Engineering Services with sufficient prior notification.

B. System shall be tested for code compliant alarm audibility upon completion of construction.

C. Completed and accurate As-Built floor plans shall be used for final testing and copies of these drawings shall be turned over to the PSU representative immediately after testing. These plans shall include full floor plans showing all fire alarm devices with address and/or loop ID information. Also, a copy of the MXL program shall be turned over to PSU at that time.

26 05 13 Medium-Voltage Cables

.01 Primary Cables

This work is typically installed by PSU Utility Services. Discuss medium voltage cable installation with Engineering Services.

26 05 19 Low-Voltage Electrical Power Conductors and Cables

.01 Cabling

A. Minimum wire size shall be #12 AWG.

B. Provide separate neutral conductor for every interior branch circuit.

C. Utilize solid conductors for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

~~C.~~1. Stranded wire for No.10 AWG and smaller will be considered, but only with Engineering Services approval. If utilized, wiring devices shall be the "plug-on" type with pre-fabricated pig-tails to allow positive connection of cables.

D. Service Entrance, Feeders, and Branch Circuits: Single conductors in raceway, minimum 75C rated. MC cable is not acceptable.

E. All exterior wiring connections, and those made at or below grade shall be waterproof with UL listed waterproof connectors.

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted

~~E.~~F. Push-on wire connectors, other than for luminaire disconnects, shall not be allowed.

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

26 05 26 Grounding and Bonding for Electrical Systems

.01 General

A. Contact Engineering Services for a copy of the basic PSU grounding connections detail.

B. Provide a common bare copper main ground bus, wall mounted adjacent to the service entrance equipment. Bus should be minimum 1/4 inch by 2 inch by 24 inches long, mounted on insulators. Confirm final bus sizing with Engineering Services.

C. Exothermically weld the connection between the service entrance equipment and the ground bus at the ground bus only. Identify each connection to the ground bus with an engraved nameplate. Run bare copper cable (minimum 1/0) from bus to ground rod bed. Make bolt-on connections at ground bus as follows:

1. Water service
2. Ground rods (minimum 3-rod bed, spaced at least rod length apart, buried at least 12 inches below grade)
3. Building steel
4. Telecom ground bus(es)
5. Lightning protection system (when provided)
6. Step-down transformer(s) within the main electrical room (when provided)

D. Any connections made below grade shall be exothermically welded.

E. Ground resistance in reference to physical earth connection shall be below levels as follows:

1. Systems below 500kVA – 10 ohms
2. Systems between 500 and 1000kVA – 5 ohms
3. Systems above 1000kVA – 3 ohms
4. Systems serving Data Center Equipment - 3 ohms
5. Point to point grounding resistance between main grounding bus and all major electrical equipment frames – 0.5 ohms

F. All conduits carrying conductors shall have a ground wire.

G. Provide separate 4/0 ground wire from ground bus to telecom room. Refer to 27 05 00 Communications for required size.

Comment [WBM1012]: Please add a hyperlink to this section.

H. Do not run ground conductors from service transformer to service entrance equipment.

I. Isolated ground systems must be approved by Engineering Service.

26 05 29 Hangers and Supports for Electrical Systems (reserved)

26 05 33 Raceway and Boxes for Electrical Systems

.01 General

A. Minimum size 3/4 inch.

B. Lighting runouts may be 1/2 inch flexible metallic conduits, no longer than 72 inches.

C. Aluminum and plastic conduit is not acceptable (interior). Use of rigid PVC conduit within corrosive environments is acceptable. Review use of PVC with Engineering Services.

D. Intermediate grade, rigid steel, and EMT conduit are acceptable. Where EMT is used, compression fittings are required. Metal or Armored cable is not acceptable, except in small lengths as final connections to luminaires, motors, or as approved by Engineering Services.

E. Install No. 12 non-ferrous or 200 lb. test nylon fish line in conduits where permanent wiring is not installed.

F. Support outlet boxes and switch boxes from two (2) adjacent studs. Outlet boxes designed to attach to one metal stud and be "sandwiched" between the front and back layers of Gypsum Wallboard are not allowed.

G. Where installed in fire-rated partitions, apply firestop putty pads or similar fire rated products on or around outlet boxes as required to maintain the fire rating of the partition.

H. Back-to-back outlets in commons walls are not permitted. Outlet boxes shall be separated by at least one stud wherever possible. In cases of outlet boxes of adjacent rooms in the same stud cavity at the same height, provide a layer of expandable spray foam insulation around each box in that cavity. There must be a minimum of a 1″ horizontal separation space between boxes of adjacent rooms. If this condition occurs in a fire rated wall, provide a 1 hour fire rated putty pad to cover the back of the outlets of one side of the partition. Other junction box installations on fire rated walls shall comply with UL requirements.

I. Surface mount raceway, when approved by Engineering Services, shall typically be non-metallic with dual channels similar to Wiremold 5400 series. Specify appropriate metallic raceway when required to resist certain chemical environments.

26 05 36 Cable Trays for Electrical Systems

.01 Cable Trays

A. Acceptable for communication cable. Refer to the PSU TNS (Office of Telecommunications and Network Services) Minimum Standards for Telecommunications Facilities for requirements.

B. May be desirable in certain research laboratories or facilities to contain equipment power and control cable.

26 05 43 Underground Ducts and Raceways for Electrical Systems

.01 Underground Ducts

A. Underground primary cables shall be installed in 5-inch PVC conduit encased in concrete. Conduit may be NEMA TC-6 Type EB or Schedule 40. Elbows shall be Schedule 40.

B. Underground service entrance secondary cables shall be installed in minimum 4-inch PVC conduit encased in concrete. Conduit may be NEMA TC-6 Type EB or Schedule 40. Elbows shall be Schedule 40.

C. Steel reinforcing is required under traffic areas. All concrete-encased duct banks shall be installed such that a minimum 3"-thick base is poured and cured prior to setting base spacers.

D. Add the following requirements to any ductbank detail.

1. “Avoid over-excavation of the ductbank trench. Ductbank walls shall be formed within 5 feet of a manhole, within a “common” utilities trench, and if the width of the pour will extend beyond the dimension shown on the detail.”

2. “Inspection and sign-off by University representative is required after the ductbank base is poured and the conduits are installed, but prior to final concrete encasement.”

E. Contact Engineering Services for typical CADD details.

.02 Manholes and Transformer Foundations

A. Electric manholes shall be precast or poured in place with pulling irons and cable supports. Coordinate size with ES.

B. Manholes shall be fitted with nonlocking type heavy frame and cover. Provide minimum 32" clear access opening. The word “ELECTRIC” shall be cast in the cover

in three (3) inch high letters. The opening shall be in one corner. A non-conductive ladder extending to the surface shall be provided.

C. Transformer foundations base shall be precast, coordinate size with ES. Base and lid shall have tongue and grove seal.

D. Factory bell ends are to be used where conduits penetrate manhole/foundation walls.

E. Grounding:

1. All electrical systems shall be suitably grounded, including all non-current carrying metallic components of all equipment and metallic conducts. Grounding shall be accomplished as required by the National Electric Code.

2. Transformer foundation shall have a minimum 2/0 AWG bare copper ground ring with at least two (2) 96″ ground rods. Exothermically weld rods and ring. Ring shall be a minimum of 24″ from the edge of the foundation, buried between 18″ and 24″ deep. Rods shall be installed at opposite corners or at a distance of more than rod length apart. Extend cabling a minimum of 48″ above grade for connection to transformer. Do not connect this ground ring to the building service.

F. Supports in Electric Manholes:

1. The Contractor shall furnish and install supports in new and existing manholes where cables are to be installed, cable rack supports of the type permitting variable vertical location of the cable supports. Supports shall be installed as required to support newly installed or relocated cables. Each cable shall be secured to each cable support. Nonmetallic support systems may be used provided they are warranted for labor and materials for a period of no less than two years.
2. All cables shall be properly dressed and racked on the support arms around the walls of the manholes providing adequate slack for future rearrangement and splicing. Existing ducts must not be blocked by cables.

G. Work within manholes must comply with the PSU Physical Plant Confined Space Entry requirements and permission obtained from the Utility Electrical Supervisor to insure safe entry procedures are followed. Due care shall be taken not to damage existing cables.

H. Contact Engineering Services for typical CADD details.

26 05 48 Vibration and Seismic Controls for Electrical Systems

.01 General

A. Refer to section 1613 of the latest IBC (International Building Code) to confirm any requirement for seismic restraint. Discuss requirements with Engineering Services prior to proceeding with design.

26 05 53 Identification for Electrical Systems

.01 General

A. All nameplates shall be fastened by rustproof screws.

B. Panel directories shall denote their source of power.

C. Utilize Engineering Services naming scheme for mechanical equipment, exterior lighting fixtures, etc.

D. Refer to 26 27 26 Wiring Devices for color coding, lab receptacle, and Class 1 Critical Research labeling.

E. Direct the contractor to use an indelible marker to inscribe panel and circuit number on the back of each coverplate and provide a durable tag inside the outlet box.

F. Color for 208/120V Circuit Conductors:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.

G. Color for 480/277V Circuit Conductors:

1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.

H. Provide emergency power warning sign at service disconnect per NEC 700, as required.

I. Label all electrical equipment.

1. Direct the contractor to use and indelible marker to inscribe panel and circuit number on the back of each device coverplate and provide a durable marking inside the outlet box. Coordinate further labeling of receptacles with Engineering Services.

