

# Electrical System Standards & Design Guidelines

Wisconsin Department of Administration  
Division of Facilities Development (DFD)

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### **I. Introduction**

This manual establishes standards and guidelines for the electrical design, construction and renovation of State of Wisconsin facilities. These standards and guidelines were developed from past Division of Facilities Development (DFD) and agency experience with the operation and maintenance of State electrical systems.

Consultants and agency personnel should routinely review these guidelines and the DFD master specifications as they apply to each particular project. The requirements of these guidelines may exceed

1 what is required by code, but in no case do these guidelines intend to allow designs not conforming to  
2 existing codes. It must be understood that there are many situations requiring special design and  
3 application which will not be covered in these guidelines. When a specific design or equipment criterion is  
4 in question, it is the responsibility of the consultant or agency personnel to discuss the issues with DFD  
5 before incorporating them into the contract documents or construction. Deviations from these electrical  
6 guidelines are not permitted without approval from DFD.

7  
8 These guidelines will remain under continuous scrutiny and change. Changes will result from the overall  
9 advancement of technology and practices in the electrical industry, from further experience in State  
10 facilities, and from the comments of consultants, contractors, and agency personnel.

11  
12 It should be noted that State agencies might maintain their own site-specific electrical guidelines. The  
13 electrical consultant shall check with the State agency to determine if any such guidelines exist that would  
14 apply to their scope of work. Agency guidelines shall supplement these DFD guidelines and the DFD  
15 master specifications. Conflicts between the guidelines shall be discussed with DFD and the agency to  
16 achieve resolution.

## 17 18 **II. General Design Standards & Guidelines**

### 19 20 **1. Electrical Service - General**

- 21 • Most of the larger existing State facilities have normal power distributed by an existing  
22 State-owned medium voltage distribution system. Power for emergency and standby  
23 systems is typically provided from generators installed within each building, or from a  
24 centrally-located generator serving numerous buildings. Electrical service for new  
25 buildings at these sites shall be extended from the existing State-owned distribution  
26 systems. The existing site distribution will dictate the design of a new building's normal  
27 and emergency power distribution systems. It is the responsibility of the system designer  
28 to verify existing system capacity when adding new building loads to an existing State-  
29 owned distribution system.
- 30 • For new facilities with multiple buildings (for example, a new prison complex), the  
31 electrical service shall typically be received from the local utility at a single location.  
32 Electrical service to buildings at the facility shall be extended on a customer-owned  
33 distribution system. The use of either a medium voltage or a 480V distribution system  
34 shall be considered. The distribution system design choice shall be based on the facility's  
35 layout, loads, etc. Power for emergency and standby systems shall be provided from a  
36 centrally-located generator serving multiple buildings, campus style, or from separate  
37 generators installed at each building intended to serve only one building. Life-cycle  
38 costing analysis shall be performed to back up distribution system design choices.
- 39 • For new stand-alone buildings (for example, a new DMV service center, DNR building,  
40 etc.), a secondary service from the local utility company shall be obtained or a feeder  
41 from another building (Remote building per NEC), a fusible, service rated disconnect  
42 shall be provided ahead of the panelboard. No panelboard with main circuit breaker shall  
43 be allowed.
- 44 • The electrical distribution system shall meet the requirements of the Wisconsin  
45 Department of Safety and Professional Services (SPS) Wisconsin Commercial Building  
46 Code SPS 360-366 and the Wisconsin Department of Safety and Professional Services  
47 Electrical Code – SPS 316.
- 48 • Pay particular attention to the requirements of providing emergency power. Emergency  
49 power to emergency devices shall be provided from the emergency power source as an  
50 unbroken distribution system separate from the normal distribution system. Multiple  
51 automatic transfer switches shall be utilized when serving emergency, legally required  
52 standby, and optional standby loads from an emergency generator. Transfer switches and  
53 distribution equipment associated with Emergency system shall be located in separate  
54 room from Normal power systems equipment and in separate room from engine  
55 generator.

