# DIVISION 26 ELECTRICAL

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***Unless stated otherwise, the standards in this Facilities Design Manual (FDM) are directed to the Design Professional to incorporate into the Project. Although the Owner encourages improved concept, method, and product recommendations by the Design Professional, deviation from these standards, including product requests for "approved equivalent" status, requires written justification from the Design Professional and written approval from the Owner's Representative before completion of Design Development Documents.***

***Links to Support Documents, external webpages, and other FDM sections are shown in underlined text.***

# 26 00 00 ELECTRICAL

## A. REFERENCE ABBREVIATIONS

| | | |
|---|---|---|
| 1. | ANSI | American National Standards Institute |
| 2. | ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc |
| 3. | IES (IESNA) | Illuminating Engineering Society (Illuminating Engineering Society of North America) |
| 4. | NEMA | National Electrical Manufacturers Association |
| 5. | UL | Underwriters Laboratories Inc |
| 6. | NEC | National Electrical Code |
| 7. | IEEE | Institute of Electrical and Electronics Engineers |
| 8. | NFPA | Nation Fire Protection Association |

## B. ELECTRICAL ABBREVIATIONS

| | | |
|---|---|---|
| 1. | AWG | American Wire Gage |
| 2. | GFCI | Ground Fault Circuit Interrupter |
| 3. | IDF | Intermediate Distribution Frame |
| 4. | MDF | Main Distribution Frame |
| 5. | KWH | Kilowatt-Hour |

## C. EQUIPMENT DEFINITIONS

1. Battery Powered Emergency Lighting Unit - A fixture with an integral emergency battery-powered supply and means for controlling and charging the battery; also known as an emergency light set.
2. Branch Panelboard - Fed from the main switchboard or distribution panelboard and feeds branch circuit loads such as lighting, receptacles, and smaller motors.
3. Dedicated Circuit - A branch circuit from the nearest available branch panelboard which will serve only one load or group of loads of a sensitive type, (i.e., computers, lab equipment, etc.)
4. Distribution Panelboard - Fed from the main switchboard and feeds branch panelboards, motor control centers, or major discrete loads.
5. Fixture (Luminaire) - A complete lighting unit, exit sign, or emergency lighting unit that includes one or more lamps and the parts required to distribute light, position and protect lamps, and connect lamps to a power supply.
    a. Internal battery powered exit signs and emergency lighting units also include a battery and means for controlling and recharging a battery.
    b. Emergency lighting units may or may not have integral lamp heads.
6. Integrated Equipment Short Circuit Ratings - Application of a series of connected circuit breakers in combinations that allow some breakers to have lower individual interrupting ratings than the available fault current.
    a. Permitted only when series combinations have been tested and listed by UL.
7. Interrupting Rating - Maximum fault current, in RMS symmetrical amperes at maximum listed voltage, that a device will interrupt (open) to clear a faulted circuit.
    a. Device must still be operational after interrupting the fault.
8. Isolation Transformer (Non shielded) - A transformer with primary and secondary windings insulated from each other.
9. Isolation Transformer (Shielded) - Same as non-shielded except has an electrostatic shield between the primary and secondary to attenuate noise.
10. 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.

11. Motor Control Center - A structure that groups and houses several "modular" type motor controllers and may also contain fusible disconnects or circuit breakers.
12. Noise Suppression - May be applied to any circuit and consists of radio frequency chokes and/or capacitors to shunt high-frequency noise to ground.
13. Power Conditioning - May be applied to any circuit (usually to individual pieces of equipment) and must be selected and sized for the exact load it serves.
    a. A voltage regulator or isolation transformer is a type of power conditioning.
14. 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 with suppression applied between all conductors.
    a. Devices are bi-directional and protect against transient voltage spikes and minor lightning strikes.
    b. See paragraphs under Section 26 40 00.
15. Uninterruptable Power Supply - Furnishes power for a limited time to a load on complete loss of building power, allowing an orderly equipment shutdown without causing damage or data loss.
16. 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 the fault is cleared.

## D. DRAWING REQUIREMENTS

1. Show, as a minimum, the following information on the Drawings.
    a. Symbols list.
    b. One-line diagrams for all systems involved.
    c. Connected load at each switchboard, panelboard, motor control center, etc.
    d. Panelboard schedules with connected loads.
    e. Fixture schedules.
    f. Home runs to panels, marked with circuit numbers.
    g. Adjacent to dedicated circuit receptacles, note type of equipment intended to use the receptacle, for example, a "-80º Freezer", "Laminar Flow Hood" or "Incubator".
    h. Location and identification of all telecommunication IDF's, MDF's and data jacks.
        1) The Owner's Representative will provide information.
    i. Horsepower or amperage, voltage, phase, and NEMA starter size for each motor.
    j. Size and class of current limiting rejection type fuses if combination starters or starters with fusible disconnects are on the line side of the starter.
    k. Amperage, voltage, and phase for special electrical loads.
    l. Size and class of current limiting rejection type fuses, if fuses are employed.
2. If coordination studies are required, submit the documentation to the Owner's Representative by inclusion in the Maintenance Manual.

## E. DESIGN REQUIREMENTS

1. In general, specify materials inspected, approved, and listed by Underwriters Laboratories and that bear a UL label, or a UL recognized component label where labeling services for that type of material are available.
2. Design following National Electrical Code (NEC) voltage drop guidelines.
3. Wherever possible, do not show conduit for branch circuits or panelboard feeders in the following locations.
    a. Under, or embedded within, a concrete slab-on-grade.
    b. Embedded within an elevated concrete slab.
4. If the conduit must be buried under a slab-on-grade, mark the location of the conduit with yellow tape.
    a. For conduit buried less than 12 inches deep, locate tape directly below slab and vapor barrier.

b. For conduit buried 12 inches or deeper, locate tape 12” above the conduit.

5. Specify each piece of equipment connected to the Owner's Building Automation System (BAS) requires a dedicated 120 VAC 20-amp circuit.
6. Specify a neutral conductor installed for each phase wire in single-phase 277V and 120V circuits.
   a. Do not specify "shared" or "common" neutrals, no exceptions.
7. Minimize the use of dedicated circuits except for research- or electronically sensitive equipment, based on electrical load and equipment requirements.
   a. For definition of dedicated circuit, see Section 26 00 00 C.
   b. For drawing requirements, see Section 26 00 00 D.
8. Aluminum wire, cable, buss bars or buss structures are prohibited, no exceptions.
9. Design for GFCI protection as required by code and as follows.
   a. For all receptacles in mechanical rooms and wash-down areas and for receptacles within 6 feet of a water cooler, vending machine, sink, shower, eye wash, or hose bib in areas including, but not limited to, wet labs, restrooms, kitchens, and custodial closets.
10. Provide a GFCI receptacle if the receptacle is visible and accessible to test and reset; otherwise, provide a receptacle protected by a GFCI breaker.
11. The following are exceptions where GFCI protection is not required.
    a. Equipment that has factory-installed code-compliant GFCI protection.
    b. A receptacle that powers a permanently installed fire alarm system or security alarm system.
    c. A single or duplex receptacle that powers equipment that contains critical research material with a sign adjacent to the receptacle.
       1) Text: "THIS RECEPTACLE IS NOT GFCI PROTECTED. ONLY EQUIPMENT CONTAINING CRITICAL RESEARCH MATERIALS IS TO BE PLUGGED INTO THIS RECEPTACLE"
       2) Provide space for a 3 inch by 5-inch sign immediately adjacent to the receptacle.
       3) Sign will be fabricated and installed by Owner.
       4) For sign standard, see FDM Part 2/ Support Docs for Div. 26/GFCI Receptacle Sign Standard.pdf.
12. For utility electrical standards, see paragraphs under Section 33 70 00 in FDM Part 2/Div. 33 Utilities.pdf.