2. Distribution Equipment Designations

a. Distribution Equipment (floor mount):

MDS	Main Distribution Switchgear (Switchboard)
SDS	Secondary Distribution Switchboard (typically a major piece of 208Y/120V equipment)
MDP	Main Distribution Panelboard
EDP	Emergency Distribution Panel (for distribution from generator)
SBDP	Standby Distribution Panel

b. Panelboards:

Branch

C	Critical (Legally Required Emergency)
E	Emergency (Code Required Emergency)
_	Normal (most branch circuit panels)
O	Emergency Only
Q	Equipment (for some generator systems)
S	Standby (Non-Required Emergency)

Voltage

H	480Y/277V
L	208Y/120V

Type

B	Lab (include lab designation)
D	Distribution Panel (3-phase loads)
L	Lighting
M	Mechanical
R	Receptacle

Building Floor

0	Basement
G	Grade
1	First
2	Second…
Etc.	
P	Penthouse

Building Area (as required)
A, B, C...

Panel Sequence (as required)
a, b, c…
or
1, 2, 3…

~~c. Color for Equipment Nameplates:~~
~~Normal Power – Black with white letters~~
~~Standby Power – Blue with white letters~~
~~Emergency Power – Red with white letters~~
~~UPS/Clean Power – Gray tag with white letters to read "UPS POWER" OR "CLEAN POWER";~~

Panel nameplate(s) shall remain with BLUE or BLACK background depending whether fed by Normal or Standby source.

c. Examples

"HL0a"	Normal power, 480V, Lighting panel, Basement (no building area, first in sequence)
"QHM2B"	Equipment branch, 480V, mechanical panel, 2nd Floor, area B (no sequence)

d. Color for Equipment Nameplates:
   Normal Power – Black with white letters
   Standby Power – Blue with white letters
   Emergency Power – Red with white letters
   UPS/Clean Power – Gray tag with white letters to read "UPS POWER" OR "CLEAN POWER"; confirm naming with Engineering Servivces

e. Color for devices on Standby, Emergency, or UPS/Clean Power shall match that above.

3. Label conductors landed at each breaker, 100A/3P and above, with the following:
   a. Circuit breaker position identification
   b. Phase information ("A", "B", or "C")
   c. Labels shall be readably visible once the deadfront cover is removed. Install so that it is wrapped around the cable and adhered to itself so that the cable heating and cooling does not cause the label to fall off.
   d. Example: "CB#1 - A", "CB#1 - B", "CB#1 - C", etc.

~~c.~~4. Require nameplate on each switchgear or switchboard upright section, mounted both front and rear of equipment. IE "SECTION 1", "SECTION 2", etc.

Formatted: Indent: Left: 2", Hanging: 1", No bullets or numbering, Tab stops: 2", Left

Formatted: Indent: Left: 1.75", No bullets or numbering

Formatted: Indent: Left: 2", Hanging: 0.25", Tab stops: 2", Left

Formatted: Indent: Left: 2"

Formatted: Indent: Left: 1.75", Hanging: 0.25", Outline numbered + Level: 3 + Numbering Style: a, b, c, ... + Start at: 1 + Alignment: Right + Aligned at: 2.25" + Tab after: 2.38" + Indent at: 2.38", Tab stops: 2", List tab + Not at 2.38"

Formatted: Font color: Auto

Formatted: Indent: Hanging: 0.63"

26 05 73 Engineering Power Studies

.01 General

A. Short circuit Studies, Protective Device Evaluation Studies, Protective Device Coordination Studies and Flash Protection Studies shall be performed by the distribution equipment manufacturer or an independent firm currently involved in high and low voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Pennsylvania. Credentials of the individual(s) performing the study and the background of the firm shall be submitted to the Engineer for approval prior to start of the work. A minimum of five (5) years

experience in power system analysis is required for the individual in charge of the project.

B. The studies shall be submitted to Engineering Services prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from Engineering Services may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. The studies shall include all portions of the electrical distribution system from the normal power incoming primary source or sources, the emergency and standby power source or sources, down to and including all panels and distribution equipment in the distribution system, and as required to comply with NFPA 70E. Normal system connections and those which result in maximum fault and/or arc flash conditions, shall be adequately covered in the study.

D. The firm performing the study shall demonstrate capability and experience to provide assistance during start up, as required.

E. The power system studies are required to confirm the adequacy of the ratings of all electrical system components and proper coordination settings of all circuit breakers. These studies shall not be used as a basis to compromise the electrical system and do not imply that short circuit ratings of distribution equipment and devices may be lower than those indicated on the drawings or specified herein.

F. The power distribution equipment manufacturer shall carry in their bid to the Electrical Subcontractor, a sufficient allowance to provide modifications to the equipment, if necessary, based on the results of the studies identified herein.

G. Perform all studies using SKM Systems Analysis software. ~~, or approved equal by one of the following:~~

~~1. EDSA Micro Corporation~~
~~2. ESA Inc.~~

H. Submit an electronic copy of the final study in the format used to perform the study. ~~Convert and submit in SKM format also.~~

.02 Coordination Study

A. Perform coordination study to support the selection of instrument transformer ratios, protective relay

characteristics and settings, fuse ratings, low-voltage circuit breaker ratings, characteristics, and settings.

B. The study shall demonstrate that the protective devices as selected and set will ensure that the minimum unfaulted load is interrupted when protective devises isolate a fault or overload anywhere in the system while satisfactory protection is provided for equipment against overloads, and short circuits are interrupted as rapidly as possible.

C. Provide technical characteristics, manuals, time characteristic curves, etc. for each protective device along with the calculations used in preparing the study to Engineering Services. Report shall be in paper as well as editable electronic format. Electronic copy shall be ~~compatible with~~ SKM Systems Analysis software.

.03 Fault Current Study

A. The short-circuit current available on the primary feeder will be given to the Professional by Engineering Services.

B. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Medium-voltage controller.
3. Motor-control center.
4. Distribution panelboard.
5. Branch circuit panelboard.
6. Other equipment as required.

.04 NFPA 70E (Arc Flash Analysis) Study

A. Calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.

C. Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.

D. The analysis shall be performed under worst-case Arc-Flash conditions, and the final report shall describe,

when applicable, how these conditions differ from worst-case bolted fault conditions.

E. The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584 (latest edition), the IEEE *Guide for Performing Arc-Flash Calculations*.

F. The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.

G. The Arc-Flash Hazard Analysis shall include the proper settings for arc flash reduction maintenance switch(es), if specified on the project. Provide settings to avoid nuisance tripping.

H. The proposed vendor shall demonstrate experience with Arc-Flash Hazard Analysis by submitting names of at least ten actual Arc-Flash Hazard Analyses it has performed in the past year.

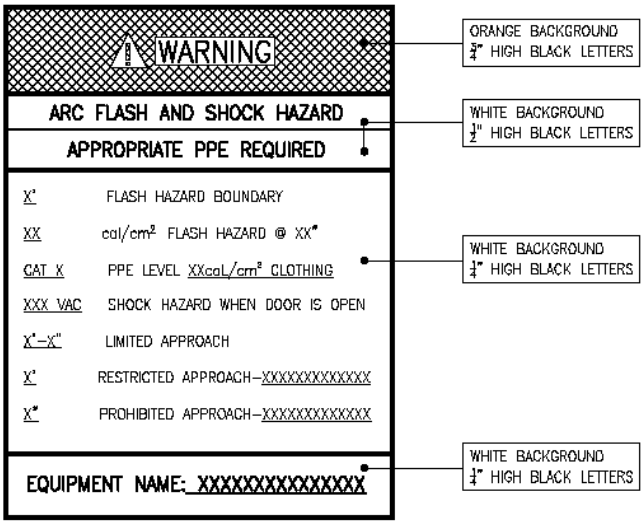
I. The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

J. The proposed vendor shall demonstrate experience in providing equipment labels in compliance with NEC-2002 section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

K. Engineer shall specify or provide study on all major electrical distribution equipment and downstream distribution and utilization equipment. This shall include, but not be limited to:

1. Substation(s), switchgear, and switchboards
2. Distribution panelboards
3. Lighting and appliance panelboards
4. Motor control centers
5. Disconnect switches
6. Controller equipment such as variable frequency/adjustable speed drives
7. Fuses and circuit breakers
8. Rotating equipment
9. Batteries
10. Generator(s)
11. Automatic transfer switches
12. Feeders

L. Provide proper labeling per NFPA 70E on all noted equipment, including any hinged doors of rear-accessible equipment. Coordinate study and labeling requirements with Engineering Services. Typical minimum label requirements shown below:



Label shall be orange and include the date of the study. Specify a second blue label to note arc-reduction levels, when using arc-flash reduction feature. Require manufacturer representative to provide a letter stating that they have visited the site and confirmed that the stickers have been applied in appropriate locations, per the approved Power System Study.

26 09 00 Instrumentation and Control for Electrical Systems

26 09 23 Lighting Control Devices

.01 General

A. Intent – PSU designs shall strive for simple and effective methods of lighting control that is robust and easy to maintain.