- 1 • **When calculating the electrical service and feeder sizes for buildings, pay particular**
- 2 **attention to the Wisconsin Electrical Code – SPS 316. This code allows for the use**
- 3 **of diversity factors or historical data when computing service or feeder sizes. DFD**
- 4 **desires that this code allowance be used in service and feeder calculations. Review**
- 5 **these calculations with DFD.**
- 6 • The majority of system voltages presently used within buildings include 208/120 Wye,
- 7 and 480/277 Wye. For large motor loads and large lighting loads, 480/277 volt systems
- 8 shall typically be used.
- 9 • Switchboard distribution shall be utilized for electrical systems sized greater than 800A.
- 10 Power distribution panelboards (I- Line type) shall be utilized for electrical panels sized
- 11 800A and below. Consult with DFD Electrical staff for applications utilizing 1200A
- 12 bussing in remodel/ retrofit applications only.
- 13 • Power distribution panelboards shall be wall mounted minimum 12” above finished floor
- 14 or equipment pad.
- 15 • When ground fault protection is required on the main breaker, fully adjustable LSIG
- 16 circuit breakers with electronic trip units shall be provided for feeder circuit breaker
- 17 frame sizes 400A and greater. This second level of ground fault protection will improve
- 18 the ability to coordinate the feeder breakers with the main breaker. The consultant shall
- 19 identify all electronic trip circuit breakers on the one-line diagram.
- 20 • Set points for the distribution system’s overcurrent and ground fault trip adjustments on
- 21 feeders (long time, short time, instantaneous and ground fault-LSIG), shall be determined
- 22 by the Short Circuit Coordination Study as required by Specification Section 26 05 73.
- 23 The system shall be designed as a fully-rated system. Series-rated designs and
- 24 calculations shall not be allowed. The system designer shall approve the set point
- 25 recommendations and shall verify that the devices have been properly set.
- 26 • The consultant shall work with the architect to ensure that adequate accessible indoor
- 27 space is identified for distribution equipment that is to be installed indoors. Doors serving
- 28 electrical and generator rooms shall swing out into the direction of egress. This shall
- 29 include spaces with equipment ratings smaller than 1200A.
- 30 • For new or remodeled buildings, provide an electrical meter that measures volts, amps,
- 31 power, demand, energy, power factor, and frequency. Meter shall be provided with
- 32 remote monitoring capability to match existing or specified building automation in
- 33 building.
- 34 • Power and signal systems shall be provided between buildings as separate manhole and
- 35 ductbank systems. Spare conduits for each system shall be provided. The consultant
- 36 shall inquire about the long-range plans for the site, and shall size the ductbanks from the
- 37 distribution point accordingly.
- 38 • The program statement for new facility or building projects shall be reviewed and may
- 39 specify additional distribution system requirements, such as providing redundant
- 40 generators or emergency feeders, sizing generators to back up larger proportions of
- 41 buildings, providing equipment to parallel generators with the utility, or providing
- 42 closed-transition switching. Consult with DFD.

## 43 2. Medium Voltage Distribution Systems

- 44 • New medium voltage distribution systems shall typically utilize a looped-primary circuit
- 45 served from a single source, with switching installed to provide a means of isolating a
- 46 failed cable section while providing power to all loads in the loop. All medium voltage
- 47 circuits shall be routed in a “daisy chain” manner from the head-end substation
- 48 switchgear to multiple buildings, and back to the substation switchgear. The head-end
- 49 substation switchgear shall typically utilize draw-out type vacuum breakers. Looped-
- 50 primary equipment at each building shall typically consist of non-fused loop switch
- 51 cubicles, fused transformer primary disconnect switches, dry-type or liquid-filled
- 52 transformers, secondary meters, and secondary distribution enclosures, all installed
- 53 indoors in a dedicated electrical room. Consult with DFD for alternate options such as
- 54 locating equipment outdoors.
- 55