## F. POWER SYSTEM DESIGN

1. Normal service to a building will be a 4,160 or 13,800-volt radial feeder from the Owner's existing underground system.
2. Design the electrical service to have a metal-enclosed three-phase switch and fuse assembly or vacuum interrupter switch with electronic fusing for each required transformer. Coordinate the type of medium voltage switchgear and utility pad-mounted transformer overcurrent protection with the Owner’s Utility Enterprise via the Owner’s Representative.
3. Incorporate primary metering where multiple transformers are required.
4. Incorporate secondary metering where only one transformer is required.
   a. Locate on or adjacent to the main distribution panel.
5. Normally, specify the transformer's secondary voltage as 120/208-volt or 277/480-volt 3-phase 4-wire.
   a. Because the secondary voltage will be determined by facility requirements, discuss and verify what voltage to use with the Owner's Representative.
6. Minimize the quantity of dry-type step-down transformers distributed throughout the facility.
7. Discuss with the Owner's Representative the use of isolation transformers with variable-frequency motor controllers.
8. Design the main electrical room to include normal and emergency power equipment (generator distribution equipment and Automatic Transfer Switches) for standard building projects. Discuss the need to design

physically separated normal and emergency power rooms based on applicable building codes with the Owner's Representative.

9. When a project requires a new utility service transformer, the design professional shall discuss the installation location with the Owner's Representative. The Owner's general preferred type and location is an exterior liquid-filled pad-mounted transformer. If an interior dry-type transformer is justified for the facility, the design professional shall designate a permanent transformer entrance and exit path in and out of the building to be maintained for the life of the building.

## 26 05 00 ELECTRICAL COMMON WORK RESULTS

### A. BASIC ELECTRICAL MATERIALS AND METHODS

1. At exterior walls below grade or other damp locations, specify electrical equipment mounted on standoffs.
2. In general, do not specify box extension rings.
   a. If box extension rings must be used, specify only one ring per box with wires extending 6 inches from the front edge of the extension ring.
3. In general, especially for concealed boxes, specify the largest practical size device and junction boxes to provide space for future wiring changes and the following requirements.
   a. For concealed device boxes, specify a 2-1/8-inch minimum depth.
   b. For concealed square boxes, plaster rings may be specified.
   c. For surface boxes, specify with 1/2 inch raised covers.

### B. WIRE CONNECTIONS

1. Comply with the following requirements.
   a. Unless approved by the Owner's Representative, do not specify exothermic joints.
   b. For #8 AWG or larger, specify compression-type connectors.
   c. For motor connections #8 AWG or larger, specify connections insulated with heat-shrink tubing.
   d. For the connection to the utility transformer, specify long barrel, 2-hole NEMA spaced, tin plated copper compression connectors with hot dipped galvanized or stainless-steel hardware consisting of 1/2-inch bolts, washers, lock washers, and nuts.
   e. Do not specify split bolt connectors and tape.
   f. Do not specify insulation displacement contact type wire connectors (e.g., Scotchlok connector).
2. Where a circuit passes through an outlet box and is tapped, specify all leads pigtailed to the wiring device, including the equipment ground wire, to prevent loss of neutral or ground during maintenance work.
   a. See FDM Part 2/Support Docs for Div. 26/Electrical Details/Uninterruptable Circuit Wiring Detail.pdf.

### C. LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

1. Comply with the following requirements.
   a. Specify only stranded Type THHN/THWN copper wire except for service entrance cable, specify Type XHHW-2.
   b. Specify outdoor underground copper wire to be USE-2.
   c. Specify minimum 90º C insulation rating unless approved otherwise by the Owner's Representative.
   d. Do not specify direct buried cables.
   e. Specify all phase and neutral conductors to have colored insulation.
   f. Specify all grounding conductors (isolated or equipment).
   g. Specify the Owner's standard wiring color code as follows.
      1) All voltages and systems
         a) Equipment ground = green.
         b) Isolated ground = green with yellow stripe or green with yellow tape bands

c) Travelers for 3-way switches = violet

2) 208Y/120v, 3 Phase, 4-wire systems

a) Phase A: Black

b) Phase B: Red

c) Phase C: Blue

d) Neutral: White

3) 480Y/277v, 3 Phase, 4-wire systems

a) Phase A: Brown

b) Phase B: Orange

c) Phase C: Yellow

d) Neutral: Gray

h. AC or MC Cable

1) New Construction – Not permitted.

2) Renovation/Existing condition – Do not specify AC Cable or MC Cable for general wiring inside buildings. AC or MC cable may be considered for use in existing conditions such as walls or ceiling spaces where standard installation methods are not possible and is only permitted with prior written Owner's Representative approval.

## D. GROUNDING AND BONDING

1. For power circuits, comply with the following requirements.

a. Specify green insulated grounding conductor as follows.

1) With feeder conductors to each new panelboard.

2) In the same conduit with power conductors from each motor control to the motor.

3) Inside any piece of raceway, regardless of type, size, or length.

4) Underground secondary service duct bank runs.

b. Specify bonding jumpers installed around all concentric/eccentric knockout rings that are not removed.

c. Specify suitable expansion and deflection fittings with grounding continuity in each conduit run at each point where the conduit crosses a building expansion joint.

d. Specify exothermic weld ground bonds in the following locations:

1) Underground in contact with earth.

2) Embedded in concrete (e.g. ground ring around interior main electrical room).

3) Other required irreversible bonding connections (discuss with Owner).

e. Specify an equipment grounding conductor installed with all surface raceway systems and bonded as follows:

1) Bond one- and two-piece raceways at every box.

2) Bond each receptacle to its box.

f. Grounding electrodes for an existing building to include a minimum grounding field of three electrodes installed outside the building envelope, bonded together, and bonded with the ground bus bar inside the electrical equipment room.

g. Specify the main electrical room ground copper bus bar for building grounding electrodes to be a minimum 4 inches high x 24 inches long x 1/4 inches deep.

h. Grounding field for a new building to include multiple ground rods interconnected with bare copper ground cable installed in multiple loops around the transformer area, electrical equipment rooms, emergency generator rooms, etc., bonded with ground risers to each piece of equipment, and bonded with the ground bus bar inside the electrical equipment room.

i. Specify 5/8 inches x 10-foot copper-clad steel ground rods.

j. Specify one supply side bonding jumper (SSBJ) sized per NEC in each conduit from the utility pad mounted transformer low-voltage section to the building main switchboard. Specify 4” copper busbar to be mounted to ground pad in pad mounted transformer low-voltage compartment and terminate all ground bonding jumpers to the busbar.

k. Specify new grounding fields tested for resistance and specify a report submitted to the Owner's Representative showing layout and measured values.

1) Specify grounding electrode resistance = 5 Ohms maximum.

2. For motor shafts, comply with the following requirements.

a. For motors controlled by variable-frequency motor controllers, specify each exposed shaft is grounded to prevent bearing damage.

b. Specify motors that have factory-installed shaft grounding or specify a field-installed shaft grounding product that requires no maintenance for the service life of the motor.

1) When grounding is field installed, specify Aegis SGR or equivalent product approved by Owner's Representative.

## E. RACEWAY AND BOXES

1. General

a. Where surface-mounted electrical raceways are required and approved by the Owner's Representative in existing buildings, specify minimum size 3/4 inch conduit or Wiremold 700 series surface raceway.

b. Specify only threaded or compression fittings.

c. Do not specify polyvinyl chloride (PVC) conduit for general raceway inside buildings.

d. For flexible conduit, specify liquid tight flexible conduit by Carlon or approved equivalent.

e. Specify insulated throat fittings or bushings at conduit terminations 1 inch and larger.