B. Automatic Lighting Control:

1. Interior building corridor, office, storage, individual restroom, and similar spaces shall be controlled via occupancy sensors (wallbox, wall mount, or ceiling mount). Use "vandal-resistant" models for wallbox mounting in individual bathrooms and small public rooms. Use dual-switch models for offices and similar spaces requiring dual level lighting (switch closest to the door frame controls the low-light level). Dual-technology is typically preferred, but consider whether the use of one technology over another is more appropriate (corridors for example).

2. When ceiling sensors are used, other than in corridors, provide switch(es) on the load side to allow some user control. ~~Building with individual HVAC control of offices shall use~~

~~2.~~3. Specify ceiling and wall-mount (non-wallbox) sensors with output relays to allow the BAS system to monitor occupancy so that local HVAC ~~unit to~~can shut down to minimum levels when no occupancy is sensed. This is especially effective for large offices, classrooms, labs, and similar spaces. Discuss control strategy with Engineering Services at schematic design phase.

~~3.~~4. Require that the successful sensor vendor submit final layout drawings for review and approval as part of the shop drawing package. Note in contract documents that the Vendor may have to modify the layout from that shown to meet vendor-specific requirements or limitations. No extras to be allowed.

~~4.~~5. Carry an allowance for extra sensors (as well as spare parts).

~~5.~~6. Provide wallbox timer switches for Telephone, Mechanical, Janitor, and similar rooms. Switch must give visual warning 5 minutes and audible/visual warning 1 minute before lights turn off, similar to Watt Stopper TS-400. Set switch to 30 minute delay.

C. Central Lighting Controls:

~~a.~~

Formatted: Indent: Left: 1.65", No bullets or numbering

2.1. When appropriate and approved by Engineering Services, interior building lighting in common spaces and certain "Night" lights shall be controlled through motorized circuit breakers (refer to Controlled Breaker Panels section of 26 24 00) via occupancy sensors and per schedule set by ~~CCS (Central Control System)~~the building users. Provide timed override stations for certain spaces that may be occupied after normal business hours. Refer to the "Interior Public Space Lighting" section of the BAS (Building Automation System) Specification for further information. Discuss this type of control with Engineering Services prior to specifying.

3.a. Exterior building mount "Night" lights shall be controlled through motorized circuit breakers (refer to Controlled Breaker Panels section of 26 24 00) via the Central Control System. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements.

Formatted

4.b. Exterior "Site" (walkway, roadway, and parking) lights shall be controlled from the CCS (Central Control System) via motorized circuit breakers, utilizing 4-20mA CT's to confirm circuit activation. In lieu of motorized breakers, contactors and CT's may be used for buildings that would not otherwise ~~require~~ utilize a motorized breaker panel. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements and discuss options with Engineering Services.

Formatted

26 09 26 Lighting Control Panelboards

Refer to 26 24 00 Controlled Breaker Panels for information.

26 10 00 MEDIUM-VOLTAGE ELECTRICAL DISTRIBUTION

26 11 00 Substations

26 11 16 Secondary Unit Substations

.01 General

A. Indoor unit substations may be required under certain designs. Where used, these shall be three-phase units equipped with a loadbreak fused switches, with current

limiting fuses. SF6 gas insulated equipment shall not be used unless approved by Engineering Services.

B. Taps, two at 2-1/2% and each alone and two at 2-1/2% each below normal shall be provided.

C. Where indoor transformer rooms are used, they must be adequately ventilated with powered ventilators, dampers, and a suitable control system.

26 12 00 Medium-Voltage Transformers

.01 Distribution Transformers

A. This work is typically installed by PSU Utility Services. Discuss medium voltage pad-mount transformer project requirements with Engineering Services.

B. Provide transformer foundation for exterior locations. Ground per "Grounding" section below.

C. Indoor oil-filled transformer, when approved by Engineering Services, shall be FM approved (not just the oil itself). Contact Engineering Services for minimum efficiency requirements.

D. Where fuses are used, a complete set of spare fuses shall be provided.

E. Provide complete information, instructions, wiring diagrams and manuals for maintenance and servicing.

.02 Grounding

A. All electrical systems shall be suitably grounded, including all non-current carrying metallic components of all equipment and metallic conducts. Grounding shall be accomplished as required by the National Electric Code.

B. Provide minimum 2/0 AWG bare copper ground ring with at least two (2) 96" ground rods around transformer foundation. Exothermically weld rods and ring. Ring shall be a minimum of 24" from the edge of the foundation, buried between 18" and 24" deep. Rods shall be installed at opposite corners or at a distance of more than rod length apart. Extend cabling a minimum of 48" above grade for connection to transformer. Do not connect this ground ring to the building service.

26 20 00 LOW-VOLTAGE ELECTRICAL DISTRIBUTION

.01 General

A. Services (480V and below)

1. Design shall include single-line diagram(s) from the Service Entrance equipment through to each branch circuit panel or large load. Show all breakers through any panelboard mains. Riser format is preferable for clarity.

2. Equipment shall be fully rated, series rated is not acceptable.

3. Provide a set of "as-built" drawings stored in the main electrical room. Storage shall be in a PVC tube mounted to the wall with caps on each end. Label tube appropriately.

4. Provide 30"x42", laminated copy of the single-line diagram(s) adjacent to the service entrance equipment. Mount in aluminum frame under plexi-glass. Smaller size may be acceptable depending on the project, contact Engineering Services for direction.

5. Consider using a SPD (surge protective device) on lighting/appliance panels. Review this with

Engineering Services.

6. Contact Engineering Services for a list of acceptable equipment manufacturers.

7. All busing and wiring is to be copper. Specify that all field-replaceable lugs are to be copper (switchgear, switchboards, and panelboards), no aluminum is allowed due to failure from over-torquing.

8. Design professional shall perform and submit voltage drop and short circuit studies. Voltage drop study shall size feeders utilizing a load equal to 80% of the overcurrent device rating. Engineer shall size feeders for a maximum 2% voltage drop. Engineer shall also provide information on each Panelboard advising the contractor as to the maximum length of a #12 AWG and #10 AWG branch circuit feeding a 12 A load to maintain no more than an additional 3% voltage drop. Short circuit study shall utilize the feeder sizes as determined by the voltage drop study.

9. Coordinate the requirement for panic hardware on door(s) exiting the main electrical room with the architect. When required, provide true panic bar setup to allow egress without use of hands, in case of electrical burns.

10. Indicating lamps on any equipment shall be LED.

11. When temporary power for a construction site is fed from a building with ground fault protection, the temporary power feeder shall be fed from a breaker with ground fault detection.

12. Electronic trip units with display must have integral power supply. Main/tie/main gear shall have dual power supplies with interconnection in tie section. Power supply must be multi-tap, capable of running on 120/240 VAC, and 48/24 VDC.

13. All circuit breakers of frame sizes from 100 amperes up to 400 amperes shall incorporate adjustable magnetic trip. Breakers 400 amperes and larger shall incorporate electronic trip units with functions as determined by the coordination study and as required by NEC. Breaker shall have cause of trip indicator targets. Trip units that utilize battery backup, shall have field replaceable batteries. Provide 20% spare batteries as well as full function secondary injection portable test set.

14. Provide Coordination Study, per the Engineering Power Studies section.

15. Specify that the Engineering Power Studies be submitted to Engineering Services prior to receiving final approval of the electrical distribution equipment shop drawings and prior to release of equipment for manufacture.

16. Require mameplate on each upright section, both front and rear, for switchgear and switchboard assemblies.

~~15.~~17. Require IR camera windows on each rear section of Switchgear, confirm scope with Engineering Services.

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

B. Service Entrance Equipment

1. Where Unit Substation is approved, provide secondary main overcurrent protection.

2. Ground fault protection – provide where required by the National Electric Code. When the main circuit breaker has ground fault protection, all second level breakers must also have ground fault protection. When a third level breaker equals or exceeds 400 amps, consider additional ground fault protection. Consult with Engineering Services. Properly interlock all levels of ground fault protection to insure tripping at the lowest possible level and verify on the Coordination Study required under the Engineering Power Studies section.

   a. Annunciate breakers with ground fault trip capability for a ground fault trip and include a ground fault trip indicator.

   b. 208V systems shall not have ground fault breakers in the secondary distribution system except as required by code.

3. Designs for PSU shall strive to provide the lowest possible arc flash incident energy. Consider the use of arc flash light/current sensing system or separate arc reduction circuitry switch for use during maintenance and inspection of the service entrance equipment. Alternative arc flash reduction methods will be considered. When utilized, the arc reduction switch system shall adjust the trip curve of the breaker relay. Systems utilizing “zone-interlock” exclusively are not acceptable. Arc reduction maintenance system shall have remote lockable switch(es) on the front of the gear to initiate this setting with separate blue LED light(s) for notification. When this circuitry is provided, monitor the activation via CCS (Central Control System), per the BAS Specification. Require dual Arc Flash stickers per NFPA 70E Study section. Manufacturer representative shall provide letter

stating that they have visited the site and confirmed that the stickers have been applied in appropriate locations, per the Study.

4. Refer to 26 27 13 Electricity Metering for requirements.

5. Refer to 26 35 33 Power Factor Correction Equipment for requirements.

6. Refer to 26 43 13 Surge Protective Devices for Low-Voltage Electrical Power Circuits for SPD requirements.

26 22 00 Low-Voltage Transformers

.01 General

A. As the Base Bid, provide high efficiency copper-wound transformer(s) meeting US Department of Energy proposed Candidate Standard Level (CSL) 3 efficiency, with extremely low no load losses, similar to PowerSmiths "E-Saver-C3", Cutler-Hammer "~~HMTE~~3", GE "QL Ultra Efficient", Mirus International Inc. Ulltra, E-Factor E, or others as approved by Engineering Services. Specify a deduct alternate for copper-wound, 115C rise, K-4 rated standard TP-1 transformers.

