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

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 – ~~Orange~~ 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”;

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

d. 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)

3. Label conductors landed at each breaker, 100A/3P and above, with the following:
   a. Circuit breaker 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.

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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~~-2002~~ (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.

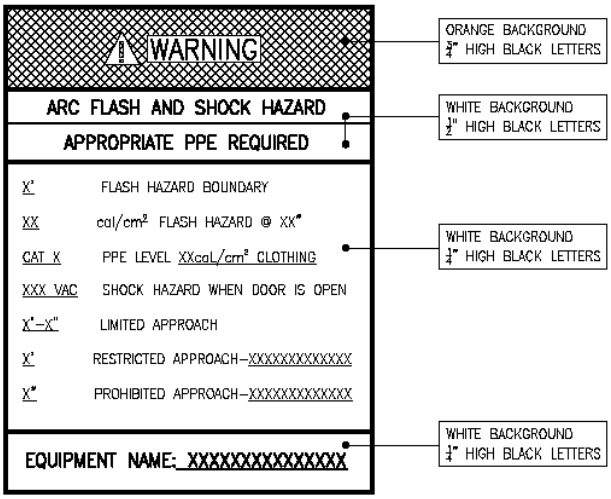
I. The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

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. Lighting Controls:

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. 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 sensors with output relays to allow the HVAC unit to shut down to minimum levels when no occupancy is sensed. Discuss control strategy with Engineering Services at schematic design phase.

a. 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.

~~1.~~b. Carry an allowance for extra sensors (as well as spare parts).

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~~3.~~2. When appropriate, 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). 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.

~~4.~~3. 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.

~~5.~~4. Exterior "Site" (walkway, roadway, and parking) lights shall be controlled from the CCS (Central Control System) via motorized circuit breakers, utilizing 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 a motorized breaker panel. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements and discuss options with Engineering Services.

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. 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.

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 “HMT”, 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 ~~CH-2470~~PS-2460, or approved equal by Genie, Vestil, or Wesco. 72” overall height, r~~R~~ated load of ~~400lbs~~1000 lbs., minimum lift height of ~~68~~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 motorized control circuit breaker panel(s) in lieu of contactor/relay panel(s) for control of interior and/or night and/or exterior 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 “Building Mount”, “Walkway”, “Parking” and/or “Roadway” zones.

3. Provide any panel feeding exterior loads with SPD.

4. Acceptable manufacturers are Cutler-Hammer Pow-R-Command ~~PRC100~~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. ~~Device~~ 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.
~~1.~~3. ~~Wiring Device Connected to~~ Emergency Power Device ~~System~~: Red ~~(with standard color cover plate)~~.
4. Standby Power Device – Blue
~~1.~~5. UPS/Clean Power Device – Gray. Require engraved nameplate in BLACK or BLUE background depending whether fed by Normal or Standby source.
~~2.~~6. ~~———~~SPD Receptacle: Standard device with Blue cover, label "SURGE PROTECTED".
~~3.~~7. ~~———~~Isolated-Ground Receptacle: Orange, label COVER "ISOLATED GROUND".
~~3.~~
~~4.~~8. ~~———~~Other Type: as approved.

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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. Emissions ~~- for i~~Internal combustion engines rated at greater than 100 brake horsepower ~~- T~~for use at the University Park campus ~~has a Title V Air Quality Permit, which sets limits on the total annual emissions, and requires documentation and testing of all fuel-burning equipment. The PA DEP is likely to use New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutant to establish emissions limits for the applicable pollutants, testing requirements, data collection and reporting, and other requirements.~~ must comply with section 01 41 00 Regulatory Requirements as well as the following:

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

Professional shall s~~S~~pecify 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. ~~and~~

~~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.~~ 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, ~~Because~~ 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.

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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.

~~A.~~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.

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~~B.~~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:

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

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

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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 40,000 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.

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 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. Linear fluorescent lamps shall be the T-8, 32-watt, rapid-start, 3100+ initial catalog lumens, 30,000+ hour rated average life with instant start ballasts based on 3 hour operating cycle. The use of other fluorescent lamps is discouraged. The use of linear T-5 high-output fluorescent lamps is allowed where design applications exist, after it is approved by Engineering Services. Compact fluorescent lamps should be triple-tube style, 32W for downlights and 18W for wall sconces. Coordinate other lamp wattages and styles with Engineering Services. All fluorescent lamps will typically incorporate a 3500 degree Kelvin temperature and a minimum CRI of 80-86. 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. 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.
3. Any wallbox dimmers or dimming system shall be set to only allow lamp operation to 90% output. This is to conserve energy as well as to extend lamp life by double.

