

## **DIVISION 26 – ELECTRICAL**

### **26 00 00 - ELECTRICAL**

A. Each drawing set should contain, at least, the following information:

1. Symbols list.
2. One line diagrams for all systems involved. (Show connected load at each switchboard, panelboard, motor control center, etc.)
3. Available fault current levels to be shown on power “one line diagram” at each power panel, disconnect and motor control.
4. Panelboard schedules with connected loads.
5. Fixture schedules.
6. Show home runs to panels, marked with circuit numbers, wire and conduit size.
7. Show number of wires in conduit via “hash marks”.
8. Show horsepower voltage, phase, and NEMA starter size for each motor.
9. If combination starters or starters with fusible disconnects on line side of starter, show size and class of current limiting rejection type fuses to be installed.
10. Show amperage, voltage and phase for special electrical loads.
11. Total connected KVA at each power panel and main distribution panel/switchboard.

B. Definitions

1. Branch Panelboard – Fed from main switchboard or distribution panelboard and feeds branch circuit loads such as lighting, receptacles and smaller motors.
2. Dedicated Circuit – A branch circuit which will serve only one load or group of loads.
3. Distribution Panelboard – Fed from main switchboard and feeds branch panelboards, motor control centers, or major discrete loads.
4. Interrupting Rating – Maximum fault current, in RMS symmetrical amperes at maximum listed voltage, that a device will interrupt (open) to clear a faulted circuit. Device must still be operational after interrupting fault.
5. Isolation Transformer (Non-shielded) – A transformer with primary and secondary windings insulated from each other.

6. Isolation Transformer (Shielded) – Same as non-shielded except has electrostatic shield between primary and secondary to attenuate noise.
7. Isolated Ground Circuit – An identified dedicated circuit NOT connected to building raceway system, but grounded by an insulated green/yellow ground wire connected to “neutral-ground bonding point”, in main switchboard. Ground wire may serve more than one outlet, circuit, or panel board, but connected only to loads requiring low noise ground (i.e., computers, work processors, instruments, etc.). Require circuits to be tested.
8. Main Switchboard – Switching, disconnecting, over current and metering equipment rated 600 volts or less, which feeds distribution panels and/or branch panelboards or motor control centers.
9. Motor Control Center – A structure which groups and houses several “modular” type motor controllers. It may also contain fusible disconnects.
10. Power Conditioning – May be applied to any circuit (usually to individual pieces of equipment) and must be selected and sized for exact load it serves. A voltage regulator or isolation transformer are types of power conditioning.
11. Surge Suppression – May be applied to any circuit and consists of varistors and /or similar type suppressors with a maximum clamping voltage of approximately 260VAC for 120VAC circuits. Devices are bi-directional. Suppression is applied between all conductors. These devices protect against transient voltage spikes and minor lightning strikes.
12. Uninterruptable Power Supply – Furnishes power to load even on complete loss of building power. Will supply power for a limited time, to allow an orderly shutdown of equipment without causing damage, or loss of data.
13. Withstand Rating – Maximum fault current, at maximum rated voltage, in RMS symmetrical amperes that a device can withstand (pass) during a fault and function after fault is cleared.

## **26 01 00 – OPERATION AND MAINTENANCE OF ELECTRICAL SYSTEMS**

- A. Normal Service to a building shall be a 12,470 volt radial feeder from the existing looped underground system. The electrical service shall be designed with a metal enclosed three phase switch and fuse assembly for each required transformer. The University utility owns 12.47 kV distribution, 12.47 kV switches, 12.47 kV transformers and electrical billing meters.
- B. Secondary metering shall be used and located on the main distribution panel.
- C. Transformer’s secondary voltage is preferred to be 277/480 volt. Required 120/208 volt systems should be achieved through dry type step-down transformers located adjacent to the 120/208 volt power panels.

## **26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL**

- A. In general, all materials shall be inspected and approved and listed by Underwriters Laboratories and bear UL label or UL recognized component label, where labeling services for that type material is available.
- B. In general, voltage drops shall follow N.E.C. guidelines.
- C. The use of direct burial wire is not allowed.
- D. Conduit embedded in any poured concrete floors must be approved by the structural engineer. PVC conduit under “Slab on Grade” construction must be in sand fill 6” below slab.
- E. Each building automation system equipment location requires a dedicated Emergency Power 120 VAC – 20 amp circuit.
- F. Do not use “shared” or “common” neutrals on any 208/120V or 480/277V receptacle or lighting circuit. Install a neutral conductor for each phase wire.
- G. **WAGO wire connectors are not allowed.**

### H. Empty Conduit Systems

- 1) Provide polypropylene pull rope in each conduit.
- 2) Provide plastic plugs or covers, for all openings, to keep system clean.
- 3) Provide a minimum of three ¾” conduits routed to an accessible ceiling space for each flush mounted panel.

## **26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

- A. All wire shall be copper and stranded (#12 and above). All devices shall be pig-tailed with solid wire or plug type similar to Hubbell SNAPConnect, Leviton Lev-Lok. (exception: see Fire Alarm Section 28 31 00 G2).
- B. 75°C. Minimum insulation rating.
- C. Type “THHN” in buildings. Use type XHHW under slabs or at exterior locations in conduit.
- D. All grounding conductors (isolated or equipment) to have green insulation in sizes #14 through #6, conductors larger than #6 may be “black” with green or green/yellow tape markers.
- E. Steel strain relief cord connections are to be used to connect to “SO” cords. Flat “NM” type connectors are not allowed.