1. Once bids have been received, the consultant shall perform a life-cycle cost analysis based upon loading profiles as agreed to with Engineering Serices, according to the building occupancy type.

2. Low-loss transformers shall be designed to an efficiency standard higher than NEMA TP-1, the lowest legal efficiency, for the following purposes:

   a. Delivering lowest life cycle cost according to the US Dept. of Energy

   b. Contributing to LEED Energy & Atmosphere Credit 1 (Optimize Energy Performance)

B. Require submission of efficiency data (for all transformers) as follows:

1. No load and full load losses per NEMA ST20
2. Linear load Efficiency data @ 1/6 load
3. Linear load Efficiency data @ 1/4, 1/2, 3/4 & full load
4. Linear Load Efficiency @ 35% loading tested per NEMA TP-2
5. Efficiency under K7 load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.

C. Maximum no load losses of CSL 3 transformers shall not exceed:
1. 15kVA: 60W
2. 30kVA: 99W
3. 45kVA: 130W
4. 5kVA: 180W
5. 112.5kVA: 260W
6. 150kVA: 330W
7. 225kVA: 450W
8. 300kVA: 560W
9. 500kVA: 850W
10. 750kVA: 1200W

D. Efficiency for CSL 3 units at 1/6 load shall meet or exceed:
1. 15kVA: 96.6%
2. 30kVA: 97.4%
3. 45kVA: 97.7%
4. 75kVA: 98.2%
5. 112.5kVA: 98.4%
6. 150kVA: 98.5%
7. 225kVA: 98.5%
8. 300kVA: 98.6%
9. 500kVA: 98.7%
10. 750kVA: 98.7%

E. Efficiency for CSL 3 units under K-7 nonlinear load at 50% of nameplate rating:

1. 15kVA: 97.2%
2. 30kVA: 97.7%
3. 45kVA: 97.9%
4. 75kVA: 98.1%
5. 112.5kVA: 98.5%
6. 150kVA: 98.7%
7. 225kVA: 98.8%
8. 300kVA: 98.8%
9. 500kVA: 98.9%
10. 750kVA: 99.1%

~~F. Require on-site revenue class efficiency and harmonic measurements of transformer once installed and operating. Data shall be collected from the primary and secondary sides of the transformer simultaneously on a synchronized cycle by cycle basis. The use of two discrete meters is not acceptable Primary and secondary readings shall to be synchronized to ensure accuracy. A performance report shall be issued by a licensed testing agency or professional engineer. On large projects (more than five (5) units), sample five (5) plus 25% of the remainder of the transformers on the project, as selected by Engineering Services. Identify any non-conforming products and replace at no cost to PSU. Any non-conforming products shall necessitate testing of all units with additional testing costs borne by the transformer manufacturer.~~

26 23 00 Low-Voltage Switchgear

.01 General

A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.

B. Circuit breakers for lab facilities, or of capacity 1,600 amperes and greater (and as required by Engineering Services for maintenance purposes), shall be of the metal enclosed low voltage power circuit breaker type, draw-out, with "Engaged," "Test", and "Disengaged" positions, to meet UL1066 mounted in switchgear to meet ANSI C37/UL1558. Racking shall be accomplished with cell door closed and latched. Each breaker cell shall be completely separated from adjacent cells. Provide each cell with protective shutter for personnel protection when breaker is racked out. Provide pad-locking provisions for all cubicles, including spaces. Primary contacts shall be field replaceable. Breakers shall have visual trip indicators. Coordinate feeder breaker types with Engineering Services.

C. Provide vertical barrier between adjacent upright sections to prevent arc event from traveling through the rear of the lineup.

D. Provide the following for any electrical equipment with draw-out breakers:

1. Overhead-circuit-breaker lifting device, track mounted, at top front of the gear.

2. Storage cabinet, with padlock and hasp, for storing equipment and breakers. Unit shall be 60”H x 24”D x 36”W, capable of 900lb/shelf built by Durham, Lyon, Stronghold, or approved equal.

3. Floor mount rolling hydraulic foot-pump platform lift, Beech Engineering (Division of Miller Products Inc.) Model PS-2460, or approved equal by Genie, Vestil, or Wesco. 72” overall height, rated load of 1000 lbs., minimum lift height of 60", and platform measuring a minimum of 20"X20".

E. Main-tie-main setup, when approved by Engineering Services, shall be electrically operated. The control sequence shall allow for automatic and/or manual transfer between sources (typical set up is for open tie with automatic transfer to available source with manual re-transfer). If provided with Kirk key interlock, include an extra “maintenance” key. “Maintenance” key shall be provided in a pad-locked box in the main electrical room and shall be properly labeled. Consider adding synch-check relay to allow for closed transition

under engineering supervision. Contact Engineering Services for typical “sequence of operation” document.

F. Provide one (1) spare breaker in each frame size and at least 10% fully provisioned space capacity.

G. Provide mimic bus on large and/or complicated equipment. Normal power shall be in white, emergency shall be in red.

H. Provide hinged doors, front and rear. Rear doors shall have hasp for padlock. Label rear doors to match the front.

I. Padlocks, provide Best #11B772-L, with core #1C7F1-626, in quantity as follows:

1. One (1) for each rear hinged section
2. One (1) for each draw-out breaker cubicle and cubicle space
3. Two (2) spare

26 24 00 Switchboards and Panelboards

26 24 13 Switchboards

.01 General

A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.
B. Provide hinged doors, front and, as applicable, rear. Rear doors shall have hasp for padlock. Label rear doors to match the front.
C. Provide vertical barrier between adjacent upright sections to prevent arc event from traveling through the rear of the lineup.
D. Provide at least one (1) spare breaker in each frame size and at least 10% fully provisioned space capacity.

26 24 16 Panelboards

.01 General

A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.

B. Provide “door-in-door” hinged front cover.

C. Panels shall have complete bus and mounting hardware requiring only the installation of additional breakers for future expansion.

D. Allow 20% spare and another 10% fully provisioned space capacity for future breakers. Critical operations, shops and research facilities may require 50 percent spare capacity, consult with Engineering Services.

E. Distribution Panels

1. Consider second level of SPD, especially if panel feeds sensitive or critical loads or has branch circuits running outside of the building footprint (site lighting, etc.).

2. When ground fault is provided on the service entrance equipment, specify ground fault sensing and shunt-trip for breaker(s) feeding site lighting panel(s). Coordinate setting of ground fault to limit nuisance tripping, but also prevent any overtrip.

F. Branch-Circuit Panels

1. Group installed panelboards shall have separate trim.

2. All circuit breakers in utilization panelboards shall be of the bolt-on type.

3. Panelboards serving dedicated computer loads shall be reviewed for 200% neutral bus and feeder application with Engineering Services.

4. Specify that the electrical contractor shall coordinate final room name and numbering with Engineering Services prior to submitting panel schedules for approval. Circuits feeding exterior lighting shall utilize the 3-letter labeling scheme as directed by Engineering Services.

5. Panelboard Installation:

a. Panels serving loads in only one room may be located in that room.

b. Panels serving more than one room shall be located in an electrical closet, corridor, or other accessible space.

c. Do not install panelboards in janitor closets or dedicated telecom rooms.

d. Where flush panelboards are used, install a one-inch conduit for every three spare poles to a point above the suspended ceiling.

e. Specify green ground wire with all circuits.

G. Controlled Breaker Panels:

1. ~~Utilize~~ Coordinate with Engineering Services whether to use motorized control circuit breaker panel(s) in lieu of contactor/relay panel(s) for control of interior and/or night and/or ~~exterior~~ site lighting loads. Panels must have the ability for each type of load to be switched on or off manually.

2. Specify that the outdoor lighting circuits also be controlled via a Hand-Off-Auto switch(es) mounted to the side of the panel (for maintenance crews to check for dead lamps/ballasts). Depending on the project, this could include switches for "NIGHT (Building Mount)", "SIGHT (Walkway)", "SIGHT (Parking)" and/or "SIGHT (Roadway)" zones.

3. Provide any panel feeding exterior loads with SPD.

4. Acceptable manufacturers are Cutler-Hammer Pow-R-Command PRC2000B (BACnet), Siemens i-3 (BACnet) Lighting Panel with I/O controller, or Square D Powerlink G3 3000C Level. Panel shall communicate via the BACnet protocol and includes an astronomic timeclock. The panel will also require a data connection and programming by a manufacturer representative so that if communication is lost, the system operates in a stand-alone mode (site and building mount exterior luminaires "ON" 30 minutes before dusk and then "OFF" 30 minutes after dawn; other lighting schedule as arranged with PSU).

5. Specify that a compact laptop computer be provided for lighting controls revisions for most new buildings and major renovations (confirm requirement with Engineering Services). Computer shall have lighting control software pre-loaded. Verify hardware and system requirements with Engineering Services.

6. Refer to Lighting Control Devices in section 20 09 23 and to the BAS Specification for further luminaire control requirements.