1) Specify that plastic bushings are installed to the full threaded depth of the bushing.

f. Specify grounding type bushings for services or feeders.

g. Specify sealing locknuts with PVC gasket for exterior electrical enclosure conduit connections.

h. On 2-inch and larger conduits, specify double locknuts regardless of the voltage involved.

i. Specify an approved thread lubricant recommended for rigid steel and aluminum conduits to ensure better equipment grounding paths.

j. Specify an approved thread sealant recommended for all underground (direct burial) threaded conduit joints.

k. Specify minimum 3/4-inch size conduit for branch circuits.

2. Material

a. Specify rigid steel conduit hot-dipped galvanized inside and outside that complies with UL Standard 6, Federal Specification WW-C-581-D and ANSI C 80.1.

b. Specify galvanized rigid steel conduit at the following locations:

1) Raceways buried in the ground under concrete slabs-on-grade.

2) All high voltage runs, independent of location.

3) Exposed exterior raceways.

4) Any raceway in hazardous areas.

5) Termination of duct bank runs at equipment or indoor areas.

6) All steam tunnel lighting and convenience outlet circuits.

c. Specify electrical metallic tubing (EMT) that complies with UL Standard 797, Federal Specification WW-C-563 and ANSI C 80.3.

d. Specify EMT at the following locations:

1) Interior branch circuits exposed and concealed above suspended ceilings, in wall partitions, in masonry and in concrete.

2) Interior feeders; exposed or concealed.

3) Interior motor circuit wiring.

4) Interior control, signal and sound wiring exposed, concealed above suspended ceilings and in wall partitions.

e. Specify rigid plastic conduit, schedule 40 PVC at the following locations:

1) Underground secondary service duct bank encased in concrete.

a) Specify rigid galvanized steel elbows where conduit runs through a concrete slab or at a 90° duct sweep.

2) Underground telecommunication service duct bank direct buried.

3) Lightning protection down leads and individual ground conductors.

4) Exterior site lighting not attached to a building.

5) Interior of underground high voltage vaults for service to lights, receptacles, and sump pumps.

6) Underground circuits to underground electrical vaults for lights, receptacles, and sump pumps.

7) Underground circuits used for temporary event power sources.

8) Underground circuits used for traffic controls.

f. Specify rigid aluminum threaded conduit only at locations coordinated with and approved by Owner's Representative.

g. Exterior Ground Boxes in Earth:

1) Specify Hubbell-Quazite ground box for exterior ground box applications. Discuss the need for larger size ground boxes with the Owner's Representative.

a) Box Model: PG1324BA18 (Telecom boxes 36")

b) Cover Model PG1324CA0009 (w/Blank logo (Telecom cover marked "COMMUNICATION")

2) For exterior wiring splices inside ground boxes, specify watertight-rated splice material.

3) Specify ground boxes installed on 6" gravel or crushed rock.

h. Exterior Ground Boxes in Pavement:

1) Specify precast concrete ground box to be installed in concrete or asphalt. See the link for precast ground box details:

http://www.iowadot.gov/erl/archiveapril2012/RS/content_eng/rm42.pdf

3. Installation

a. Wherever possible, specify underground electrical duct bank runs installed at a minimum of 36 inches below grade to the top of the bank.

1) Where 36 inches is not possible and is approved by the Owner's Representative, specify concrete encased ducts installed to the minimum burial depth required by the NEC.

b. To all motors, heating, and ventilating controls, and at other locations where vibration, movement, moisture, or oil-vapor atmosphere are encountered, specify liquid-tight flexible nonmetallic conduit no longer than 18 inches with a continuous copper bonding conductor.

c. For connections to recessed and chain-hung lighting fixtures, specify hot-dipped galvanized, single-strip flexible steel conduit of length no longer than 6 feet.

1) Conduit of 3/8" diameter may be specified.

d. In corrosive atmospheres, specify plastic jacketed rigid steel galvanized conduit.

e. Wherever possible, specify concealed wiring in ceilings, walls, slabs, pipe chases, and furred spaces.

f. Specify pull/junction boxes to be installed as follows.

1) For 120-to-480-volt systems, install at maximum 360º equivalent bends and at maximum 100-foot runs for all raceways.

2) For control and fire alarm systems, install at a maximum of 360º equivalent bends and a maximum of 100-foot runs for all raceways.

3) For Information Technology systems, install a maximum of 180º equivalent bends and a maximum of 100-foot runs for all raceways.

4) For high voltage systems, install at a maximum of 180º equivalent bends and a maximum of 100-foot runs for all raceways; confirm pull box size with the Owner's Representative.

g. Regarding Information Technology systems, for the conduit to floor boxes approved by the Owner's Representative, specify embedded within a thickened slab to maintain at least 2 inches of concrete cover on all sides.

h. Conduit may be specified exposed only in mechanical rooms, electrical rooms, and custodial closets.

i. Specify exposed conduit installed as follows.

1) In a direct line, with bends as long as practicable

2) Parallel to or at right angles with the lines of the building, located as close as possible to walls, ceilings, columns, and other structural members while providing adequate access to boxes, yet occupying a minimum of space.

3) Parallel and equally spaced where exposed conduits are grouped.

j. For exposed runs in finished areas, counter and workbench power, and data outlets, specify Wiremold 4000 or larger surface metal raceways. Review applications of surface raceway use with the Owner's Representative.

k. Do not specify underground warning tape buried above exterior concrete duct banks or conduits.

## F. EMPTY CONDUIT SYSTEMS

1. Specify a continuous #12 nylon draw line with an identification tag securely attached to both ends in each conduit.
2. Specify plastic plugs or covers for all openings to keep the system clean. A taped cover is not permitted.
3. Specify a locator wire installed in all empty underground non-metallic conduits or ducts instead of the nylon draw line.

1) Specify solid copper 12 AWG with 30 mil polyethylene insulation Model PE-30 by Kris-Tech Wire Company.

## G. IDENTIFICATION

1. Specify the Owner's standard color codes for junction boxes and covers.

a. Fire Alarm: Red with "FA" stenciled on the cover

b. Emergency and Standby Power: Yellow

c. Telecommunications: Brown

d. Building Automation System: Blue

e. Sound Systems: Gold

f. Primary Distribution System: Gray

g. 480/277 Volt: Orange

h. 208/120 Volt System: White

2. In general, specify nameplates on the following items.

a. Motor starters, motor controls, motor control centers, push-button stations, control panels, and time switches.

b. Disconnect switchboards, circuit breakers, contactors, or relays in separate enclosures.

c. Power receptacles where the nominal voltage between any contact is greater than 150V to ground.

d. Special electrical systems to be identified at junction boxes, pull boxes, terminal cabinets, and equipment racks.

3. Specify signs 1-1/8 inches by 2-1/4 inches or larger.
4. Specify the nameplate to describe the function or use of the equipment involved clearly.
   a. Discuss the panelboard naming convention with the Owner's Representative during design. At a minimum:
      1) For panelboards and switchboards, specify nameplates to include the panel designation, voltage, and phase of the supply, and where the circuit-feeding panel originates, such as the following example.

         Panel A
         480/277 V
         3 Ph - 4 W
         FED from "MDP"

   b. When equipment has more than one power source, such as a separate control power source, specify all power sources clearly identified on the nameplate at the equipment location.
   c. Specify that all wires in panelboards are marked with the circuit number they serve.
   d. Specify feeder conduits entering and leaving a panelboard or switchboard are clearly marked with their destination.
5. Specify receptacle device cover plates to receive an adhesive label with panelboard and circuit number displayed.
6. Materials - General
   a. Specify that nameplates shall be fabricated from laminated phenolic plastic, black front and back with a white core, with lettering engraved through the outer covering.
      1) For push-button station starters, receptacles, and similar devices where the nameplate is attached to the device plate, specify lettering 3/16 inches high.
      2) Specify lettering 1/4 inch high at all other locations unless otherwise detailed on the Drawings.
   b. Other types and sizes of signage may be specified if approved by the Owner's Representative.