- F. Owner's standard wiring color code; posted on main service panel.
  - 1) All voltages and systems.
    - Equipment ground = green.
    - Isolated ground = green with yellow stripe or green with yellow tape bands.
  - 2) 208Y/120v, 3 Ph., 4 w. systems
    - Phase A = Black
    - Phase B = Red
    - Phase C = Blue
    - Neutral = White
  - 3) 480Y/277v, 3 Ph., 4w. systems
    - Phase A = Brown
    - Phase B = Orange
    - Phase C = Yellow
    - Neutral = Gray

### **26 05 19.23 – MANUFACTURED WIRING ASSEMBLIES**

- A. Owner's standard is "Wiremold" brand. Includes FPP and MOA's. Furniture power pole to be used only if approved by UNI Engineering.
- B. Provide 120-volt convenience receptacles at each landing level in stairwells, and in corridors, spaced not over 50 feet apart.
- C. Only grounding type receptacles acceptable. Minimum general purpose receptacles, gray 20 amp, with stainless steel covers. Controlled receptacles will have, permanently marked on the face, a power symbol as well as the word "controlled". Basis of design is Hubbel BR20C1GRY.
- D. The use of "Common" or "Shared" neutrals on 120VAC convenience receptacle circuits is strictly prohibited.
- E. Switches
  - 1) Rated 20 Amp. At 277v. (minimum), with stainless steel covers.
- F. Mounting heights
  - 1) Switches = +42 inch AFF to device centerline.
  - 2) Wall receptacles = +18 inch AFF to device centerline.
- G. Wall switch control may be required for classroom projector power circuits, depending on application. Confirm with Owner where applicable.
- H. Device boxes are to be rigidly supported. The support bracket (or the device box itself) shall span between and connect to both studs located on opposite sides of the device box.
- I. Provide GFCI receptacles at regular spacing throughout the mechanical room where additional task lighting or service equipment such as shop vacuums, welders may be

required. Maximum spacing shall be 30 ft.

- J. Provide one welding outlet per mechanical room.
- K. Provide one receptacle and minimum of one light fixture on e-power by the main switchgear.

### **26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

- A. These guidelines for power handling circuits only.
  - 1) Install equipment grounding conductor with all surface raceway systems. Bond as follows:
    - a) One or two piece raceway – bond at every box.
    - b) Receptacles – bond each to box.
  - 2) Install equipment grounding conductor in ALL conduit runs.

### **26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL**

- A. Where electrical equipment is mounted on exterior walls below grade or other damp locations, mount on standoffs.
- B. The use of box extension rings is only allowed with written permission.
- C. In general, the largest practical size device and junction boxes should be used to provide space for the future. This is especially important for concealed boxes.
- D. ½” minimum conduit for single electrical device, ¾” minimum size for electrical (normal). 1 inch or 1-1/4” minimum size for telecommunications (see division 27). For control wiring in conduit, red conduit for fire, blue for data.
- E. No indent fittings.
- F. Provide “locator wire” buried with all non-metallic conduit or duct.
- G. Fittings:
  - 1) Steel compression or steel set-screw for EMT.
- H. PVC conduit as a general raceway inside buildings is unacceptable.
- I. Recommend all underground conduits be PVC Schedule 40 or heavier. Convert to rigid steel before penetrating walls or floor. Rigid steel or PVC schedule 80 under roadways.

- J. In general, flexible conduit shall only be used for motor or equipment connections. Internal fittings not allowed.
- K. Flexible conduit required for light fixtures in suspended or open ceilings (Max length of 6ft).
- L. Provide pull/junction boxes at 270° maximum equivalent bends, and/or 100 feet maximum run.

### **26 05 33.23 – SURFACE RACEWAY FOR ELECTRICAL SYSTEMS**

- A. Owner's standard is "Wiremold" brand.
- B. Surface raceways are to be used only where concealed wiring is impractical. When used, field route for most inconspicuous location practical.
- C. Minimum size raceway = 700 series.
- D. Constructor should provide a typical example of work for Owner's inspection. Remainder of work to be of equal quality.

### **26 05 43 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

#### **A. Handholes and Boxes**

##### **1. Description: Comply with SCTE 77.**

- a) Tier 22 rated.
- b) Color: Gray.
- c) Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
- d) Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- e) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- f) Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- g) Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- h) Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
  - a) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Highline Products.
    - 2) Quazite, Hubbell Power Systems.
    - 3) UNI Engineering approved equal.
  - b) Cover Legend: Cast in, selected to suit system
    - 1) Legend: "ELECTRIC" for duct systems with power wires and cables for systems operating at 600 V and less.
    - 2) Legend: "ELECTRIC" for duct system with medium-voltage cables.
    - 3) Legend: "COMM" for communications, data, and telephone duct systems.

## 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

A. In general, the following items shall be equipped with nameplates:

1. All motor starters, motor controls, motor control centers, push-button stations, control panels and time switches.
2. Disconnect switchboards, circuit breakers, contactors or relays in separate enclosures. Power receptacles where the nominal voltage between any contact is greater than 150V to ground. Use at least 1 1/8" x 2 1/4" signs.
3. Nameplate inscription: Nameplate shall adequately describe the function or use of the particular equipment involved. Nameplate for panelboards and switchboards shall include the panel designation voltage and phase of the supply, and where the circuit feeding panel originates, i.e.,

Panel A 480/277 V. FED from "MDP"
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4. When equipment has more than one source of power, i.e.: separate control power source. The location of all power sources shall be CLEARLY identified at the equipment location. i.e.: Nameplate on door, etc.
5. Mark all wires in panelboards with the circuit number they serve.

6. All devices will have circuit information on back side of device plate
7. All junction boxes will be marked with the circuits they contain.
8. Any wire spliced in a junction box must have the circuit marked on it.

#### B. Materials – General

1. Nameplate construction shall be laminated phenolic plastic, black front and back with white core, with lettering engraved through the outer covering. Lettering shall be 3/16 inches high at push-button station starter, receptacles and similar devices where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high unless otherwise detailed on the drawings.
2. Other types and sizes of signage may be used (if appropriate and approved by Owner's Representative).

#### C. Conduit Colors

1. Red Conduit – Fire
2. Blue Conduit – Data/Control Wiring
3. Galvanized – All others
4. No other colors allowed.

### **26 05 73 SHORT-CIRCUIT/COORDINATION/ARC FLASH STUDY**

A. The University will hire separate consultant to perform arc flash analysis for new electrical panels and switchboards. Constructor to install label.