H. Lab Panels – limit available short-circuit current to under 10,000 AIC. Discuss current-limiting solution with Engineering Services. Provide main breaker, door with lock, and tamperproof screws.

26 24 19 Motor-Control Centers

.01 General

A. Motor Control Centers

1. Structures shall be totally enclosed, dead front, free standing. Provide guide rails for control units, accessible wireways and terminal blocks for control wiring. Individual buckets must be of the draw-out design capable of safe removal (with door shut and latched) without de-energizing the common bus, to permit compliance with latest edition of NFPA 70E. Provide product similar to Eaton/Cutler-Hammer I.T. FlashGard.

2. Each starter shall have two normally open and two normally closed auxiliary contacts wired to the terminal blocks, hand, off, auto switch, green run light, red off light. All indicating lamps shall be LED.

3. Starters shall be wired so that upon loss of electrical power, they revert back to automatic operation when power is restored.

4. The motor control center shall be sized for a minimum 25 percent spare capacity, minimum 1 bucket space per upright. Size spaces to accommodate, at minimum, one (1) each of the largest starters provided. It shall be complete with buss bar, rails, wireways and other appurtenances so that other than new starters, no additional hardware is required for future expansion.

5. All internal control wiring to terminate at screwed terminal strips, properly identified for connecting field control wiring.

26 25 00 Enclosed Bus Assemblies

.01 General

A. Consider bus duct for shops and facilities with changing power requirements, as approved by Engineering Services.

26 26 00 Power Distribution Units

.01 General

A. Provide units with electrical metering, networked via BACNet or Modbus that can be accessed via a web browser.

26 27 00 Low-Voltage Distribution Equipment

26 27 13 Electricity Metering

.01 General

A. Provide provisions for digital meter within isolated compartment integral to the service entrance equipment. Compartment shall include CT's on a shorting block and voltage connection brought to a fuse block with disconnect (mount CT's and voltage connection ahead of the main). PSU Utilities will install service metering. Compartment shall accept a Square D circuit monitor style meter. Provide data connection from the meter location back to the nearest data closet.

1. Sub-meters - When approved, sub-meter location(s) shall have provisions to match those above and shall be co-located within an isolated compartment integral to the service entrance equipment. Provide communication interconnection back to the service entrance meter. Confirm type of meter provisions required with Engineering Services.

2. Distribution panels, ATS's (where required by ES), and other equipment that does not have space for an integral meter compartment shall incorporate a stand alone meter cabinet, Hoffman #A1412CHFL (14″x12″x6″) or similar. Provide provisions for PSU meter per paragraph A.

26 27 26 Wiring Devices

.01 General

A. Receptacles

1. Receptacles shall be rated 20A, specification grade. Install with ground pin up or left.

2. All requirements for special receptacles shall be discussed with Engineering Services.

3. Receptacles shall be provided at least every 50 feet, in all corridor areas, for operation of floor care equipment.

4. Class 1 Critical Research – provide dedicated twist-lock receptacle on "Standby" (NEC 702 optional standby systems) system power. Provide equipment with a twist-lock cord and cap assembly including an engraved brass tag (consult with Engineering Services for labeling). Engrave outlet cover to read "Class 1 Emergency Power" and the panel/circuit feeding the load. Any load with this designation must be reviewed and approved by Engineering Services.

5. Lab receptacles – utilize stainless steel cover plate and require engraved nameplate with panel and circuit number feeding outlet. Color code per below.

6. Flat screen TV - Use a 2-gang recessed combination receptacle and CATV outlet similar to the Arlington Industries indoor "in-box", Leviton "recessed entertainment box", or approved equal.

7. Refer to 26 05 53 Identification for Electrical Systems for further labeling requirements.

B. Switches

1. Local wall switches shall be heavy duty, specification grade, quiet operating rocker or toggle type, 20A, 120/277V.

2. Require labeling of switch cover plate for three (3) or more devices ganged together.

C. Color Coding:

1. Cover Plates - match normal power device color, unless otherwise approved. Stainless steel for labs and similar spaces.
2. Normal Power Device – white, almond, or ivory; as selected by the consultant.
3. Emergency Power Device: Red .
4. Standby Power Device – Blue
5. UPS/Clean Power Device – Gray. Require engraved nameplate in BLACK or BLUE background depending whether fed by Normal or Standby source.
6. SPD Receptacle: Standard device with Blue cover, label "SURGE PROTECTED".
7. Isolated-Ground Receptacle: Orange, label COVER "ISOLATED GROUND".
8. Other Type: as approved.

26 28 00 Low-Voltage Circuit Protective Devices

26 28 16 Enclosed Switches and Circuit Breakers

Provide equipment by the same manufacturer as the service entrance equipment.

26 29 00 Low-Voltage Controllers

26 29 23 Variable-Frequency Motor Controllers

Refer to PSU Variable-Frequency Drive specification.

26 30 00 Facility Electrical Power Generating and Storing Equipment

.01 Essential (Emergency and Standby) Power Systems

A. Emergency power source at the University Park Campus should typically be the campus “emergency” and, when required, the campus “standby” cable systems (4160Y/2400V). Coordinate availability with Engineering Services.

B. Where the emergency cable system is not available an engine driven generator shall be provided. Emergency system distribution voltage should be 480Y/277V or 208Y/120V for three phase installations (greater than 50 KVA) and 240/120V for single phase installations (less than 50 KVA). For further requirements, refer to 26 32 13 Engine Generators.

C. Wiring from each branch of the essential power systems shall be kept separate from each other and the normal power system.

.02 Life Safety Power

A. The Life Safety (NEC 700, code required emergency systems) power source at the University Park Campus shall be the campus “emergency” cable system (4160Y/2400V) wherever possible. Coordinate availability with Engineering Services.

B. When provided by the University “emergency” cable, installation shall include:

1. Primary fused disconnect switch with current limiting fuses and lighting arrester
2. Dry type, high-efficiency transformer
3. Secondary overcurrent protection
4. Transfer switch
5. Provide provisions for power meter (meter provided by PSU). Provisions shall match those as noted in Electricity Metering section.

C. Life Safety service Loads shall include, but not be limited to:

1. Egress lighting
2. Exit signage
3. Fire alarm system
4. Sprinkler equipment
5. Smoke detection system
6. Telephone equipment
7. Building Automation System infrastructure equipment

.03 Critical Power

A. Installation only to occur when approved by Engineering Services. The Critical Branch (NEC 701, legally required standby systems) power source at the University Park Campus shall utilize the campus “standby” cable system (4160Y/2400V), wherever possible. Coordinate availability with Engineering Services.

B. When provided from the “standby” cable, installation shall include same components as the Life Safety Power system.

C. Critical service Loads shall include, but not be limited to:

1. Elevator, but only when required by AHJ
2. Animal rooms
3. Other loads as required by AHJ

.04 Standby Power

A. The Standby Branch (NEC 702, non-required standby systems) power source at the University Park Campus shall utilize the campus “standby” cable system (4160Y/2400V) wherever possible. Coordinate availability with Engineering Services.

B. When provided from the “standby” cable, installation shall include same components as the Life Safety Power system.

C. Standby service loads shall include, but not be limited to:

1. Class 1 (irreplaceable) research loads shall be determined by each College. Utilize dedicated breaker and single twist-lock receptacle per “Devices” section. Coordinate these loads with the Engineering Services so that they can be numbered and tracked.

26 32 00 Packaged Generator Assemblies

26 32 13 Engine Generators

.01 General

A. When use of a generator is approved by Engineering Services, coordinate manufacturer, silencer type, fuel type, amount of fuel storage, and other options.

B. Maintenance: Not more than four hours' normal travel time from Installer's place of business to University.

C. Equipment shall not be installed on building roof or other locations that are difficult for service and replacement.

D. Consider paralleling equipment, for units 500kW and above, to allow for testing under load and demand side reduction.

E. Specify a 5 year full coverage warranty.

F. Coordinate monitoring requirements with the BAS Specification.

G. Digital Interface to BAS: for engine/generators of 500kW and larger, require that the controller interface with the BAS via BACnet (preferred) or Modbus (allowed) protocol and provide detail generator operational information to CCS.

H. Emissions - Internal combustion engines rated at greater than 100 brake horsepower for use at the University Park campus must comply with section 01 41 00 Regulatory Requirements as well as the following:

Design professional must review all applicable emissions regulations including, but not limited to, Sub parts to EPA 40CFR60 and EPA 40CFR63.

Professional shall specify that each engine manufacturer provide emissions data for the identified pollutants that are the lowest achieved by the proposed engine type in practice, and that can be guaranteed when installed at University Park. One manufacturer should be the base bid, and the “equals” as bid alternates so that the material costs can be compared versus each engine pollutants during the bid process. Non-responsive bidders may be eliminated from consideration. Note that the successful bidder will be judged only partially on the cost, the emissions data will also weigh heavily in the final equipment selection. The manufacturer shall submit the following:
1. Copy of applicable regulations with highlighting of

emissions limits for this specific unit or units
2. Chart comparing identified pollutant limits to those of the proposed engine.

If the engine is to be utilized as other than a standby source, these emission limits will have to be supported by data collection. Professional shall specify equipment to collect, record, and report such data. Discuss provisions and costs of installing CEMS (Continuous Emissions Monitor System) and CPMS (Continuous Parametric Monitoring System) equipment with Engineering Services.