- 1 • Looped-primary switches at the buildings shall be free standing load break air interrupter  
2 switchgear. Where possible, the design shall provide for nine feet working clearance in  
3 front of the closed switch door. As a minimum, code clearances shall be maintained.
- 4 • New medium voltage electric rooms shall be isolated, lockable areas with ventilation and  
5 adequate openings for installation and removal of equipment. Route of travel for moving  
6 equipment through the building from electric room to exterior shall be provided. No  
7 mechanical piping unrelated to the electrical equipment shall be permitted in room. Fire  
8 sprinklers are generally not required in electrical rooms when only dry-type electrical  
9 equipment is used (NFPA 13, article 8.15.10.3). Proper working space and fire ratings to  
10 meet code requirements shall be part of the design.
- 11 • All medium voltage rooms shall contain a ground bus installed completely around the  
12 perimeter of the room. Consultant shall provide a detail of this ground bus on the  
13 drawings.
- 14 • EPR insulated shielded cable (133% insulation level), type MV-105, shall be used for all  
15 above and underground medium voltage applications and shall be contained in conduit.  
16 Provide a full-size 600-volt insulated copper ground conductor in all conduits and  
17 raceways with medium voltage cable.
- 18 • Outdoor medium voltage pad-mounted switchgear and transformers shall be utilized only  
19 when approved by DFD and at facilities where locating medium voltage equipment  
20 indoors is not practical. Outdoor pad-mount air interrupter switchgear shall be equipped  
21 with four, 3-pole group operated, 600A rated switches (two loop switches and two tap  
22 switches). The two loop switches shall be equipped with key interlocks capable of  
23 preventing the paralleling of the source interrupter switches. The key interlocks shall be  
24 used in the operation of the distribution system to require that one switch is open in a  
25 typical two source distribution loop. The interlock keying must match and be fully  
26 interchangeable with the existing key interlock scheme on the existing distribution loop.  
27 Outdoor pad-mounted transformers shall be liquid-filled type utilizing less-flammable  
28 fluid.
- 29 • Specialized field testing of medium voltage cabling and equipment will be performed by  
30 an independent testing consultant, hired by DFD.

### 31 **3. Utility Coordination**

- 32 • The consultant shall coordinate service entrance arrangements with the serving utility and  
33 shall note the utility requirements on the project drawings. This shall include utility  
34 furnished available Fault Current information.
- 35 • Drawings shall specify if utility costs are to be included in the bid or if they are covered  
36 under separate contract. The State prefers to pay for utility extensions under separate  
37 contract with the utility. The consultant shall coordinate extension with utility, obtain  
38 extension cost from utility, and notify the DFD project manager of cost.
- 39 • Consultant shall coordinate with Division 1 and utility or agency staff for requirements of  
40 temporary construction power. If provided by utility, identify responsible costs and  
41 voltage/amp requirements. If provided from existing facility or campus, identify source  
42 and voltage/amp requirements along with source location.
- 43 • Consultant shall take into account any utility or municipal easements on State property  
44 and State easements on municipal property. Consultant shall confer with utility or  
45 municipality to determine the conditions for new and/or existing utility routing and/or  
46 rerouting on municipal property. Confer with agency when new easements are requested  
47 on State property.

### 48 **4. Site Work**

- 49 • Electrical consultant shall coordinate the excavation work required for Division 26 work  
50 with the site plan and other architectural work. All excavation and backfill work to  
51 accomplish electrical systems installation shall be performed in accordance with DFD  
52 Division 31 – Earthwork. Make sure this specification section, or its requirements, are  
53 included in the project specifications.

- Consultant shall identify known underground utilities on the electrical project drawings for areas where excavation for electrical installations will be taking place. Consultant shall be aware of major underground utilities such as steam tunnels, which will affect underground electrical installations, and design accordingly.
- For projects at existing facilities, consultant shall coordinate with DFD and the agency to have agency-owned utilities located. The agency is responsible for locating utilities that they own.