## H. SHORT CIRCUIT, DEVICE COORDINATION AND ARC-FLASH STUDIES

1. Specify the Constructor to furnish a short-circuit study, a protective device coordination study, and an arc flash hazard analysis study prepared by either the equipment manufacturer or a third-party qualified engineer.
   a. The engineering firm hired by the Owner is not allowed to prepare these studies.
   b. Specify studies comply with NFPA 70E requirements and calculations are based on IEEE Standard 1584, current edition.
   c. Incorporate Owner-furnished standard specifications into the project manual. Must be requested from the Owner's Representative.
2. Specify studies to include the required scope for the type of project as follows.
   a. New building site: Include all electrical systems throughout the facility.
   b. Major addition to an existing facility: Include all new construction and existing facilities served by the building's electrical system.
   c. Full building renovation: Include all electrical systems throughout the facility.
   d. Partial building renovation: Confirm with the Owner's Representative if studies are required.
3. Specify Contractor to furnish all data for studies except utility system required data furnished by Owner.
4. Arc Flash Labels
   a. Specify Contractor to furnish and install labels for the type of equipment as follows.
      1) At each 480-, 240- or 208-volt panel board, lighting control and disconnect: 1 arc flash label.

a) Include all panels that are served through a 125 KVA or smaller transformer with a voltage of 240 or less.

2) At each motor control center: 1 arc flash label for each group of 3 sections.

3) At each local starter, VFD or other isolated equipment: 1 arc flash label.

4) At each low voltage switchboard: 1 arc flash label for each vertical section containing circuit breakers or exposed conductors if covers are removable.

5) At a main circuit breaker where the arc flash study indicated different hazard levels on the load side and line side: 1 arc flash label on the load side and line side.

b. Properties

1) Minimum size: 5 inches wide by 3.5 inches high.

2) Material: Durable polyester stock, self-adhesive, designed to resist degradation from scuffing, chemicals, moisture, and wide temperature fluctuations.

3) Black ink laser-printed on a white background with a prominent red danger symbol and two yellow triangles - one for arc flash hazard and one for shock hazard.

4) Top layer protection: Polyvinyl polymer over-laminate to assure color stability, and resistance to UV, chemicals, and common cleaning solvents.

5) Suitable for use in either interior or exterior locations.

c. Minimum Required Information

1) Equipment name or identification number.

2) Voltage of equipment.

3) Flash Protection Boundary in feet and inches.

4) Calculated incident energy in calories per square centimeter (Cal/cm$^2$).

5) Working distance in inches of the calculated incident energy.

6) Issue date that matches completion of studies.

## 26 09 00 ELECTRICAL SYSTEM INSTRUMENTATION AND CONTROL

### A. CONTACTORS

1. Specify tested and listed under UL508.
2. Specify mechanically held type, with clearing contacts.

### B. LIGHTING CONTROL DEVICES

1. Interior Spaces

a. General

1) Design lighting control to comply with the current adopted edition of the International Energy Conservation Code requirements or the project program to meet specific project requirements, whichever is more restrictive.

2) Design performance-based lighting control using only local sensors and switches; do not specify remote master control systems.

a) Exceptions: Remote master control systems may be considered for existing facilities. Pre-approval from the Owner’s representative is required before specifying.

3) Design control of artificial light levels to adequately compensate for varying daylight levels. Confirm project-specific requirements with the Owner’s representative.

4) Include proposed lighting control sequences and strategies in the Project Design Narratives submitted to the Owner for review during the design process.

5) Specify comprehensive testing of lighting controls at no additional cost to the Owner to include, but not be limited to, the following events.

a) A pre-installation meeting with attendance and participation by the Design Professional, Owner's Representative, qualified manufacturer's representative, and installing contractor

b) A post-installation walkthrough of controlled spaces to test, calibrate, troubleshoot, and correct as necessary.

b. Lighting Control Guidelines by Space Type Comply with the more restrictive requirement.

| Space Type | Sensor Mode | Time Delay | Multi-level Control | Recommended Average Lighting Levels[7] (fc) |
|---|---|---|---|---|
| Auditoriums | No sensor[5] | NA | Yes[4] | 45-50 |
| Classrooms | Vacancy[1] | 30 min | Yes[4] | 40-50 |
| Conference Rooms | Vacancy[1] | 30 min | Yes[4] | 35-45 |
| Corridors | Occupancy[2,3] | 30 min | Yes[4] | 10-15 |
| Custodial Rooms | Vacancy[1] | 15 min | No | 15-20 |
| General Public Spaces | Occupancy[2,3] | 30 min | Yes[4] | 20-30 |
| Laboratories - Computer | Vacancy[1] | 30 min | Yes[4] | 45-50 |
| Laboratories - Research | Vacancy[1] | 30 min | Yes[4] | 75-100 |
| Mech & Elec Rooms > 200 SF | No Sensor[6] | NA | No | 30-40 |
| Mech & Elec Rooms ≤ 200 SF | Vacancy[1] | 30 min | No | 30-40 |
| Open Offices | Vacancy[1] | 30 min | Yes[4] | 40-50 |
| Private Offices | Vacancy[1] | 15 min | Yes[4] | 40-50 |
| Public Restrooms & Lactation Rooms | Occupancy[2] | 30 min | No | 20-30 |
| Stairwells | Occupancy[2,3] | 30 min | Yes[4] | 10-15 |
| Storage Rooms | Vacancy[1] | 15 min | No | 15-20 |
| Telecom Rooms | Vacancy[1] | 30 min | No | 50-55 |
| Vestibules | Occupancy[2,3] | 30 min | Yes[4] | 20-30 |

**NOTES:**

1. A sensor set to vacancy mode operates "manual-on & auto-off", turning lights off following a time delay when it detects the space is unoccupied. The manual-on switch can also turn lights off.
2. A sensor set to occupancy mode operates "auto-on & auto-off", turning lights on when it detects the space is occupied and turning lights off following a time delay when it detects the space is unoccupied. It also may have a manual override on/off switch.
3. When turned off, the occupied space is still illuminated for safe egress by lighting on a separate circuit. See paragraphs d, 2, b and d, 2, b, 1 below.
4. Dimmable LED fixtures are acceptable.
5. A system shall be provided for manual-on, manual-off, and auto-off based on time. Provide a captive key override switch for time limit override. Confirm with the Owner's Representative to meet project program requirements.
6. Light fixtures in Mechanical & Electrical Rooms > 200 SF shall be controlled with toggle switch(es).
7. Confirm lighting level requirements with the Owner's Representative for exceptions based on project program requirements. Measured at 30" A.F.F.

c. Sensors

1) Specify spaces with ceiling-mounted or high wall-mounted sensors to have a standard wall-mounted toggle switch visible at each entrance for manual on-off control.

2) Specify the installation of 10 extra feet of control wiring per sensor to allow possible sensor relocation during the testing and troubleshooting.

3) Define sensor detection areas and control sequences for each space.

a) Consider dividing large areas into multiple groups or zones.

4) Specify the type of occupant movement required for sensor detection, such as normal handwriting or computer mouse movement.

5) Specify initial sensor sensitivity and time delay settings.

6) Specify the sensor/control manufacturer to determine sensor type, quantity, and location.

7) Specify the sensor/manufacturer and installing contractor to be responsible for a complete system that performs as specified.

8) Acceptable manufacturers are as follows.

a) Hubbell Building Automation Inc

b) Wattstopper

c) Acuity Brands Inc

d) The Owner's Representative must approve proposed equivalents

e) Exceptions may be considered for existing systems with the Owner's Representative pre-approval.

d. Daylight Control

1) Define coverage areas and control sequences for each space.

a) Consider dividing large areas into multiple groups or zones.