26 35 00 Power Filters and Conditioners

26 35 33 Power Factor Correction Equipment

.01 General

A. Building power factor shall be, at minimum, 0.95 lagging. Provide central dynamic PF correction at each normal power service entrance as a deduct alternate (estimate the amount of capacitance required and dedicate floor space in the main electrical room).
B. For main-tie-main systems, provide separate dynamic PF correction at each end, each not less than 0.95 lagging when feeding each side of the gear separately. Specify a second set of CT's, one (1) on each side of the tie breaker, connected in parallel with the CT on it's side of the main. Each "tie" CT must be wired in reverse polarity to the main so that the system works properly with the tie closed.
C. Final capacitor selection shall occur within 6 months after building occupancy and shall be based upon actual field measurements at that time.
D. Coordinate sizing with Engineering Services.

26 36 00 Transfer Switches

.01 General

A. Transfer switch shall contain SPDT contacts for central control system, and a sufficient number of poles to switch phase wires plus a neutral wire where necessary. Transfer switch shall include capabilities for monitoring "normal source acceptable", "emergency source acceptable" and "switch status". Monitoring points shall be connected to the building automation system. Transfer switch shall include provisions to accept two remote inputs; "transfer/exercise" and "engine

exercise". Refer to BAS Specification for complete requirements.

B. Transfer switch shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. Data logging capability to show total number of transfers, number of transfers caused by power failures and total days controller has been energized.

C. Transfer switch shall be similar to ASCO 4000 series or ASCO 7000 series if bypass isolation is required. Typically, provide solid neutral connection and open transition without delay. Discuss the following options with Engineering Services:

1. Overlapping neutrals on systems with ground fault protection
2. Closed transition (for generator systems only)
3. Paralleling
4. Delayed transition
5. Bypass Isolation (for buildings requiring maintenance without interruption)

26 40 00 ELECTRICAL AND CATHODIC PROTECTION

26 41 00 Facility Lightning Protection

.01 General

A. For new buildings, major renovations, and additions, perform and lightning risk assessment per NFPA 780. Consult with Engineering Services to determine if a lightning protection system is required.

B. System components shall be copper.

C. System installation shall be concealed within the building structure.

D. Design per NFPA 780 and require a U.L. Master Label.

26 43 00 Surge Protective Devices

26 43 13 Surge Protective Devices for Low-Voltage Electrical Power Circuits

.01 General

A. Service Entrance – Provide SPD at each building service. Unit should typically be 240 kA per phase, 120 kA per

mode (including all phases and phase to ground), but confirm actual rating with Engineering Services. Unit to have disconnect and field replaceable MOV's.

B. Panelboard – Provide SPD at panels serving predominantly computer loads (server rooms), any exterior loads, and as directed. Unit should typically be 160 kA per phase, 80 kA per mode (including all phases and phase to ground), but confirm actual rating with Engineering Services.

C. Integral mounting within the electrical equipment is preferable, but surface mounting is acceptable, as approved by Engineering Services (keep the leads to the bus 60 inches or less).

D. Unit shall comply with most recent edition of UL 1449 and UL 1283.

26 50 00 LIGHTING

26 51 00 Interior Lighting

.01 Lighting Design

A. Minimize the use of different lamp styles and wattages. Maximize the use of the 48 inch T8 lamp as this source has the best combination of efficiency (about 100 lumens/watt), life (~~approaching~~ exceeding ~~40~~50,000 hours for major manufacturers), and low cost. The use of this lamp will save energy, reduce material sent to recycling/landfills, decrease maintenance costs, and save money on lamp replacements.

B. The professional shall submit two (2) copies of computer generated point-by-point calculations of most interior spaces to Engineering Services for review. The use of certain "typical" rooms shall be acceptable except when the amount of fenestration or the room orientation changes. Show calculations for each space without daylight contribution as well as with daylight contribution and lighting controls. Point levels shall be legible shown on a scale drawing. All pertinent calculation parameters shall be indicated and highlighted where non-IES compliant. Engineering Services will provide direction and variance where deemed adequate. Utilize AGI-32 full calculation mode or similar program, as approved by Engineering Services.

C. The Illuminating Engineers Society Lighting Handbook, current edition, shall be used as a standard for lighting levels. Provide a spreadsheet showing all room names and numbers along with target illumination levels. For television studios and classrooms used for TV production, consult Engineering Services for guidelines.

D. Discuss the use of LED technology with Engineering Services where applications exist. LED shall be used for downlights and decorative luminaires. CFL shall no longer be specified on projects.

E. Medium and high bays in shops, lobbies, etc. should take into account lamp life, lamp replacement, and controllability. Investigate the use of T8 fluorescent lamps (with high ballast factor ballast) versus T5HO in these applications, and discuss options with Engineering Services. Ballasts must be rated for high temperature environment.

F. Provide two (2) copies of a light fixture cutsheet booklet with any submittal showing lighting layouts. Booklet shall be in color and include the light fixture schedule as well as proposed lighting controls.

G. Specify the proper disposal of ~~high~~ mercury ~~content~~ containing lamps per PSU Policy SY-31 and PCB ballasts per PSU Policy SY-26 for all renovation work.

H. Include the luminaire fixture schedule within the drawings, not within the specifications. As-built drawings shall include final luminaire information.

.02 Lamps

A. ~~A.~~ Unless otherwise approved, linear fluorescent lamps shall either be the "extra-long life" T8, 32-watt, rapid-start, ~~3100~~2900+ initial catalog lumens, ~~30~~46,000+ hour rated average life with ~~instant~~ program start ballasts based on 3 hour operating cycle or the reduced wattage (28-watt) T8. Confirm selection with Engineering Services.

B. ~~—~~The use of other fluorescent lamps is discouraged. The use of linear ~~T5 and~~ T5HO (high-output) fluorescent lamps is allowed where design applications exist, but ~~only after~~when it is approved by Engineering Services. Compact fluorescent lamps ~~should be triple-tube style, 32W for downlights and 18W for wall sconces~~shall not be specified. Coordinate other lamp wattages and styles with Engineering Services.

~~B.~~ C. All fluorescent lamps will typically incorporate a ~~3500~~ 4100 degree Kelvin color temperature and a minimum CRI of ~~80~~-8682. ~~Qualifying T8, 48 inch linear lamps are as follows:~~

~~1. GE High Lumen: F32T8/XL/SPX35/HL/ECO~~
~~2. Philips Advantage: F32T8/ADV835/ALTO~~
~~3. Sylvania XPS: F032/835/XPS/ECO~~

B. Qualifying extra-long life 32 watt T8, 48 inch linear lamps are as follows:

1. GE Super Long Life:	F32T8/SXL/SPX41/ECO
2. Philips XLL:	F32T8/TL841/XLL/ALTO
3. Sylvania Octron XP/XL:	FO32/841/XP/XL/ECO3

Qualifying reduced wattage T8, 48 inch linear lamps are as follows:

4. GE Ecolux UltraMax:	F28T8/XL/SPX41/ECO
5. Philips XLL:	F32T8/ADV841/XLL/ALTO 28W
6. Sylvania Octron XP/XL:	F028/841/XP/XL/SS/ECO3

C. Do not use incandescent lamps, unless a specifically approved by Engineering Services. When allowed, provide the following:

1. "A" lamps shall be long-life, rated 125 volts, with inside frost.
2. ~~—~~MR-16 lamps, up to 50 watt, ~~shall be 10,000 hour~~shall be replaced with LED equivalent.
3. Any wallbox dimmers or dimming system shall be set to only allow lamp operation to 90% output. This is to

Formatted: Outline numbered + Level: 2 + Numbering Style: A, B, C, ... + Start at: 1 + Alignment: Left + Aligned at: 0.75" + Tab after: 1" + Indent at: 1"

Formatted: Indent: Left: 0.88", First line: 0", Outline numbered + Level: 2 + Numbering Style: A, B, C, ... + Start at: 1 + Alignment: Left + Aligned at: 0.75" + Tab after: 1" + Indent at: 1"

Formatted: Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 2 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: Outline numbered + Level: 2 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 1.25" + Tab after: 1.55" + Indent at: 1.55", Tab stops: 3.63", Left

Formatted: Font: (Default) Courier New

Formatted: Indent: Left: 1.55", Tab stops: 3.63", Left

Formatted: Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: Indent: Left: 1.25", Hanging: 0.38", Outline numbered + Level: 2 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 1.25" + Tab after: 1.55" + Indent at: 1.55"

conserve energy as well as to extend lamp life by double.

D. Require that the contractor obtain all similar lamp types through one source from a single manufacturer.

E. Lamp Orientation: All lamps shall be specifically rated for the burn position in which they are used. Universal burn lamps are only acceptable in luminaires that will require aiming that will result in a lamp orientation that is neither vertical nor horizontal.

F. Fluorescent dimming: All fluorescent lamps on dimming ballasts shall be burned in at full brightness ~~for 100 hours (or~~continuously for the length of time as required by the lamp manufacturer~~) continuously~~ prior to any dimming (typically 10 hours). Bypass local control as necessary to accomplish this task. Most applications only require a minmum dimming range of 5% to 10%.

G. CFL Lamp Disposal and Cleanup: Refer to PSU Environmental Health and Safety data sheet for disposal and/or cleanup of broken CFL lamps.