#### 5. Coordination with Other Divisions

- Coordinate all electrical systems with the architectural and mechanical prints. Take care to consider the electrical services to HVAC and plumbing equipment, as well as special architectural equipment. If electrical work is shown on the architectural or mechanical drawings, make note of that on the electrical drawings.
- Make sure the division-of-work (between electrical and mechanical contractors) is properly and clearly coordinated for mechanical equipment. This often comes up with Division 23 equipment that involves control wiring. Control wiring for Division 23 equipment should typically be done by the Division 23 contractor, with the electrical contractor providing the power circuits to the equipment and control panels. This coordinated division-of-work shall be reflected in the drawings and specifications.
- The architectural and electrical design shall be integrated so as to provide adequate space to install and maintain all equipment. No electrical equipment subject to failure shall be installed in any location that would require excavation or building modification in order to replace such equipment.
- Check the ceiling design for electrical and telecommunication rooms. Pan and beam ceilings should be avoided. If architectural drawings indicate this, let architect know that DFD prefers flat ceilings for these rooms.
- Show all smoke partitions and fire-rated walls (and their hourly ratings) on the electrical drawings, or provide a note to refer to the architectural drawings for their identification.
- Show all paths of egress routes on the electrical drawings from architectural code sheet, for egress illumination calculation and submittal requirements.
- Coordinate with architectural code sheet for location of path of egress exit signs.
- Sleeves and Openings – Sleeves and openings for electrical items shall be coordinated with the other consultants to determine the location, clearances from other trades, structural concerns, etc. These concerns shall be addressed during the design phase.
- Access Panels and Doors – The consultant shall ensure that electrical equipment is not installed in inaccessible or concealed locations. Make sure that adequate access panels and doors are provided in plaster walls. The electrical consultant shall coordinate these access requirements with the architect, ensuring that locations of access panels and doors are specified in the appropriate architectural drawings.
- Ventilation and Cooling – Adequate ventilation or cooling shall be provided for electrical rooms and equipment. As a minimum, ducted fresh air should be provided for electrical rooms with transformers. Ventilation and cooling requirements shall be coordinated with the architect and mechanical engineer.
- Electrical rooms serving emergency and standby distribution equipment separate from normal power transformers and switchgear shall be ventilated directly to and from the exterior when building design includes a smoke control system.
- Consultant shall review the architectural drawings to identify ADA required Areas of Rescue Assistance. Provide required two-way voice communication system and illuminated signage. The two-way communication system shall include both audible and visible signals.

#### 6. Continuity of Services and Systems

- Electrical outages shall be scheduled when the interruption causes the least interference with normal institutional schedules and business routines. The consultant is expected to discuss the interruption of any service with the user agency and/or occupants of the

1 building, prior to the final drawings/specification review, to determine how the electrical  
2 changes can best be made. If work is required on weekends, nights, holidays, or during  
3 certain weekly periods, this shall be indicated in the specifications and/or on the  
4 drawings.

- 5 • When power needs to be shut down in an area to allow for project work, consideration  
6 should be given for a temporary generator to be supplied to power essential loads. If  
7 required, indicate on the drawings and in the specifications.

## 8 9 **7. Conduit and Raceways**

- 10 • It is expected that all wiring will be installed in metallic or non-metallic raceway systems,  
11 except for low voltage control or signal cables routed above accessible ceilings. See  
12 Wire and Cable section.
- 13 • Conduit shall be run concealed, unless in mechanical rooms or in remodeling projects  
14 involving existing wall construction that does not allow for recessed conduit and boxes.  
15 Consultant shall note on the drawings any locations where conduit shall be run exposed.  
16 All surface (channel-type) raceway locations shall be identified on the drawings.
- 17 • Routing paths for large or difficult conduit runs shall be verified. Consultant shall put  
18 notes on the drawings identifying any conduit routing requirements or complications that  
19 the contractor shall be aware of. Such requirements include specific rooms/areas where  
20 conduit risers can be run, ceiling areas where conduit cannot be run, etc. These notes are  
21 to provide guidelines to the contractor for determining conduit routings. Actual conduit  
22 routing shall not be shown on the drawings.
- 23 • Conduits shall be independently supported. Do not support conduits from ductwork.  
24 Vertical feeder conduits and bus duct shall be independently supported at each floor  
25 level.
- 26 • Exterior conduits penetrating buildings via above grade penetration shall incorporate  
27 expansion joint per NEC 330.5 (J). Utilize DFD detail.