### **26 09 00 – INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS**

A. The electrical constructor is responsible for installing all conduit and wiring the BAS control system. The electrical constructor will provide all wire, cable, conduit, junction boxes, hangers, etc. as required for a complete installation. The electrical constructor will install all BAS control wiring in a neat, workmanlike manner per the specifications, NEC, and as directed by the BAS constructor. Wire and cable must meet the specifications provided by the BAS constructor. The electrical constructor is responsible for installing all field hardware provided by the BAS constructor including control panels, controllers, sensors, relays, current switches, damper actuators, etc. according to the BAS control drawings and installation instructions. The electrical constructor is responsible to terminate wiring at both ends and label all wiring as directed by the BAS constructor and as shown on the BAS control drawings. The electrical constructor is responsible for storing material delivered to the job site by the BAS constructor.



- B. The electrical constructor will provide a single point of contact for coordination directly with the BAS constructor. The BAS constructor will lead a kick off meeting with the electrical constructor and provide 4 hours initial instruction. The BAS constructor is responsible for coordinating directly with the electrical constructor and will be available to answer questions throughout the project. All control wiring must be completed in a timely manner according to the project schedule. The electrical constructor must be available to assist in troubleshooting any wiring problems found during the system start-up phase

**26 09 19 – ENCLOSED CONTACTORS**

- A. Prefer mechanically held type, with clearing contacts.

**26 10 00 – MEDIUM-VOLTAGE ELECTRICAL DISTRIBUTION**

- A. Campus standard for electrical distribution cable is “Okoguard – Okoseal” Type MV-105 with 133% insulation.

**26 12 00 – MEDIUM-VOLTAGE TRANSFORMER**

**26 12 16 – DRY-TYPE MEDIUM-VOLTAGE TRANSFORMERS**

- A. Temperature rise shall be 115°C.

**26 12 19 – PAD MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS**

A. DESCRIPTION

1. This section shall include the furnishing, installation, and connection of pad mounted transformers.
2. The pad mounted transformer shall be complete, continuous duty, integral assembly, grounded, tamper-resistant, weatherproof, outdoor type with liquid-immersed transformers.

B. CERTIFICATIONS

1. Two weeks prior to final inspection, require three copies of the following certifications to be delivered to the Owner:
  - a) Certification by the Constructor that the pad mounted transformer has been properly installed adjusted and tested.
  - b) Certification by the manufacturer that the equipment conforms to the requirements of the drawings and specifications.

## C. INSTRUCTIONS

1. Require the Constructor to instruct Owner's maintenance personnel, for not less than a 2-hour period, in the operation and maintenance of the equipment on the date requested by the Owner.

## D. EQUIPMENT, GENERAL

1. Equipment shall be in accordance with ANSI, IEEE, NEMA, and NEC.
2. Provide units designed to withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses, which occur during operation.
3. Require factory fabricated units so that only the external cable connections are required at the job site.
4. Specify manufacturer to thoroughly clean, phosphatase and finish all the metal surfaces at the factory with a rust-resistant primer and dark green enamel finish coat, except where a different color is specified. All surfaces of the unit to be in contact with the concrete pad shall be treated with corrosion-resistant compounds and epoxy resin, or a rubberized sealing compound.

## E. COMPARTMENTS

1. Construction:
  - a) The medium and low voltage compartments and the transformer compartment shall be fabricated by a single manufacturer. The compartments and the transformer tank shall be assembled as an integral unit by a single manufacturer.
  - b) Separate the medium and low voltage compartments with a steel barrier.
  - c) Construct the compartments of sheet steel of sufficient gage to meet ANSI requirements, with bracing, reinforcing gussets and jig-welding to assure rectangular rigidity.
  - d) Use cadmium or zinc plated bolts, nuts, and washers, unless exposed to weather, then use stainless steel.
  - e) Permanently affix the transformer instruction nameplate to the unit within the low voltage compartment. Voltage ratings, kVA, connection configuration, impedance, and serial number shall be shown on the nameplate.
2. Doors:
  - a) Provide a separate door for each compartment with provision for a single padlock

to secure the compartment area. The high voltage compartment door shall be prevented mechanically from opening, unless the low voltage door is opened.

- b) The secondary compartment door shall have one-piece steel handle and incorporate three-point locking mechanisms to assure a secure and tight door closing. Provide each compartment door with open-position doorstops and tamper proof hinges. The hinge assembly shall be made of corrosion-resistant material welded in place.
- c) Provide a 2-inch size Best (only) padlock for each assembly as approved by the Owner. Padlocks shall be keyed to the Owner's established Best Key System key set. Firmly attach the padlock to the door assembly by a chain.

#### F. PRIMARY COMPARTMENT

- 1. The primary compartment shall be live front. Cable entrance shall be from below the transformer. The primary line equipment shall be arranged for a radial feed.
- 2. Terminate the medium voltage cables in the medium voltage department. Load-break elbow connections are not acceptable. Spade lugs with NEMA pattern.
- 3. Ground metallic cable shields.
- 4. Allow 3 feet minimum slack in medium voltage cable and ground wire.

#### G. SECONDARY COMPARTMENT

- 1. The secondary compartment shall enclose low voltage bushings and lugs. Cable entrance shall be from below transformer. Terminate secondary conductors with two hole crimp lugs with standard NEMA pattern.
- 2. Provide an insulated neutral bushing with an externally removable ground strap.
- 3. Provide ground connections for neutrals and transformer cases.
- 4. The transformer secondary compartment shall be designed to accommodate current transformers for metering as required.

#### H. BIL RATING

- 1. 15 kV class equipment shall have a minimum 95 kV BIL rating.

#### I. TRANSFORMER

- 1. Transformer shall be three-phase, liquid-immersed, isolated winding, and self cooled by natural convection.
- 2. The kVA ratings shown on the drawings are for continuous duty without the use of

cooling fans.