H. LED ~~downlights~~ shall be used instead of CFL for ~~most~~ all applications (downlights, decorative luminaires, etc.). Specify luminaire with a minimum ~~lumine~~ lumen output (typically 1000 or 2000 lumen), minimum CRI of 80, minimum L_{70} of 50,000 hours, and minimum efficiency of ~~50~~ 60 lumens per watt. Require testing to IES LM-79 and LM-80 standards and life calculations based on IES TM-21. CCT shall be 4100K, chips shall be binned to no more than a 2-step MacAdam Ellipse. Consult Engineering Services as to acceptable manufacturers.

~~H.~~I. LED screw-in lamps using medium base, GU24, GU10, bi-pin, etc. shall be approved by Engineering Services prior to specification. PSU prefers purpose-built LED luminaires over socket based solutions.

.03 Ballasts & Drivers

A. Fluorescent ballasts shall be NEMA "premium" efficiency, electronic, CBM and ETL approved with a sound rating of A. Ballast shall also be Class P, thermal cut-out switch, rated where required by U.L. Investigate use of high or low ballast factor as part of the illumination calculations. Linear ballasts shall be as follows:

1. PRS (programmed rapid start ballast) with parallel lamp operation – use with occupancy sensors or in frequent switching applications.

a. Advance "Optanium" (PRS)
b. GE "UltraStart"
c. Sylvania "PROStart"

Formatted: Indent: Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: Indent: Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: Indent: Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: Indent: Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: Indent: Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: Indent: Hanging: 0.38", Outline numbered + Level: 1 + Numbering Style: A, B, C, ... + Start at: 3 + Alignment: Left + Aligned at: 0.9" + Tab after: 1.25" + Indent at: 1.25"

d. Universal "~~AccuStart8~~ULTim8" (PRS, HE)

2. IS (instant start ballast) – use with manual switched lighting and unswitched emergency luminaires.

a. Advance "Optanium" (IS)
b. GE "UltraMax"
c. Sylvania "QHE"
d. Universal "ULTim8" (IS, HE)

B. Provide label sticker on each fluorescent luminaire ballast chamber (in 1/8" lettering) to read either "___V; Instant-Start; _.__ Ballast Factor" or "___V; Program-Start; _.__ Ballast Factor" (insert the voltage and ballast factor in each underlined space). As an example, label might read "120V; Program Start; 0.88 Ballast Factor." Label is to be visible when luminaire cover is opened or, for indirect luminaires, when viewed from a ladder looking into the fixture.

C. LED drivers shall have the following characteristics (unless approved by Engineering Services):

1. Maximum drive current: 350mA.
2. Minimum Efficiency: 85%.
3. Operating Temperature Range: -40°C to 50°C.
4. Minimum Rated Life: 50,000 hours.
5. Dimming range: 100% to 10%.
6. UL Class I or II output.
7. Power Factor: • 90%.
8. Total Harmonic Distortion: • 20%.
9. Comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards
~~B.~~10. Consult Engineering Services as to acceptable manufacturers.

~~C.~~D. Specify an in-line disconnect to meet ~~2008~~ NEC ~~410.130(G)~~. Further require that the lighting manufacturer provide a "wire nut" connection on the load side of the disconnect to facilitate ballast replacement. Refer to picture below:

.04 Luminaires

Formatted: Font: (Default) Courier New
Formatted: Indent: Left: 1.25", No bullets or numbering
Formatted
Formatted: Font: (Default) Courier New
Formatted: Font: (Default) Courier New
Formatted: Font: (Default) Courier New
Formatted: Font: (Default) Courier New
Formatted: Font: (Default) Courier New
Formatted: Font: (Default) Courier New
Formatted: Font: (Default) Courier New

A. All luminaires shall be UL or CSA/US approved and labeled.

~~A.~~B. Lens shall be 100% virgin acrylic injection molded prismatic diffusers meeting the ASTM specifications for methacrylite molding compounds D.788-69A. Minimum lens thickness shall be 0.125".

~~B.~~C. In mechanical rooms, storage rooms, and other unfinished areas consider lensed fluorescent strip lighting with wire guard protection.

D. Classrooms~~—~~

1. For ceilings up to 10 feet, use high quality lensed "volumetric" recessed luminaires. Most fixtures shall incorporate 0-10v 5% dimming ballasts.
2. In certain applications, utilize ~~Utilize~~ high quality pendant mount indirect/direct lighting (with fully separate indirect and direct components) for ~~classrooms~~large lecture halls, as long as luminaires don't interfere with sight-lines and ceiling-mount projection equipment.

~~C.~~3. Refer to the classroom committee recommendations for additional information.

E. Use high quality pendant mount indirect/direct lighting for offices, laboratories. Provide 2-level ~~of~~ switching ~~in accordance with IECC requirements~~and occupancy sensing. Incorporate daylight harvesting as appropriate.

~~D.~~F. HID luminaires shall not be used indoors.

~~E. Where HID luminaires are used indoors, they shall be of the low sound level with encapsulated ballasts, or electronic ballasts when available for specified wattages.~~

~~F.~~G. ~~Metal Halide Lamps and ballasts shall be pulse start, where available for specified wattages, and rated for "open" fixtures.~~

.05 Installation

A. When approved, recessed ~~compact fluorescent and~~ 2x2 ~~fluorescent~~ luminaires shall be installed such that ~~lamps~~ they are aligned in the same relative orientation from one fixture to the next. Confirm the use of ~~either of these~~ this luminaire type~~s~~ with Engineering Services prior to specification.

B. Cleaning: All luminaires shall be thoroughly cleaned and clear from dust, paint, construction debris and fingerprints after all other trades are complete, but prior to the date of substantial completion.

Formatted: Indent: Left: 1.25", No bullets or numbering

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

.06 Commissioning

A. Require that the lighting control elements be properly set and tested for optimal operation. Commissioning agent shall provide a report for the following systems (edit as required for the project):

1. Daylight harvesting
2. Occupancy sensors
3. Motorized breaker panels, to include basic programming and interface of BAS for CCS dusk/dawn signals. Also review the settings of the BAS CT's and run tests to confirm when CCS is signaled due to loss of multiple lamps/ballasts
4. Dimming Systems
5. Emergency relays (similar to Bodine GTD)

B. Engineering Service shall be invited to attend these sessions. Provide at least 7 days notice prior to any session.

.07 As-Built Documentation

A. Require that the Luminaire Schedule be amended on the as-built documents to reflect the actual products installed.

~~B.~~ B. Require that an Excel spreadsheet of the as-built Luminaire Schedule is provided to PSU that includes the information above, including warranty info of lamps, ballasts, LED modules, LED drivers and contact information regarding each luminaire and/or component.

Formatted: Outline numbered + Level: 2 + Numbering Style: A, B, C, ... + Start at: 1 + Alignment: Left + Aligned at: 0.75" + Tab after: 1" + Indent at: 1"

Formatted: Outline numbered + Level: 3 + Numbering Style: 1, 2, 3, ... + Start at: 1 + Alignment: Left + Aligned at: 1.38" + Tab after: 1.63" + Indent at: 1.63"

Formatted: Outline numbered + Level: 2 + Numbering Style: A, B, C, ... + Start at: 1 + Alignment: Left + Aligned at: 0.75" + Tab after: 1" + Indent at: 1"

Formatted: No bullets or numbering

26 52 00 Emergency Lighting

.01 General

A. Each building shall be equipped with an egress lighting system as required by the Pennsylvania Department of Labor and Industry or other applicable code(s).

B. Provide emergency lighting along the path of egress, including the exterior of a building and ending at a public way (or as approved by Engineering Services).

C. All egress lighting (which includes stairwell lights, exit lights, selected corridor lights), fire extinguisher identification lights, and elevator cab lights shall operate twenty-four (24) hours a day and shall be connected to the Life Safety panel. There may be some deviation from this depending on the type emergency lighting installed and the amount of daylight available in any given space.

D. Battery type emergency lighting is not allowed without prior approval from Engineering Services.

E. Stairwells, lobbies, hallways and entrances shall have ample lighting to allow for night cleaning. Wall mounted ADA compliant fixtures with integral occupancy

sensors and dimming ballasts are preferred for stairwells because they reduce energy usage and eliminate the need of high ladders and scaffolds for re-lamping. Utilize the Lamar Lighting "VO" series, Lumax "COD", or equal ADA compliant luminaire with occupancy sensing to save energy when stairs are empty.

F. Do not use compact fluorescent lamps with end-of-life protection (compact fluorescent and standard T5) in Normal/emergency lighting applications. Ballasts for these lamps have "end of life" circuitry that can turn off lamps in certain power fluctuation conditions and leave the building without egress lighting until fixtures are de-energized and re-energized. Specify these ballasts to have automatic re-strike capability. T5HO may be utilized for emergency illumination, with prior approval from Engineering Services.

26 53 00 Exit Signs

.01 General

A. Exit lights shall be ~~red~~ green LED and have stencil face with ~~red~~ green letters. Flush mount types are desirable because they are more vandal-proof. Consider vandal-resistant models for dormitory design.

B. Self-contained exit signs powered by a radioactive source (tritium or similar) are not acceptable.

~~B.~~C. Equipment shall be UL or CSA/US approved and labeled.

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

26 56 00 Exterior Lighting

.01 General

A. Roadway and Open Parking Area Lighting

1. Light Source: Light sources for roadway and open parking area lighting shall be ~~of the high intensity discharge, single arc tube, high pressure sodium or metal halide type~~4100K LED.