## 28 29 **8. Wire and Cable**

- 30 • Generally, all wire and cable shall be new and installed in conduit. Low voltage control  
31 or signal cables may be installed without conduit above accessible ceilings if the cable  
32 meets NEC and UL listing requirements for the application. If certain low voltage or  
33 signal cabling is to be run in conduit (Correctional facilities), make sure the appropriate  
34 drawings, riser diagrams, and specification sections indicate this.
- 35 • All conductors shall be sized at a minimum, for the nameplate of the source OCPD.
- 36 • All phase, neutral and ground conductors shall be sized to prevent excessive voltage drop  
37 at rated circuit ampacity. As a minimum use 10 AWG conductors for 20 ampere, 120  
38 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt  
39 branch circuit home runs longer than 200 feet (61 m). For lengths greater than indicated,  
40 a voltage drop calculation shall be provided to properly size phase and ground  
41 conductors.
- 42 • In buildings provided with a Smoke Control System, all wiring serving the Smoke  
43 Control System (ventilation system power, detection, and control systems), regardless of  
44 voltage, shall be fully enclosed within continuous raceway. In addition, control wiring  
45 and power wiring for the Smoke Control System shall utilize a 2-hour rated cable or  
46 cable system.
- 47 • In areas where low voltage or signal cables are to be run without conduit, air return  
48 plenum locations shall be identified on the drawings.
- 49 • The use of multi-wire branch circuits with a common neutral is not permitted. Dedicated  
50 neutrals shall be provided for all single phase circuitry.
- 51 • Wiring methods under raised floors shall be specified.
- 52 • Short lengths of existing cable shall typically be replaced instead of spliced.
- 53 • Copper conductors shall be used as the basis of all design. Refer to DFD specification  
54 section 26 05 19 for use of Aluminum conductors.

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**9. Grounding and Bonding**

- Consultants shall detail the requirements of the grounding system in the drawings and specifications. References only to the NEC are not sufficient. Provide detail on drawings of grounding electrode system and grounding electrode conductor. Utilize DFD detail.
- A separate equipment grounding conductor, sized per the NEC, shall be provided within each raceway and cable tray, with each end terminated on a suitable lug, bus, enclosure, or bushing. (A cable tray listed for grounding can be used without a grounding conductor installed in the tray when used for telecommunications cabling).