3. Temperature rises shall not exceed the NEMA Standards of 65 degrees C by resistance, and 80 degrees C hot spot at rated kVA.
4. Transformer insulating liquid shall be less flammable (Envirotemp FR3 by Cargill) per UL and NEC 450-23.
5. Impedance is to be as shown on the drawings, but not less than 4.5 percent for sizes 150 kVA and larger.
6. Sound levels shall conform to NEMA Standards.
7. Primary and Secondary Windings for Three-phase Transformers:
  - a) Primary windings shall be delta connected, 12,470 volts.
  - b) Secondary windings shall be wye connected, except where otherwise indicated on the drawings. Provide isolated neutral bushings for secondary wye connected transformers.
  - c) Bring secondary leads out through pressure-tight epoxy bushing.
8. Provide four 2-1/2 percent full capacity voltage taps in the primary winding; two taps above and two below rated voltage.
9. Core and Coil Assemblies:
  - a) Cores shall be rigidly braced, grain-oriented, non-aging silicon steel to minimize losses.
  - b) Brace the core and coil assembly to withstand the stresses caused by rough handling during shipment, and stresses caused by short circuit currents.
  - c) Primary, secondary and tap connections shall be braced or pressure type.
  - d) Provide end fillers or tie downs for soil windings.
10. The transformer tank, cover, and radiator gage thickness shall not be less than that outlined in ANSI.
11. Accessories:
  - a) Provide standard NEMA features, accessories, and the following:
    - 1) No-load tap changer (Provide warning sign), externally operated.
    - 2) Lifting and jacking facilities.
    - 3) Globe-type valve for filtering and oil draining, including sampling device.

- 4) Pressure relief valve.
  - 5) Liquid level gage and filling plug.
  - 6) A grounding pad in the medium and low voltage compartments.
  - 7) A diagrammatic nameplate and operating instructions enclosed by a transparent cover located in the low voltage compartment.
  - 8) Dial type thermometer.
- b) The accessories shall be made accessible within the compartments without disassembling trims and covers.
- c) E 1 All gauges, ports and instrumentation devices shall be located outside of the cable compartments such that access to them does not require exposure to any live circuits. They shall be located inside a separate tamper resistant NEMA 4 rated enclosure on the low voltage side of the tank. Devices shall include

Stainless steel or aluminum engraved Nameplate information

Liquid level gauge

Dial type Thermometer

Pressure/vacuum gauge

One-inch upper filling plug

Nitrogen blanket fill port

One-inch drain valve

#### J. LIGHTNING ARRESTERS

1. Provide each ungrounded medium voltage conductor with an arrester.
2. Lightning arresters shall be 9kV MOV type, distribution class, with wet process porcelain insulators. Supports that hold the porcelain in compression shall be rustproof steel.

#### K. VOLTAGE WARNING SIGN

1. Mount on the transformer enclosure approximately 42"- 60" above grade, a clearly lettered sign for warning personnel. The sign shall be of durable enameled steel or durable plastic attached with rustproof metal fasteners.
  - a) Exception: Adhesive may be used where fasteners should not penetrate substrate.

#### L. INSTALLATION

1. Install the equipment in accordance with the NEC, as shown on the drawings, and as recommended by the equipment manufacturer.
2. Foundations:
  - a) Provide foundations of reinforced concrete. Locate the top of foundation pads six inches above the adjacent finished grade, unless otherwise shown on the drawings.
  - b) Grade the adjacent terrain so that surface water will flow away from the foundation.
  - c) Anchor the unit with bolts not less than ½-inch diameter.
3. Grounding:
  - a) Ground each pad mounted transformer in accordance with the requirements of the NEC. Three-quarter inch diameter by 10 feet long copper-clad ground rods, driven 10 feet below grade, shall be used to maintain a maximum resistance of five ohms to ground. Thermitite weld the cable to the ground rods.
  - b) Connect the ground rod to the ground pads in the medium and low voltage compartments, and to the secondary and primary neutral with not less than a 2/0 AWG bare copper conductor.
  - c) Independently connect cable shield grounding to ground with three feet minimum slack.
4. Adjust transformer taps to provide 480/277 volts//208/120 volts under building no-load conditions.
5. A 3 Oil to be filtered, dried, and stored under vacuum before being added to the completed transformer to result in a maximum saturation of 15% or less of water to oil. Insulation on coils of new transformer to have 0.5% or less moisture per Dry Weight of insulation.

## **26 13 00 – MEDIUM-VOLTAGE SWITCHGEAR**

### **A. GENERAL REQUIREMENTS**

1. Design the switchgear to withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses which will occur during operation of equipment.
2. Assemble, connect and wire the components for the pad-mounted gear at the factory so that only the external circuit connections are required at the construction site. System shall be fully tested at the factory prior to shipment.
3. The manufacturer of the pad-mounted gear shall be the same as the manufacturer of the load break switches. The enclosure, fuses, switches and operators shall be

coordinated to assure a fully integrated system assembly.

4. 10'-0" minimum clearance required on each side of switchgear containing access doors.

**B. MANUFACTURERS:**

1. Manufacturers: Subject to compliance with requirements, provide products of one of the following (Information based on S & C Electric Co., Model PMU-19):
  - a) S & C Electric
  - b) Federal Pacific

**C. RATINGS:**

1. The ratings from the integrated pad-mounted gear shall be as designated below:

KV, Nominal	14.4
KV, Maximum Design	17.0
KV, BIL	95
Main Bus Continuous, Amperes	600

**D. HOUSING**

1. The equipment and structure shall have the following features:
  - a) Frames and enclosures:
    - 1) Brace the assembly with reinforcing gussets and jig weld as required to assure rectangular rigidity.
    - 2) The enclosure shall be free-standing, self-supporting, steel construction of not less than the gauge required by the NEMA and ANSI Standards, with an integral structural-channel base around the four sides and with provisions for cable entrance and exit through the bottom.
    - 3) All bolts, nuts and washers shall be zinc chromated. There shall be no screws, bolts or other fastening devices that are externally removable.
    - 4) Lifting lugs shall be included.
  - b) Doors:
    - 1) Shall be equipped with snap locks, self-latching holders, three concealed cam-type high strength latches, stainless steel hinge pins, and recessed padlockable door handle.
    - 2) Doors of compartments containing power fuses shall be equipped with storage

racks for spare refill units.