2. Luminaire: Luminaire shall utilize a cut-off optical assembly, ~~a 250 watt high pressure sodium lamp and~~ LED source, and an IES distribution as required to maintain recommended lighting and uniformity levels. Luminaires shall be rectangular in shape and conform to a "shoebox" design. Integral ~~ballast~~ driver shall be ~~auto-transformer, regulated type,~~ 0-10v dimming, multi-voltage or as directed by Engineering Services. Luminaires shall

be similar to Lumark ~~Tribute~~ Ridgeview LED series, finished dark bronze with a 10 inch arm for connection to square pole. Any exception to this luminaire must be approved by Engineering Services Architect prior to the final design submission.

3. Pole: Poles shall be 25 ft, 5″ square, non-tapered fiberglass with handhole at base, finished dark bronze. Professional shall coordinate final height of poles with local ordinance stipulations and other University requirements. Suggested manufacturer for pole is Shakespeare, Series AR. Use of poles lower than 25 ft is discouraged and must be approved by Engineering Services.

4. Concrete Base: Concrete bases shall utilize rebar reinforcement and embedded anchor bolts, and shall be designed to support the pole and luminaire assembly utilizing local wind load parameters and assembly effective projected area (EPA). Bases shall protrude above grade 6″ with a top beveled edge. Bases shall protrude 36″ above grade where damage from vehicles is possible. Above grade concrete shall be finished smooth.

5. Contact Engineering Services for typical CADD details.

6. Illumination Levels:

   a. Roadway and open parking area maintained illumination levels shall comply with the following tables (Ratios listed are maximum values). Areas not covered herein shall comply with the latest IES recommendations. Roadway illumination levels outside of core campus shall be reviewed with Engineering Services. Lower average levels may be acceptable.

ROADWAYS		
	Avg Maintained FC	Avg/Min Ratio (Max)
Roadway Illumination @ Grade	1.50	3 : 1

BUS PULL-OFF AREAS		
	Avg Maintained FC	Avg/Min Ratio (Max)
* Bus Pull-Off Area Illumination @ Grade	2.50	3 : 1

* Bus pull-off area shall include the area of roadway traversing the length of the bus pull-

off and all roadway pedestrian crosswalks within the area of the pull-off.

EXTERIOR OPEN PARKING FACILITIES				
	General Parking & Pedestrian Areas		Vehicle Use Only	
Activity Level	Min FC @ Grade	Avg/Min Ratio (Max)	Avg FC @ Grade	Avg/Min Ratio (Max)
* High	0.9	4 : 1	2.0	3 : 1
Medium	0.6	4 : 1	1.0	3 : 1

* Beaver Stadium and Jordan Center are considered areas of high activity levels.

7. Calculations – The professional shall submit two (2) copies of computer generated point-by-point calculations to Engineering Services for review. Point levels shall be legible and plan to scale. All pertinent calculation parameters shall be indicated and highlighted where non-compliant. Engineering Services will provide direction and variance where deemed adequate.

8. Sub-metering of Parking Lots – Provide provisions for Square D power meter (actual meter by PSU) for all parking lots. Provisions shall match those as noted in "Electricity Metering" section. Confirm requirements with Engineering Services.

B. Walkway Lighting:

1. Light Source: Light sources for walkway lighting shall be of the high intensity discharge, 100 watt ceramic metal halide type clear lamp, pulse-start. Source shall provide a minimum color rendition index (CRI) of 92 and a Kelvin temperature of 4000. Where sidewalks are adjacent to roadways, the roadway light source shall be deemed acceptable where the minimum lighting levels are satisfied. Otherwise, the professional shall review alternatives with Engineering Services. Consider the use of LED source, confirm with Engineering Services where its use is appropriate.

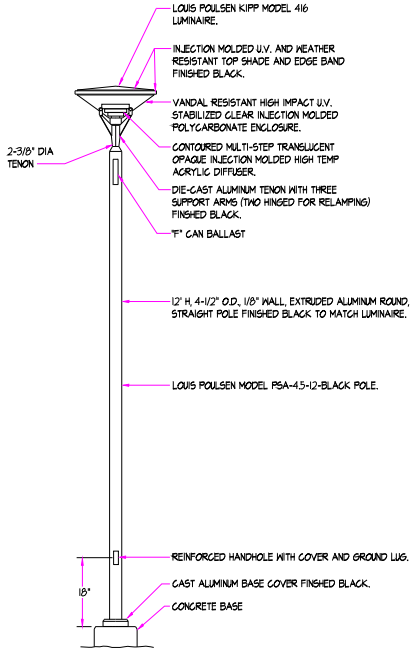
2. Luminaire: Luminaire shall be conical shaped, low profile, incorporating a pressure die-cast UV and weather resistant black top shade, vandal resistant high impact UV stabilized clear injection molded polycarbonate enclosure and a three-arm support. Lamp shall be concealed by use of a contoured, graduated reflector shade creating a symmetrical round type V distribution. Luminaire shall include 100 watt metal halide lamp and integral "F" can

ballast available in either 120V or 277V. Luminaire shall be Louis Poulsen KIPP, model 416. Any exception to this luminaire must be approved by the University Architect prior to the final design submission.

3. Pole: Pole shall be 4.5 inch diameter, round, straight aluminum pole with handhole at base, split cast aluminum base cover and shoe base. Pole shall be 12 ft in height and finished black. Pole shall be Louis Poulsen model RSA-4.5-12-Black.

4. Concrete Base: Concrete bases shall utilize rebar reinforcement and embedded anchor bolts and shall be designed to support the pole and luminaire assembly utilizing local wind load parameters and assembly effective projected area (EPA). Bases shall protrude above grade 6" with a top beveled edge. Above grade concrete shall be finished smooth.

5. Contact Engineering Services for typical CADD details.



STANDARD WALKWAY LUMINAIRE AND POLE DETAIL

6. Illumination Levels:

a. Walkway area maintained illumination levels shall comply with the following. Areas not covered herein shall comply with the latest IES recommendations. Walkway calculation areas (distant from roadways) shall include a 6 ft area bordering the walk on each side, illuminated to a level of one-third the levels suggested for walkways for additional pedestrian safety. Walkways leading to a building entrance shall be designed for the specified walkway illumination levels, and not the levels set forth by IES Building Entrance requirements.

Walkway Classification	Avg Maintained FC @ Grade	Min Vertical FC @ 6Ft Above Grade	Avg/Min Ratio (Max)
Roadside Walkways	1.0	1.5	4 : 1 or less
Walkways Distant from Roadways	0.5	0.5	4 : 1 or less

7. Calculations:

a. The professional shall submit two (2) copies of computer generated point-by-point calculations to Engineering Services for review. Point levels shall be legible and plan to scale. All pertinent calculation parameters shall be indicated and highlighted where non-compliant. Engineering Services will provide direction and variance where deemed adequate.

b. Coordinate the method of calculating the vertical footcandle requirement for Walkways with Engineering Services.

8. Façade Lighting – Do not light the building façade unless otherwise approved by Engineering Services.

.02 "Site" (Walkway, Roadway, and Parking) Lighting Circuitry

A. All underground circuitry shall be installed in 1-1/4" PVC schedule 40 conduit with burial depths in accordance with the latest edition of the NEC, or as directed by Engineering Services.

B. Utilize multiple phases of power for circuit (minimum of three (3)), luminaires shall be connected to alternate

phases (to neutral) throughout run to avoid the loss of a single phase shutting off all lights. When the electrical service includes ground-fault protection, utilize an interposing transformer to avoid an over-trip of a ground-fault to the upstream breaker(s), possibly including the service entrance.

C. A direct buried handhole shall be installed adjacent to the base of each concrete pole base. Handholes installed within grass areas shall be similar to Penncell model PE-9. Handholes installed in concrete shall be similar to Quazite model PG, minimum 12″ x 12″ square OR 9″ diameter round, with open bases. Provide heavy-duty covers where subject to vehicular activity.

D. Provide in-line waterproof fuseholders with appropriate fuse for each luminaire, installed in handhole serving the pole. Fuse holders shall be similar to Bussman HE Style.

E. Provide 5/8″ x 8′ copper clad ground rod for each pole, installed inside direct buried handhole. Rod shall be connected / bonded to equipment ground and pole grounding lug, where applicable.

F. All wiring connections made at or below grade shall be waterproof with UL listed waterproof connectors.

G. Run separate circuit(s) to each type of site lighting (roadway, parking, and walkway). Refer to "Lighting Control Devices" in Section 26 09 00.

H. Contact Engineering Services for typical CADD details.

~~H.~~I. Control Site and Night lights with a contactor or motorized breaker setup. Confirm which method with Engineering Services and request the appropriate detail to use. Contactor setup shall be fail-safe using an electrically-held, normally-closed setup that turns lights ON in case of any component failure.

~~I.~~

Formatted: List Paragraph, No bullets or numbering, Widow/Orphan control

Formatted: No bullets or numbering

END of revision

Update Commentary:

Section was updated primarily for the following reasons:

1) Update BAS interconnection with electrical systems.
2) Update testing requirements.
3) Update elevator connection requirements.
4) Insert several miscellaneous updates to section.

~~J.~~

Formatted: No bullets or numbering