2) For spaces with sufficient daylight, design lighting controls to reduce artificial light levels, for example, manually by using wall switches or automatically by using photosensors.

a) Control artificial light levels using either on/off switching or dimming systems.

b) For lighting of occupied egress pathways, specify daylight sensors (single or multi-level or dimmable type) that control artificial lighting to provide a light level of at least 10 foot-candles at the walking surface (as recommended for corridor spaces by the IESNA Lighting Handbook, 9th edition) when daylight levels fall below 10 foot-candles at the walking surface.

(1) The use of daylight sensors to control egress lighting as described above has been approved by the State Fire Marshal's office in response to a formal request by the Owner.

3) Specify on/off switching in normally unoccupied spaces. Confirm the function of these spaces with Owner's Representative early in the design phase.

4) Consider specifying automatic dimming controls for normally occupied or task-oriented spaces to minimize user distraction.

a) Wherever automatic control is specified, also specify manual override control.

5) Specify the daylight control manufacturer to determine device type, quantity, and location.

6) Specify the daylight control manufacturer and installing contractor to be responsible for a complete system that performs as specified.

7) Acceptable manufacturers are as follows.

a) Hubbell Building Automation Inc

b) Leviton Manufacturing Co

c) Wattstopper

2. Exterior Spaces

a. Specify pole-mounted fixtures controlled by individual photocells.

1) Pole-mounted fixtures shall include a standard photocell receptacle.

b. Specify building-mounted fixtures controlled by the following methods in order of preference. Confirm with the Owner's Representative.

1) Building automation system (BAS), which is normally preferred

2) Photocell/ contactor combination

3) Photocell on each fixture

# 26 20 00 LOW-VOLTAGE ELECTRICAL SYSTEM

## A. BUILDING DISTRIBUTION DESIGN

1. For the service transformer's secondary voltage, design using either 120/208 or 277/480 volts, depending on project program requirements.
    a. Minimize using 120/208 volt dry-type step-down transformers wherever possible.
2. Design using 480/277 volt for motors and HVAC loads in larger facilities.
3. Design using 208/120 volts for control, receptacle, and lighting loads in larger facilities.
4. Design using 208/120 volts for all loads in smaller buildings and residence system facilities.
5. Do not design using step-up transformers unless pre-approved by the Owner's Representative.
6. Do not design using 240-volt equipment unless pre-approved by the Owner's Representative.

## B. DRY TYPE TRANSFORMERS

1. Specify shielded type for smaller dry-type transformers used inside buildings for their electrical noise reduction qualities.
2. Specify dry type, low loss, and high-efficiency transformers that meet the following requirements.
    a. Comply with most current adopted US Department of Energy Standards or NEMA TP-1 performances for 15 to 500 kVA sizes
    b. Impedances between 4.0% and 6.6%
    c. All copper windings
    d. 115 degree C rise with 220 degree C insulation system
    e. Self-cooled using no fans
    f. Sound level per NEMA ST-20
    g. Six 2-1/2% taps (2 ANFC and 4 BNFC).
3. To reduce noise, specify transformers are connected with flexible conduit, have internal vibration isolation, or are mounted on isolation pads.
4. Consult with the Owner's Representative with respect to designing oversized or special transformers and oversized neutral conductors due to the increasing use of computer equipment with switching-type power supplies that generate harmonic currents.
5. Acceptable manufacturers are as follows.
    a. Eaton Corp
    b. ABB
    c. Schneider Electric Square D
    d. Siemens Corp
    e. Approved equivalent

## C. SWITCHBOARDS

1. Specify to contain the following instruments.
    a. Multifunction metering package
    b. Metering grade potential transformers and current transformers
    c. Master metering following requirements under Section 26 20 00 E. Electrical Meters
    d. Building Automation metering following requirements under Section 26 20 00 E. Electrical Meters
    e. LEED metering following requirements under Section 26 20 00 E. Electrical Meters
2. Specify 50% additional breaker "growth space" minimum or space for a future switchboard section.
3. Specify copper bus bars only.
4. Specify fully rated equipment.

5. Specify current transformer leads wired to 6 pole shorting type terminal blocks.
6. Specify a spare 3-pole circuit breaker of 400 to 800 amps as determined by the Owner's Representative.
7. Specify an internal mounted surge protective device (SPD) at the service entrance main switchboard and other locations required per NEC.
8. Acceptable manufacturers are as follows.
    a. Eaton Corp
    b. ABB
    c. Schneider Electric Square D
    d. Siemens Corp
    e. Approved equivalent

## D. PANELBOARDS

1. Specify hinged door-in-door construction for both enclosure and breaker access.
2. Specify keyed locks for panelboards with 42 circuits or more.
3. Specify bolt-on type breakers rated 60/75º C and 10,000 AIC minimum.
4. Specify the equipment ground bar bolted to the enclosure.
5. Specify a neatly lettered directory card that clearly shows the following information.
    a. Panel name
    b. Breaker size and feed location to the panel
    c. Final room numbers
6. Specify minimum "Integrated Equipment Short Circuit Rating".
7. Specify a minimum of 25% additional spare 20-amp single pole breakers or 25% additional blank spaces for future expansion.
8. Specify a 42-circuit panel as a minimum for normal situations.
    a. It is acceptable to specify larger than 42 circuit panels based on the number of circuits required in an area. Consult with the Owner’s Representative before specifying these panels.
        1) 84 pole panel boards are commonly specified for dedicated laboratory locations only.
    b. Instead, provide additional feeder circuits and additional single panels, which usually results in smaller feeder circuits and lower interrupting capacity requirements at the panelboards.
    c. Locate each panelboard near the center of its service area for economical branch circuit lengths.
9. Specify tested and labeled per UL 67.
10. Specify copper bus bars only. Aluminum bus bars are prohibited.
11. Acceptable manufacturers are as follows.
    a. Eaton Corp
    b. ABB
    c. Schneider Electric Square D
    d. Siemens Corp
    e. Approved equivalent
12. Specify manufacturer must have single-pole GFCI breakers up to 30 amps and two-pole GFCI breakers up to 50 amps readily available for use by the Owner.
13. Specify all connections re-torqued after installation.
14. Specify flush-mounted panels to have a minimum of 7 square inches of raceway area to an accessible junction box above lift-out ceilings or below access floors.
    a. Specify junction boxes are sized as large as space permits for future conduit entries.

15. Panelboard Locations
    a. Do not locate panels in hallways, stairwells, or other building public areas.
    b. Locate panels for classrooms, offices, restrooms, break rooms, and similar public areas in secure locations such as a mechanical room or similar type of space controlled by the Owner's maintenance personnel.
        1) Do not locate panelboards in custodial spaces.
        2) Where public areas require multiple panels due to the area or number of rooms served, locate panelboards in a dedicated or secured electrical room.
    c. Locate panelboards for laboratories, research areas, server rooms, information technology, and similar type spaces within their respective spaces.