- 3) Provide mechanical interlock to prevent opening the door unless the switchblades are open.
- c) Louvers:
- 1) Screened, corrosion-resistant and rain-resistant louvers shall be provided at the top and bottom of each door and the top and bottom of each compartment outside wall.
- d) Gasketing:
- 1) Gasketing shall be provided at the top and both sides of each door opening and between the roof and the enclosure outside walls to guard against water entry.
- e) Barriers:
- 1) Provide interphase and end barriers of fiberglass reinforced polyester with each switch and each set of fuses where required to achieve published BIL ratings. Phase barriers shall be dual-purpose type for the full length of the switchblade and fuse for each pole.
  - 2) Provide additional barriers of the same material to separate the front compartments from the rear compartments and isolate the tie bus.
  - 3) Provide full length steel barriers to separate adjoining compartments.
  - 4) Provide protective shield to cover the cable connections on the load side terminals.
- f) Finish
1. Finish shall be olive green "Super Durabake II" or equal.

## E. BUS

1. Bus Bars and Interconnections:
  - a) Copper bus fully rated at 600 amperes continuous.
  - b) All bus bar joints shall be made by employing belleville type conical washers under the nuts and over the plated flat steel washers that are against the bus to assure constant pressure.
  - c) Mount the buses on appropriately spaced insulators and brace to withstand the short circuit currents indicated.



- d) Design the bus and bus compartment so that the acceptable NEMA Standards temperature rises are not exceeded.
- e) Install a copper ground bus the full length of the switchgear assembly securely connected to the steel frame of each bay.
- f) Provide each switch section and each fuse section with individual ground studs.

**26 13 13 - MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR**

1. Shall have the following features:

- a) Air break, group-operated, 600 ampere rated, 3 pole, two position, 95 kV BIL, 14.4 kV nominal, 17 kV maximum, S & C “Mini-Rupter”, copper blades.
- b) External handle operated, folding type, secured inside the switch-operating-hub-pocket.
- c) Duty cycle fault closing ratings;
  - 1) Two-time:
    - a] Asymmetrical.....40,000 amperes RMS
    - b] Symmetrical ..... 25,000 amperes RMS
    - c] Peak ..... 62,500 amperes RMS
  - 2) Momentary..... 40,000 amperes RMS
  - 3) One-second..... 25,000 amperes RMS
- d) Quick-make, quick-break, stored energy type operation mechanism.
- e) The fuses shall be de-energized when the associated switch is open.
- f) Boric acid type power fuses with provisions for refill units, S & C type SMU-20. (Consultant to confirm interrupting capacity.) Provide three spare refills in door storage shelf.
  - 1) Provide certified test of switch and fuse as integral assembly. Verify fusing.

**A. OTHER EQUIPMENT**

1. Cable Terminations:

- a) Provide NEMA pads suitable for cable termination. Cable size is 500 MCM, EPR, 220 mil, 15 kV power cable.
- b) Conduit/cable entrance into switchgear shall be from the bottom.

2. Medium Voltage Lightning Arresters:

- a) Lightning arresters shall be 9 kV MOV type, distribution class, with wet process porcelain insulators. Supports that hold the porcelain in compression shall be rustproof steel.
- b) Provide each ungrounded conductor with an arrester.

## B. INSTRUCTIONS

1. A complete set of operating instructions of the switchgear shall be provided on inside door of cubical. Include circuit diagrams and switch/fuse ratings.

## C. VOLTAGE WARNING SIGN

1. A voltage warning sign is to be mounted on switchgear.

## D. FOUNDATION

1. Locate the top of the foundation six inches above the adjacent grade, unless otherwise indicated on the drawings.
2. Grade the adjacent terrain away from the switchgear to allow water to run away from the structure.
3. Use anchor bolts, not less than ½-inch in diameter, to fasten the structure to the foundation.

## E. INSTRUCTION AND FINAL INSPECTION

1. A complete set of operating instructions of the switchgear shall be laminated or mounted under Plexiglass and installed in a frame on the door of switchgear assembly.

## **26 16 00 – MEDIUM-VOLTAGE METERING**

## **26 18 00 – MEDIUM-VOLTAGE CIRCUIT PROTECTION DEVICES**

## **26 18 16 – MEDIUM-VOLTAGE FUSES**

- A. Provide spare fuses (1 set each size) in fuse cabinet.

## **26 18 39 – MEDIUM-VOLTAGE MOTOR CONTROLLERS**

## **26 21 00 – LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE**

- A. Normally underground services.
- B. Normal distribution is 12,470v.-3Ph.-4w.-60Hz. Owner has the option to provide and install all high voltage cables in building and those between transformers and high voltage switchgear. Review with Owner. Raceway and manholes for cables are to be included in

Constructor's work.

- C. Available fault level on the primary side – contact Owner's Representative.
- D. Low voltage distribution within buildings.
  - 1) 480/277v. for motors and lighting loads.
  - 2) 208/120v. for receptacle loads.
  - 3) Use of step up transformers, i.e. 208 to 480 volts is discouraged.
  - 4) Use of 240v. equipment is discouraged.
- E. Install high voltage switchgear for primary feeder protection. High voltage shall be single service with fusing for each set of transformers.
- F. For building remodel projects in existing building, Design Professional to verify additional loads will not exceed existing transformers and/or main switchboard capacities. If existing capacities are exceeded, include new transformers and/or switchboards in design. For major building addition projects where the additional electrical requirements exceed the capacity of the existing transformers a totally new service shall be installed. The new services shall have the capacity to support the total building. The original building incoming service shall be removed so only one electrical service remains. Coordinate work with Owner's Representative.

## **26 24 00 – SWITCHBOARDS AND PANELBOARDS**

### **26 24 13 - SWITCHBOARDS**

- A. Provide 25% additional breaker "growth space" minimum.
- B. Copper Buss bars only.
- C. Acceptable Manufacturer: General Electric, Square D, Siemens, Cutler-Hammer.