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

D. 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.

E. Fluorescent dimming: All fluorescent lamps on dimming ballasts shall be burned in at full brightness for 100 hours (or as required by the lamp manufacturer) continuously prior to any dimming. Bypass local control as necessary to accomplish this task.

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

.03 Ballasts

A. Fluorescent ballasts shall be “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) – use with occupancy sensors or in frequent switching applications.

   a. Advance “Optanium”
   b. GE “UltraStart”
   c. Sylvania “PROStart”
   d. Universal “AccuStart8”

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

   a. Advance “Optanium”
   b. GE “UltraMax”
   c. Sylvania “QHE”
   d. Universal “ULTim8”

B. Provide label sticker on each 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.”

C. 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

A. 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. In mechanical rooms, storage rooms, and other unfinished areas consider lensed fluorescent strip lighting.

C. Classrooms – Utilize high quality pendant mount indirect/direct lighting (with fully separate indirect and direct components) for classrooms, as long as luminaires don't interfere with sight-lines and ceiling-mount projection equipment. Refer to the classroom committee recommendations for additional information.

D. Use high quality pendant mount indirect/direct lighting for offices, laboratories. Provide levels of switching in accordance with IECC requirements.

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

.05 Installation

A. Recessed compact fluorescent and 2x2 fluorescent luminaires shall be installed such that lamps are aligned in the same relative orientation from one fixture to the next.

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.

.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.

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 ~~should be avoided~~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 luminaire.

F. Do not use of lamps with end-of-life protection (compact fluorescent and 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.

26 53 00 Exit Signs

.01 General

A. Exit lights shall be red LED and have stencil face with red 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.

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.

2. Luminaire: Luminaire shall utilize a cut-off optical assembly, a 250 watt high pressure sodium lamp 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 shall be auto-transformer, regulated type, voltage as directed by Engineering Services. Luminaires shall be Lumark Tribute 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 (Min)	Avg/Min Ratio (Max)
Roadway Illumination @ Grade	1.50	3 : 1

BUS PULL-OFF AREAS		
	Avg Maintained FC (Min)	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 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.

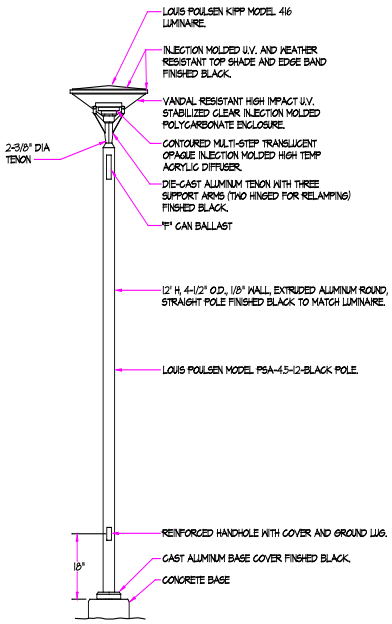
2. Luminaire: Luminaire shall be conical shaped, low profile, incorporating a pressure die-cast UV and weather resistant black top shade, vandal resistant high impact UV stabilized clear injection molded polycarbonate enclosure and a three-arm support. Lamp shall be concealed by use of a contoured, graduated 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)	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 ~~are utilized~~ for circuit (minimum of three (3)), luminaires shall be connected to alternate phases (to neutral) throughout run.

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 lighting (roadway, parking, and walkway). Refer to "Lighting Control Devices" in Section 26 09 00.

H. Contact Engineering Services for typical CADD details.

END of revision

Update Commentary:

Section was updated primarily for the following reasons:

1) Clarify labeling of equipment and conductors
2) Revise the IEEE Standard 1584 reference.
3) Revise requirements for lift equipment for draw-out breakers to allow for variations between suppliers and improve bidding
4) Update lighting control requirements.
5) Update air quality permitting requirements of generators.
6) Add transfer switch monitoring requirements to improve consistency of equipment specifications and improve bidding.
7) Add surge suppression at server room panelboards.
8) Update commissioning requirements for electrical systems.
9) Clarify emergency lighting requirements.