## E. ELECTRICAL METERS

1. Meter Instrument Transformers
    a. Specify that potential transformers and current transformers are furnished and installed by the Constructor at service entrance equipment.
        1) For potential transformers, specify 120 volts at the secondary and overcurrent protection at both the primary and secondary.
        2) For current transformers, specify 5 amp secondary and all leads terminated on shorting type terminal blocks accessible in the switchboard.
        3) Specify instrument transformers in the multifunction metering package for switchboard, utility, and Building Automation System metering.
2. Utility Meter
    a. Specify the Owner will furnish the following standard kilowatt hour/demand meter.
        1) Basis of Design: Itron Centron Polyphase CP3S (or equivalent) electronic meter, Form 36S, 13 terminal, 120-to-480-volt range, class 20, 15-minute demand for 3 phase 4 wire wye service.
        2) Wired with a 120-volt input
    b. Specify that the Owner will install the KWH meter described above in a socket furnished, installed, and wired by the Constructor and located adjacent to service entrance equipment.
        1) Specify the meter socket to have the following features.
            a) Automatic circuit closing design
            b) Current and voltage test switch
            c) Two pole fuse block
            d) All current leads shall automatically short out when the meter is removed or the test switch is opened.
            e) Two-piece cover
    c. Specify the meter socket is wired as shown in the Owner's standard wiring diagrams.
        1) See FDM Part 2/Support of Div. 33/Utility Electrical Details.
3. Building Automation Meters
    a. Specify the Owner's standard VERIS meter compatible with the Owner's Building Automation System.
    b. Specify a VERIS meter mounted remotely from building service entrance equipment in a separate cabinet.
    c. Specify a VERIS meter wired as shown in the Owner's standard wiring diagrams.
        1) See FDM Part 2/Support of Div. 33/Utility Electrical Details
4. Service Equipment Multifunction Meters
    a. Specify integral to service entrance equipment.
    b. Display the following information at a minimum.

1) Voltages - all phase-to-phase and phase-to-ground
2) Current - all phases
3) KW, KVAR and KVA
4) Power Factor
5) Total Kilowatt Hours

c. Consult with the Owner's Representative before specifying additional features or communication options.

5. LEED Measurement and Verification Meters
   a. Design the electrical distribution system to limit LEED meters to one for receptacle loads and one for lighting loads.
   b. Determine mechanical system loads using Building Automation System meters to subtract receptacle and lighting consumption.
      1) Additional meter locations will require approval by the Owner's Representative.
      2) Specify VERIS Meters mounted remotely from the building service entrance equipment or distribution panel in a separate cabinet.
      3) Specify VERIS split core current transformer H6810-300A-.3VU for panels sized at or below 400A. Provide VERIS H6812-800A-.3VU for panels sized above 400A up to 800A.
   c. Specify VERIS meters connected to the Building Automation System.
   d. Specify VERIS meters wired as shown in the Owner's standard wiring diagrams.
      1) See FDM Part 2/Support of Div. 33/Utility Electrical Details.
6. Do not specify submeters.

## F. DISTRIBUTION EQUIPMENT

1. Multi-Outlet Assemblies
   a. Specify Legrand Wiremold Plugmold 2400-PM.
2. Wiring Devices
   a. Specify devices with pigtails or clamp-type wire connections.
      1) Do not specify wiring devices with crimp-on connections.

## G. CIRCUIT PROTECTIVE DEVICES

1. Fuses
   a. For fuses 600 volts or less, specify classes RK1, RK5, J or L.
   b. Do not specify spare fuses of 600 volts or less.
2. Enclosed Switches and Circuit Breakers
   a. Specify fusible type disconnects have rejection devices and current limiting fuses.

## H. MOTOR CONTROLS AND CONTACTORS

1. Specify tested and labeled under UL508.
2. Specify combination starters and motor control centers with type RK5, RK1, or J fuses and rejection devices.
3. Specify phase loss, unbalance, and reversal protection for the following three-phase motors.
   a. All critical motors, regardless of size, such as hydronic radiation pumps, etc.
   b. Specify automatic re-energization upon correction of the fault.
4. Specify only NEMA-type overload heaters (Class 20).
5. Specify only NEMA-sized motor starting contactors.
6. Acceptable manufacturers are as follows.

a. Eaton Corp
b. ABB
c. Rockwell Automation Allen Bradley
d. Schneider Electric Square D
e. Siemens Corp
f. Approved equivalent

7. For motor control circuits, specify the following.
   a. Specify 120 VAC control voltage.
   b. To prevent uncontrolled equipment restarts which could overload building electrical systems, specify momentary contact control circuits on all but small motor applications.
      1) An exception is critical equipment, such as hydronic radiation pumps, animal room air handling equipment, etc.
   c. For pilot lights, specify transformer push-to-test type red neon that indicates "On".
      1) No "Off" pilot light is required.
8. For motors above 40 horsepower without variable-frequency motor controllers, generally specify solid-state reduced voltage starters, particularly on belt drive equipment.

## I. VARIABLE-FREQUENCY MOTOR CONTROLLERS

1. General
   a. Specify all controller components to be "burned in" as sub-assemblies and entirely drive tested under load before shipment.
      1) Because full load endurance testing is not considered a cost-effective option, do not specify.
   b. Wherever possible, specify single-motor controllers instead of multi-motor controllers.
   c. Do not specify regenerative braking.
   d. Unless approved by the Owner's Representative, do not specify current source controllers.
   e. Specify an automatic-restart-after-power-outage feature that is field selectable.
   f. Comply with IEEE 519-2022 “IEEE Standard for Harmonic Control in Electric Power Systems”
      1) To reduce noise, specify a notch depth of 5 percent or less and voltage distortion of 3 percent or less on the line side of the drive.
      2) Design to reduce objectionable noise from either the controller or the motor.
   g. Where disconnect or transfer switches are used, specify an interlock switch is installed to shut down the controller before the main switch poles open.
   h. Consider specifying a manufacturer only if it has an established authorized distributor and service facility within Iowa.
   i. Acceptable manufacturers are as follows.
      1) ABB
      2) Danfoss NA
      3) Eaton Corp
      4) Rockwell Automation Allen Bradley
      5) Siemens Corp
      6) Schneider Electric Square D
      7) Approved equivalent
   j. Specify keypad programming types with digital readout.
   k. Consider installation requirement to prevent stacking VFDs at installation, need to confirm with manufacturer installations.

l. Separate 8x8x6 junction box to be installed on the load side of VFD for controls.

2. Output Requirements:
   a. Generally specify 460 or 208 VAC motors for all new and most existing applications.
3. Specify the following performance requirements.
   a. Capable of 110 percent rated current for 1 minute
   b. Working frequency range = 6 to 60 Hz
   c. Speed regulation = +/- 1/2 percent of maximum
   d. Adjustable linear acceleration & deceleration, with a range of approximately 1 to 60 seconds
   e. Accept 4 to 20 milliamp (isolated and ungrounded) speed input signal
   f. Accept Start/Stop momentary contact or maintained contact 120 VAC devices
   g. Separate, form "C" contacts, rated 1 Amp @ 120 VAC, to indicate "inverter fault" & "drive run"
   h. Input power factor of at least 0.95 throughout the speed & load range
   i. Displacement power factor of not less than 0.95 lagging at all loads and speeds
4. Protection Requirements
   a. Specify to endure the following faults without permanent damage.
      1) Short circuit and/or ground fault at output terminals
      2) Input over-voltage, under-voltage, phase loss, or phase reversal
      3) Energized into a coasting motor
      4) Internal cooling fan failure
   b. Specify faults individually and visually indicated, with reset required before restart.

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

### A. PHOTOVOLTAIC COLLECTORS, WIND TURBINES, FUEL CELLS AND MICROTURBINES

1. Approval by the Owner's Representative is required for the use of equipment at any location.
2. Specify equipment to use a utility-interactive inverter or similar equipment that will automatically disconnect the local electric power production equipment from the utility upon loss of the utility source.
3. Specify a fully labeled disconnecting means to isolate and lock out the local electric power production equipment at the connection point to the utility source.
4. Specify the connection point on the load side of the utility electrical meter.
5. Specify to meet requirements of NEC Article 705, currently adopted edition.