### **26 24 16 – PANELBOARDS**

- A. Door-in-door construction, with key locks.
- B. All breakers rated 60/75°C. and 10,000 A.I.C. (minimum). Bolt on type only.
- C. Provide both equipment ground bar (bolted to enclosure). Isolated ground bar (insulated) when shown.
- D. Typewritten directory card with final room numbers. Provide copy in O&M manuals.
- E. Specify minimum "Equipment Short Circuit Rating".
- F. Provide a minimum of 10% additional "spare" 20 amp. Single pole breakers plus 15% additional "blank" spaces for future.

- G. 42 circuit panel, as minimum for normal situations.
  - 1. Avoid “multiple-tub” (i.e. more than 42 pole) branch panelboards. Instead, provide additional feeder circuits and additional single panels. This concept usually results in smaller feeder circuits and lower interrupting capacity requirements at the panelboards. Locate each panelboard near the center of its load for economical branch circuit lengths.
- H. Copper buss bars only. All panelboards 225 amp or less, are to have either intermediate supports on the bus bars to prevent deflection, or are required to have 800 amp/square inch bus bars if the bus bars are only supported at each end of the bus.
- I. Acceptable Manufacturer: General Electric, Square D, Cutler- Hammer or Siemens.
- J. Include statement for retorquing all connections after installation.
- K. Flush mounted panels to have: (3 - 3/4” conduit) to an accessible J-box above lift-out ceilings or below access floors.

## **26 24 23 – ENCLOSED LOW-VOLTAGE MOTOR CONTROLLERS**

- A. Combination starters and motor control centers to have “RK5” or “RK1” fuses and rejection devices with fuses sized to act at a “back up” to overload heaters. Motor short circuit protectors “MSCP” or circuit breakers are not acceptable.
- B. Provide phase loss, phase unbalance and phase reversal protection for these three-phase motors:
  - 1. All critical motors, regardless of size, i.e.: hydronic radiation pumps, etc.
  - 2. All 5 horsepower and larger motors.
- C. Use only “NEMA” type overload heaters (Class 20). Bimetallic “IEC” type overload heaters are not acceptable. Electronic overload units may be employed.
- D. Use only NEMA sized motors starting contactors.
- E. Motor control centers to have COPPER buss bars.
- F. Acceptable Manufacturer: Square D, Allen Bradley, General Electric
- G. Guidelines for motor control circuits.
  - 1. General:
    - a) Preferred control voltage is 24V for all applications.  
(Low voltage ac or dc is acceptable but not desired.)

- b) All control circuits arranged so safeties and interlocks will shut down equipment and require manual reset before restart.
- c) Momentary contact control circuits are preferred on all but small motor applications. This prevents uncontrolled restarts of equipment which could overload building electrical systems. Exception: critical equipment, such as hydronic radiation pumps, animal room air handling equipment and etc.
- d) Pilot lights: transformer, push to test type. Color: Red = "Run" Green = "Off"

#### H. Variable frequency drive for fans and pumps

##### 1. General:

- a) All drive components shall be "burned in" as sub-assemblies and entire drive tested, under load, before shipment. Full load endurance testing is not considered a cost effective option.
- b) Single motor drives are preferred over multi-motor drives.
- c) Regenerative braking not required.
- d) Current source drives not acceptable without Owner approval.
- e) Automatic restart after power outage feature, must be field selectable.
- f) "Resonant Null" feature for voiding (jumping) specific speeds due to critical frequency vibrations is not required. (We have not encountered this problem in any centrifugal fan.)
- g) Meet requirements of IEEE Standard latest "Guide for Harmonic Control and Reactive Compensation of Static Power Converters".
  - a) Noise: Notch depth five percent or less and voltage distortion three percent or less on line side of the drive.
  - b) Audible noise from either the drive or the motor may be objectionable and should receive careful consideration.
- h) If disconnect or transfer switches are used, an interlock switch shall be installed to shut down the drive before the main switch poles open.
- i) Any manufacturer specified must have an established authorized distributor and a service facility within the state of Iowa.
- j) Provide manual bypass (confirm with owner).

- k) Provide interface board to allow communication with the Owner's building control system. Communications interface card shall be integral to the drive. Configuration of the communications interface shall be the responsibility of the drive supplier.
- l) Provide breaker-type over protection devices.
- m) Design Professional to add note to specifications that input, output and control wiring shall be installed in separate conduits.
- n) Acceptable Manufacturers: Danfoss Graham. These will be provided through the Siemens Controls contract. Installed by Constructors.

2. Output Requirements:

- a) Use of 480 volt motors is preferred for all new and most existing applications.

3. Performance Requirements:

- a) Capable of 110% rated current for one minute.
- b) Working frequency range = 6 to 60 Hz.
- c) Speed regulation = +/- ½% of maximum.
- d) Adjustable linear acceleration & deceleration. Range approximately. 1 to 60 seconds.
- e) Accept 4 – 20 Ma. (isolated and ungrounded) speed input signal.
- f) Accept Start/Stop (momentary contact) or maintained contact devices (120 vac. preferred.)
- g) Provide separate, form "C" contacts, rated 1 Amp. @ 120 vac., to indicate "inverter fault" & "drive run".
- h) Input power factor at least .95 throughout speed & load range.

4. Protection Requirements:

- a) Capable of enduring these faults, without permanent damage:
  - 1) Short circuit and/or ground fault at output terminals.
  - 2) Input overvoltage, undervoltage, phase loss or phase reversal.
  - 3) Energized into a coasting motor.
  - 4) Internal cooling fan failure.

- b) Faults individually indicated, by visual means, and require reset, before restart.

## **26 27 13 LOW VOLTAGE ELECTRIC METERING**

- A. Owner's standard kilowatt hour/demand meter:
  - 1. Electronic meter, ION 8600A (Owner Provided).
  - 2. The electrical Constructor is to furnish and install a meter socket on the wall adjacent to the switchgear/panel and install the Owner provided electronic meter. Meter socket to include lever operated jaw release and be "CT" rated. Landis & Gyr HQ-13T or Alliant Energy Standard Milbank UC7449-XL-871-ALT or equal.
- B. Connect and transmit data via building Ethernet system to UNI ION meter software. Electrical Constructor to install CAT6 cable from the meter to a data jack located adjacent to the meter.
- C. Prefer PTs connected on line side of main switch.