## 26 32 00 PACKAGE GENERATOR ASSEMBLIES

### A. ENGINE DRIVEN GENERATOR SETS

1. Generator requirements for projects require approval by the Owner's Representative.
2. Coordinate generator fuel type with Owner's Representative
3. Location
   a. The preferred location is outdoors on grade, provided with a weather-proof, sound-attenuated enclosure.
   b. Alternate locations are within a building on the basement or ground floor.
   c. Rooftop or below grade areaway locations require pre-approval by the Owner's Representative.
4. Specify equipment with the following options
   a. Integral fuel tank with capacity to operate for at least 12 hours under full load conditions.
   b. Non-resettable hour meter.

5. Specify equipment meeting current EPA emission standards.
    a. A copy of the EPA engine certificate must be submitted to the Owner if available from the manufacturer, Certificate number is not acceptable. Over 400 required, under 400, if available from the manufacturer.
6. Engines greater than or equal to 400 bhp require a Title V Air Construction Permit before any related construction begins. Engines less than 400 bhp must be registered through IDNR. Coordinate requirements with Owner's Environmental Health and Safety stakeholders.
7. For new units, at minimum, specify the Constructor must provide the following to the Owner before proceeding with any construction related to the installation of the unit:
    a. Engine manufacturer
    b. Date of construction
    c. If the engine has been modified or reconstructed, provide the modification date
    d. Fuel type
    e. Engine Model
    f. Model year
    g. Brake horsepower
    h. Location on campus
    i. Specification sheet to attach to the registration form.
8. Testing:
    a. Specify load bank test for onsite commissioning as follows: 2-hour load bank at 50% load, and 4-hour load bank at 100% load.
    b. Engines with greater than 500 bhp must conduct an initial performance test or other initial compliance demonstration per EPA RICE requirements within 180 days of construction. Notify EH&S to receive the proper inspection form for the engine type.
9. Generator Alarms
    a. Specify that a standard list of generator alarms is submitted for use by the Owner.
    b. Specify alarm points are parallel wired to provide the following alarms/status to the Building Automation System:
        1) Generator Run Status
        2) Generator Trouble/Fault Alarm
10. Acceptable manufacturers are as follows.
    a. Caterpillar
    b. Cummins Power Generation
    c. Generac
    d. Kohler Co.
    e. MTU Onsite Energy
    f. Waukesha
    g. Approved equivalent

## 26 36 00 TRANSFER SWITCHES

### A. AUTOMATIC TRANSFER SWITCHES

1. Specify open transition type or as special conditions dictate otherwise. Do not specify programmed transition type switch that includes center OFF position.
2. Specify the capability to test the generator with or without load transfer.
3. Specify current transformers on load cables with digital indication on the front of the transfer switch.

4. Specify transfer switches serve emergency, legally required standby, and optional standby loads as required for the application per sections B, C, and D below.
5. Specify a timing sequence for transfer switch programming when multiple switches are required.
6. Specify all phases and neutrals switched (4-pole transfer switch). 4-pole transfer switches with overlapping switched neutral are prohibited.
7. Transfer Switch Alarms
    a. Specify that a standard list of transfer switch alarms is submitted for use by the Owner.
    b. Specify that only alarm points indicating “Transfer Switch in Emergency Position” are wired to the Building Automation System for each transfer switch.
8. Acceptable manufacturers are as follows.
    a. ASCO Power Technologies
    b. Caterpillar
    c. Cummins Power Generation
    d. Generac
    e. Kohler Co.
    f. Approved equivalent

## B. EMERGENCY SYSTEMS (NEC ARTICLE 700)

1. Emergency system loads for the building may include the following subject to approval by the Owner’s Representative.
    a. Illumination and exit signage for safe egress from the building.
    b. Fire Safety system (includes fire alarm and fire pumps).
    c. Cab lighting only in all elevators.
    d. Building Energy Management systems
        1) Include all master and sub-panels.
    e. Access Control systems
    f. Telecommunication system equipment rooms (MDF and IDF).
2. Design temporary generator connection equipment required per NEC 700.3 (F).
    a. Trystar GDS Dual Purpose Docking Station model (size as required for the project)
    b. Pre-approved equal must obtain written approval from the Owner’s Representative before specifying.

## C. LEGALLY REQUIRED STANDBY SYSTEMS (NEC ARTICLE 701)

1. Legally required systems for the building may include the following, subject to approval by the Owner’s Representative. These are systems required to maintain power to avoid the building becoming hazardous during evacuations and firefighting operations.
    a. Elevators
        1) Passenger elevators only if located in buildings described as follows.
            a) Buildings greater than three floors above grade, not including penthouses.
            b) Buildings containing sleeping facilities.
        2) Freight elevators require pre-approval by the Owner’s Representative.
    b. Storm and sewage sump pumps
    c. Smoke exhaust systems
    d. Other systems as needed per the project program.

### D. OPTIONAL STANDBY SYSTEMS (NEC ARTICLE 702)

1. Optional standby systems for the building may include the following, subject to approval by the Owner's Representative.
    a. Research laboratory equipment.
    b. Animal research associated area.
    c. Building HVAC systems.
    d. Data processing/computer equipment areas.
    e. Other systems as needed per the project program.

## 26 40 00 ELECTRICAL PROTECTION

### A. FACILITY LIGHTNING PROTECTION

1. Specify compliance with NFPA 780 for all new buildings and major renovations/additions.
2. Where approved by the Owner's Representative to prevent accidental impalement, specify a lightning rod product without a sharp point or an equivalent product approved by the Owner's Representative.
    a. Example: Flathead™ Safety Air Terminal by National Lightning Protection
3. Confirm the responsible lightning protection design provider with the Owner's Representative. (Delegated to Constructor and sub-contractor or by Professional Consultant)

### B. SENSITIVE ELECTRONIC EQUIPMENT

1. Purpose
    a. Sensitive electronic equipment requires special considerations to avoid power and operational problems.
2. Guidelines
    a. Coordinate and identify circuits with sensitive electronic equipment loads with the Owner's Representative and identify circuits in the contract documents (panel schedule, etc.)
    b. Harmonics
        1) Newer electronic or computer-based equipment uses technology that may produce a high harmonic current content and lead to power system problems.
        2) Specify individual neutrals for each single-phase circuit and consider specifying over-sized three-phase neutral.
            a) Design the neutral-to-ground voltage drop at the lowest possible level.
        3) K-Rated Dry Type Transformers
            a) Specify copper winding and comply with US Department of Energy Candidate Standard Level (CSL-3) or NEMA Premium performances for 15 to 500 kVA sizes.
            b) Discuss specifying K-rated transformers with the Owner's Representative.
        4) Where isolation transformers are used, specify the shielded type.
    c. Grounding
        1) Specify an insulated green wire included with all feeders and branch circuits.
        2) Specify bonding jumpers between receptacles and raceway.
        3) Specifying isolated ground circuits/receptacles is not generally necessary; discuss with the Owner's Representative if requested by the users.
        4) Specify the grounding and voltage drop of each sensitive electronic equipment receptacle in the final inspection using a "Sure Test" branch circuit analyzer or equivalent.
            a) Report required to be submitted by the Constructor when complete.
    d. Surge Protective Device (SPD)
        1) Specify SPD receptacles on sensitive circuits.

2) Consider specifying an additional upstream SPD.

e. Power conditioning

1) Specifying power conditioners, voltage regulators, and UPS units are not generally required; discuss with the Owner's Representative if requested by the users.

## 26 50 00 LIGHTING

### A. GENERAL

1. Comply with light levels recommended in the IESNA Lighting Handbook, 9th edition, using less power for lighting than allowed by the International Energy Conservation Code (IECC) and ASHRAE 90.1, currently adopted by the State Building Code.
2. Include lighting energy reduction goals in the Electrical Systems Narrative submitted to the Owner for review.
3. Locate fixtures to be easily accessible for maintenance and replacement by the Owner.
4. For lighting control requirements, see Section 26 09 00 B Lighting Control Devices.

### B. INTERIOR LIGHTING

1. Consult with the Owner's Representative early in the design phase of the project for the type of lighting to be specified. LED lighting is the preferred type to be installed on campus based on the scope, application, and cost.
2. Specify LED light fixtures to be:
   a. Correlated Color Temperature (CCT) of 4,000 degrees Kelvin and a Color Rendering Index (CRI) of 80 or higher. Confirm use of CRI of 90 or higher with the Owner's Representative to meet the project program requirements.
   b. IESNA LM-79-08 tested using absolute photometry criteria.
   c. Rated at greater than or equal to 70% lumen maintenance at 50,000 hours of operation.
   d. RoHS compliant and mercury free.
   e. Indoor LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.
3. Specify interior LED light fixtures for the following applications:
   a. Recessed 2x2 or 2x4 in corridors, offices, meeting rooms, and open office areas.
   b. Pendant mounted fixtures where higher ceilings allow for pendant lighting.
   c. Recessed downlights.
4. LED drivers:
   a. Power Factor rating greater than or equal to 0.90.
   b. Certified to be UL Class 2 for dry to damp locations.
   c. Input voltage 120-277VAC.
5. Fluorescent Light Fixtures
   1) Not permitted.
6. Lamps
   a. Do not specify CFL, incandescent or High Intensity Discharge (HID) lamps.
   b. For most general lighting, specify with a Correlated Color Temperature (CCT) of 4000K degrees Kelvin and with a Color Rendering Index (CRI) of 85 or higher, 90,000-hour minimum life.
      1) Special lamps may be specified for spaces requiring higher lumen output.
   c. Only specify lamps on the current list of Owner-stocked lamps, which is available by request from the Owner's Representative.
      1) Do not specify non-stocked lamps unless approved by the Owner's Representative.

d. In the project fixture schedule, indicate each fixture's required lamp type and quantity.

e. Specify lamps furnished and installed by the Constructor.

7. Space Requirements

a. See FDM Part 1 Section 03 Space and Site Design under Subsections 03.03 through 03.10.

8. Lighting Control

a. See Section 26 09 00 B Light Control Devices.

## C. EMERGENCY/EXIT SIGN LIGHTING

1. Where an emergency generator power source is available, specify un-switched (24-hour) emergency lighting only for building entrances, corridors, and stairwells.
2. Where no emergency generator power source is available, specify emergency lighting fixtures and exit signs powered from the unswitched portion of the lighting circuit feeding the area served and furnished with individual battery pack units.

a. Specify self-diagnostic units capable of performing a 90-minute test locally, with an indicator light and test button to be visible and easily accessible to maintenance personnel.

3. Specify switched emergency lighting to have a relay to override the switch position upon loss of power.
4. Locate exterior emergency lighting fixtures building-mounted above door height along the exterior path of egress.

a. Maintain a minimum illuminance of 1.0 footcandles at ground level to a safe distance from the building.

5. Specify exit signs with white aluminum housing and red letters illuminated by light-emitting diodes (LEDs).

a. Match the lettering color of existing when performing work in an existing facility.

6. Specify self-powered (battery type) exit signs with the following properties.

a. Integral automatic high/low trickle charger in a self-contained power pack

b. Sealed, maintenance-free nickel-cadmium battery.

7. Do not specify self-powered luminous type exit signs that contain a radioactive source.
8. Specify emergency lighting units with the following features.

a. Self-contained type with integral self-diagnostics

b. In compliance with UL 924

c. Fully automatic solid-state charger with a minimum of two charging rates and a sealed transfer relay

9. Acceptable manufacturers are as follows.

a. Dual-Lite

b. Lithonia

c. Approved equivalent

## D. EXTERIOR LIGHTING

1. General

a. Perform photometric calculations and layouts based on standard Owner fixtures and pole heights.

1) For details of standard fixtures and poles, see FDM Part 2/Support of Div. 33/Utility Electrical Details.

2) See Section 26 50 00 D.2. Typical Area Requirements for fixture types and mounting heights.

3) Submit photometric calculations to the Owner’s Representative for review during the Design Development phase.

b. Show applicable ISU standard lighting details on the Drawings.

c. Specify the Contractor furnish and install poles, light fixtures, pole foundations, conduit, photocells, lamps, and wire per the Owner’s light pole details.

d. Specify wiring installed in the raceway both above grade and below grade.

e. Specify the fixture supply voltage to be either 208 volts or 277 volts.

f. Do not illuminate building exterior surfaces.

g. Do not illuminate exterior artwork unless approved by the Owner's Representative.

h. For spaces other than those listed in Section 26 50 00 D.2., specify luminance requirements on the latest IESNA recommendations.

2. Typical Area Requirements

a. Parking Lot Lighting

1) Specify pole-mounted fixtures as follows.

a) LED light fixture with IES Type II distribution

(1) Kim Entablature Model 1A-ETA2-54L-750-4K7-2-SQ-UNV-DBS-7PR

(2) No exceptions. Fixture IES file is available from the manufacturer.

b) Fixture(s) mounted on a 30-foot steel pole with a precast foundation extending 30 inches above grade.

(1) Kim Lighting pole Model SSS-K-30-50-B-1-K1-DBS (single fixture)

(2) Kim Lighting pole Model SSS-K-30-50-B-2-K1-DBS (double fixture)

c) No more than 2 fixtures per pole mounted 180 degrees apart.

d) Maintained Luminance Levels

(1) Minimum 0.8-foot candles on a horizontal surface at grade

(2) Minimum 0.4-foot candles on a vertical surface 5 feet above grade

(3) Average-to-minimum uniformity ratio not to exceed 4:1 at grade.

b. Roadway Lighting

1) Specify pole-mounted fixtures as follows.

a) LED cobra head with IES Type II distribution

(1) Cooper Lighting, Lumark part number LDRC-T2-E04-E-PER (120-277V)

(2) Cooper Lighting, Lumark part number LDRC-T2-E04-480-PER (480V, 1-phase)

(3) No exceptions. Coordinate voltage required with Owner's Representative.

b) Fixture(s) mounted on 30-foot pole-and-arm with 17-inch breakaway base.

(1) Valmont pole Model DS70-R800A270-8S-FP-DB-LAB (with 8-foot arm)

(2) Valmont pole Model DS70-R800A270-15S-FP-DB-LAB (with 15-foot arm)

(3) Valmont breakaway base Model TB1-17/M093-DB

(4) Discuss the light pole arm length required with Owner's Representative.

c) Maintained Luminance Levels

(1) Minimum 0.5-foot candles on a horizontal surface at grade

(2) Average-to-minimum uniformity ratio not to exceed 3:1 at grade

c. Walkway Lighting

1) Specify pole-mounted fixtures as follows.

a) LED light fixture with IES Type II distribution

(1) Kim Entablature Model 1A-ETA-54L-560-4K7-2-SQ-UNV-DBS-7 PR

(2) No exceptions. Fixture IES file is available from the manufacturer.

b) Fixture(s) mounted on 14-foot aluminum pole.

(1) Kim Lighting pole Model PSA14-4125-ET-A-DBS-BC-PC-ABT

c) No more than 2 fixtures per pole mounted 180 degrees apart

d) Maintained Luminance Levels

(1) Minimum 0.3-foot candles on a horizontal surface at grade

(2) Minimum 0.6-foot candles on a vertical surface 6 feet above grade

(3) Average-to-minimum uniformity ratio not to exceed 4:1 at grade

d. Wall Mounted Lighting

1) Specify wall-mounted fixtures as follows.

a) LED light fixture with IESNA full cutoff classification with no up-light component

(1) KIM LED Wall Director or approved equivalent

**END OF DIVISION 26 ELECTRICAL**