## **26 30 00 – FACILITY ELECTRICAL POWER GENERATING AND STORING EQUIPMENT**

### **26 32 00 – PACKAGED GENERATOR ASSEMBLIES**

#### **A. GENERAL**

- 1. Preferred manufacturers:
  - 1) Caterpillar
  - 2) Kohler
  - 3) Onan/Cummins
- 2. Natural Gas fueled.

#### **B. INTEGRATION**

- 1. Provide circuiting to the campus Building Automation System (BAS) utilizing dry contact closure inputs, to indicate the following:
  - 1) Generator run
  - 2) Generator transfer
  - 3) Generator fault
  - 4) Generator fuel tank bladder rupture (if applicable)

### **26 35 00 – POWER FILTERS AND CONDITIONERS**

#### **A. Purpose:**

1. Sensitive electronic equipment requires special considerations to avoid power and operational problems.

B. Guidelines:

1. Harmonics

- a) Most newer electronic or computer based equipment uses technology which produces a high harmonic current content and may lead to power system problems.
- b) The use of individual neutrals for each single phase circuit and the oversizing of any three phase neutral involved, needs engineering consideration. The neutral to ground voltage drop should also be considered.
- c) The use of K-rated transformers and harmonic traps needs to be considered.
- d) If isolation transformers are employed, they should be the shielded type.

2. Grounding

- a) An insulated green wire should be included with all feeders and branch circuits. Bonding jumpers between receptacles and raceway are desired.
- b) The use of isolated ground circuits/receptacles is not generally necessary and if requested by occupants should be discussed with the owner.
- c) The grounding of each receptacle should be checked in the final inspection.

3. Transient Voltage & Surge Suppression (TVSS)

- a) The use of TVSS receptacles on sensitive circuits is encouraged.
- b) Additional upstream TVSS device may be warranted in some cases.

4. Power conditioning

- a) Power conditioners, Voltage regulators and UPS units are not generally required and, if requested by occupants, should be discussed with Owner's Representative.

## **26 36 00 – TRANSFER SWITCHES**

### **26 36 23 – AUTOMATIC TRANSFER SWITCHES**

A. Prefer capability to test generator with or without transfer of load.

B. Owner preference: Onan/Cummins

C. Provide connection to Building Automation System for:



1. Generator Run
  2. Generator Fault
  3. Generator Transfer
  4. Bladder rupture in fuel tank.
- D. Utilize form C contacts-dry.
- E. Provide 4-wire transfer switch (3-phase plus switch neutral).
- F. Provide programmable seven-day exercise clock.
- G. Transfer switch shall have programmed transition.

## **26 40 00 – ELECTRICAL AND CATHODIC PROTECTION**

### **26 41 00 – LIGHTNING PROTECTION**

- A. Required for all buildings susceptible to lightning strikes, i.e., not in another building's cone of protection, roof mounted antennas, copper roof, overhead conductors, etc.

### **26 43 00 –SURGE PROTECTIVE DEVICES**

- A. GFCI type receptacles (5 milliamp) are preferred over GFCI breakers, for convenience receptacle outlets. Convenience receptacles fed through a GFCI receptacle must be in sight of that GFCI receptacle, i.e. All receptacles on a single lab bench or along the same wall.

### **26 50 00 – LIGHTING**

- A. LED shall be used. In general, decorative or accent lighting is not allowed.
- B. Place lighting on 480Y/277 volt system whenever possible.
- C. In fixture schedule, indicate lamp type to be installed in fixture, and fixture description.
- D. Exterior lighting controller by BAS. No time clocks or switches.
- E. The Illuminating Engineering Society (IES) Lighting Handbook shall be used as a guide for all lighting levels.
1. Controls for interior lighting controlled by lighting controller should be daisy chained to one location for each room.
- F. In classrooms where video recording or presentations (projection screens, monitors) takes

place, consider the following:

1. Even illumination throughout the room.
  2. Lamp reflection in monitor(s)
  3. Back light, on wall behind instructor
  4. Aiming of floodlights
  5. Location of light controls
  6. Consider split switching or dimming capabilities.
- G. Review manufacturer's list with Owner's Representative.
- H. In general, vacancy sensors (manual on, auto off) are to be used in all spaces except mechanical rooms, tunnels, corridors and similar type spaces. Mechanical rooms and tunnels shall have toggle switches.
- I. Corridor lights shall be controlled by the BAS system.
- J. Use of daylight sensors is encouraged.
- K. Specify factory commissioning for vacancy sensors and daylight controls.
- L. In general all light fixtures shall be installed so maintenance take place using a 6 Ft. ladder. Any deviation from this shall be reviewed with the Owner.
- M. In suspended ceilings, branch circuits are not allowed in fixtures.

## **26 51 13 – INTERIOR LIGHTING FIXTURES**

### Fixtures

- A. Furnished and installed by Constructor.
- B. All ~~interior~~ light fixtures are to be LED. LED fixtures to have 5 year minimum warranty on light source and driver. Specify 3500K color temperature indoors. ~~and 4000K outdoors.~~
- C. Install light fixtures inside of large air handling units for service work.

## **26 53 00 – EXIT SIGNS**

- A. Shall be LED panels. Owner prefers cast aluminum housing and red letters. (No plastic cases.)

- B. Individual battery pack emergency lighting, and exit signs, to be powered from the unswitched portion of lighting circuit feeding area served.
- C. Emergency generators, engine driven, natural gas powered, preferred over individual battery pack equipment.

**26 55 00 – SPECIAL PURPOSE LIGHTING**

- A. Review photometrics with owner.

**26 56 00 – OUTDOOR LIGHTING**

- A. Controls: Mechanically latching contactor. Follow UNI wiring diagram, Virtual Photo Eye CT for “on” verification to BAS. Provide local manual bypass switch.

- B. Specify 4000K color temperature outdoors.

**26 56 16 – PARKING LOT LIGHTING**

- A. Parking Lot Light Levels

1. Most lots will be “low activity” – minimum maintained horizontal light level – 2 Lux (0.2 FC) with average to minimum uniformity ratio not to exceed 4 to 1. Vehicle only traffic areas (i.e. entrance/exit) – 5 Lux (0.5 FC) minimum with average to minimum – 4 to 1.
2. Lots such as those at the UNI Dome will be “medium activity” – minimum maintained horizontal light level – 6 Lux (0.6 FC) with average to minimum uniformity ratio not to exceed 4 to 1. Vehicle only traffic areas – 11 Lux (1.1 FC) minimum with average to minimum – 3 to 1.

- B. Generally light trespass must be considered and cut-off type fixtures used. After evaluation of conditions for each project some adjustment of the above criteria may be necessary.

- C. Maximum 2 fixtures per pole, 180° apart.

**ROUND LUMINARIES ON ROUND TAPERED POLES**

- A. Parking lot fixtures shall be CREE-ARE-EDR- # -DA- ## -D-UL-PB-43K (Platinum Bronze).

# - Lighting Distribution Type  
 ## - Number of LEDs Needed

- B. Poles

1. Poles shall be round tapered steel designed for 80 mph wind with gust factor of 1.33.
2. Poles shall be by KIM Lighting, Beacon, Hubble, AAL, Valmont, or WJM.

- a) Pole Shaft
    - 30' nominal height
    - Pole diameter to measure 7.5" – 8" at base with uniform taper
    - One piece section
    - 11 gauge steel
    - Include vibration dampener
    - Standard 3" x 5" handhole with two threaded bolts for cover
  - b) Base
    - 10.5" bolt circle diameter
    - Base cover
    - 1" diameter anchor bolts
  - c) Finish
    - Factory applied powder coat 3 mils thick
    - Typically Platinum Silver for KIM, Beacon, Hubble or AAL (~~color to be verified by Owner~~).
    - Natural Aluminum for Valmont
    - Gray (GY) for WJM (all colors to be verified by Owner)
3. Anchor bolts & templates shall be shipped prior to delivery of poles.

## MATERIALS AND COMPONENTS

- A. General: Provide roadway and parking area lighting units of sizes, types and ratings indicated, complete with, but not limited to, poles/standards, brackets, mast arms, luminaries and other components and accessories required for complete roadway and parking area lighting systems.

## POLE BASES

- A. Reinforcing shall conform to the requirements of Section 2404 of the Standard and Supplemental Specifications of the Iowa Department of Transportation.
- B. Precast light pole bases using UNI base design is preferred.

## GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for each roadway and parking area lighting unit as indicated with grounding rod at each fixture pole.

## **26 56 19 - ROADWAY LIGHTING**

- A. Roadway Fixtures shall be:

The same fixture and pole as specified for parking lots.  
~~Valmont DS70-900A336-12GV-HH-VD-AB-W/TB1-17-TBASE-pole-  
RFL-180W-##-LED4K-T-R#M-UNIV-DMGRCD-WCID-GY3  
##-Number of LEDs  
#-Type of Distribution~~

B. Roadway Light Levels

1. Classification per IES, generally on campus will be “Local, intermediate” – minimum average maintained horizontal light level – 7 Lux (0.7 FC) with average to minimum uniformity ratio not to exceed 6 to 1. Modify to suit pavement and usage.
2. Generally light trespass must be considered and cut-off type fixtures used. After evaluation of conditions for each project some adjustment of the above criteria may be necessary.
3. See Section 265616 for fixture and pole specifications.

C. Voltage shall be 480V, 277V, or 208V.

**26 56 33 – WALKWAY LIGHTING**

A. Pedestrian Walkways (sidewalks) Light Levels

1. Minimum average maintained horizontal light level – 5 Lux (0.5 FC) with average to minimum uniformity ratio not to exceed 4 to 1.

B. Constructor will furnish and install all footings, conduit and wire.

1. Wire to be in conduit. All wiring shall include a neutral and grounding connector.

C. Constructor will furnish and install fixture, pole, anchor bolts, pole base, and lamps.

D. Owner’s Standard fixture:

1. Traditional Fixtures - F1
  - a) Exterior fixtures shall be Spring City ALMYRK-LEØ4Ø/EV#/X2-40-CR##-PPLO, # - Voltage Type, ## - Distribution Type, (Verify with Crescent) complete with adapters to fit existing poles.
  - b) Pole: Holophane Part # as of 1/3/2014 – WP11/18 CIU841A-AB-31-4 TMP-77 RFD109259.
  - c) Color: Powder Coat. Sherwin Williams custom color finish (S/W 6005) Verify with Owner

d) Fixtures shall be furnished with low temperature ballasts suitable for operation to minus 30 degrees F.

2. New Fixtures – F2 – Sidewalk

- a) Sidewalk fixtures shall be Cree – ARE-EDR-2#M-R3-04-UL-PB-350-40K (Platinum Bronze). # - Type of Distribution.
- Owner approval is required to deviate from this model number.

3. Poles

- a) Poles shall be by KIM Lighting, **Beacon, Hubble, AAL, Valmont**, or WJM

Pole Shaft

- 14' nominal height
- 2-3/8" x 4" tenon mount
- One piece section
- 11 gauge steel
- Uniform taper of 0.14" diameter per foot of length
- Pole diameter from 5.1" to 3.1"
- Standard 3" x 5" handhole with two threaded bolts for cover.

Base Plate

- 8" bolt circle diameter
- Base cover

Anchor Bolts

- 3/4" diameter

Finish

- Factory applied powder coat 3 mils thick
- **Platinum Silver for KIM, Beacon, Hubble or AAL (~~Color to be Verified by Owner~~)**
- **Natural Aluminum for Valmont**
- **Gray (GY) for WJM (all colors to be verified by Owners)**

- b) Other poles may be approved by Owner.

E. Identification number by Owner.

F. Pole Bases

1. Furnish and install electric pole bases as shown on the drawings.
2. Reinforcing shall conform to the requirements of Section 2404 of the Standard and Supplemental Specifications of the Iowa Department of Transportation.

3. Precast light pole bases using UNI base design is preferred.
- G. Splice points shall be enclosed with a "Pencell" enclosure or University of Northern Iowa Engineer approved equal.