**10. Wiring Devices**

- Allow no more than six duplex receptacles on a general receptacle circuit. Where a circuit is designed for shop type equipment, maintenance equipment, appliances, etc., as few as one or two receptacles per circuit might be appropriate.
- The specification of circuits for systems furniture installation is the responsibility of the electrical consultant for the project. The consultant shall verify the electrical bus arrangement and feeder whip arrangement (10-wire, 8-wire, etc.) supplied with the furniture when identifying the furniture circuiting requirements. The agency's interior designers will typically provide the layout of the system furniture, and the location of large office equipment. The following guidelines for systems furniture power circuits shall apply:
  1. For systems furniture assemblies from one to four workstations, two 20 amp circuits with separate neutrals and shared ground shall be provided, along with a dedicated 20-amp circuit with dedicated neutral and ground when the plan calls out the location for a potential printer or copier.
  2. For systems furniture assemblies with five or six workstation, three 20-amp circuits with separate neutrals and a shared ground shall be provided, along with the dedicated 20-amp circuit for printer or copier locations.
  3. For systems furniture assemblies larger than six workstations, coordination between the consultant and interior designer is required so the dividing point of the two electrical feeds is understood and properly anticipated.
  4. The use of multi-wire branch circuits, with common neutral feeding single-phase loads, is not permitted.
  5. If the use of multi-wire branch circuits with a common neutral are required by the furniture supplier, all ungrounded branch circuit conductors shall be served from a common trip circuit breaker or multi-pole disconnect switch, which will disconnect all single phase circuits together per NEC 605.6.
- University residence halls (Traditional Style) have typically standardized on circuiting of 3 circuits per 2-person dorm unit. (One circuit down each long wall and one for the microwave and mini-refrigerator, etc.). Circuits shall not be shared between units. The branch circuits shall be protected by a listed arc-fault circuit interrupter per NEC Article 210. Feed-through style arc-fault receptacles are encouraged in Traditional Style residence hall rooms, one per circuit, to protect the remaining downstream receptacles. Receptacle outlets in residence halls shall also be tamper-resistant type per NEC Article 406.
- University residence halls (Suite Style) shall be provided with individual load centers sized to serve each suite. The branch circuits shall be protected by a listed arc-fault circuit interrupter per NEC Article 210. Receptacle outlets in residence halls shall be tamper-resistant type per NEC Article 406.
- Special equipment that requires electrical connection using a cord with a cap and receptacle shall have a wiring device specified. The voltage, NEMA configuration, phase and amperage rating shall be coordinated with the equipment supplier. Specify installation heights of specific-use receptacles on drawings.

- All required GFCI, Weather Resistant (damp and wet locations), Tamper Resistant, and Hospital Grade receptacles shall be noted on the drawings. Refer to specification section 26 27 26 for specific locations.
- Healthcare listed occupancies per Wisconsin Commercial Building Code SPS 360-366 (IBC occupancy class I-2) and NEC Article 517 shall be provided with Hospital Grade devices throughout.
- All devices installed in damp or wet locations shall be Weather Resistant listed devices per NEC Article 406.
- Where electrical systems feed computers or sensitive electronic equipment, not including personal computers, the requirements for isolated ground devices shall be carefully reviewed. The supplier of the electronic equipment shall be consulted and coordination provided. Use Isolated Grounds Only When Required by equipment supplier. If used, isolated grounds are in addition to the equipment ground. Electrical consultant shall ensure that an existing panelboard has an isolated ground bus which is connected back to the applicable separately derived system or service, before specifying isolated ground conductors from the panel.
- Dwelling units shall have branch circuits protected by a listed arc-fault circuit interrupter per NEC Article 210. Receptacle outlets in dwelling units shall be tamper-resistant type per NEC Article 406.

**11. Motors and Motor Control**

- It is the responsibility of the electrical consultant to coordinate motor schedule and motor connections with architectural, mechanical, plumbing, fire protection, food service, and laundry consultants.
- In general, all electric motors will be supplied with equipment, apparatus, and/or appliances covered under Specification section 23 05 13 and 23 05 14 of the DFD Master Specifications. The electrical trade shall set and connect all specified non-integral starting equipment, install all non-integral power conduits and wiring, and shall furnish and install all non-integral connections from starting equipment to motors as required to leave the apparatus in running condition.
- Limiting the motor inrush current shall be investigated. Generally, 200 or 230 volt motors 25 HP and over; and 460 volt motors 50 HP and over need reduced voltage starting. Variable Frequency Drives (covered under specification section 23 05 14 of the DFD Master Specifications) or solid-state reduced voltage starters are typically recommended. Typically, VDF's are specified by the mechanical designer and are furnished under Div. 23 specifications. Consultant to coordinate with mechanical consultant and incorporate starter and drive information on motor schedule.
- Variable frequency drives shall be specified as stand-alone devices and shall not be incorporated into motor control centers. Unit shall be provided with integral fusible disconnect.
- Coordinate the location of VFD's with the mechanical drawings and ensure that sufficient working clearance is denoted on electrical drawings. If downstream disconnect is required, provide with Aux Contacts to de energize VFD when disconnect is opened.
- Stand-alone motor disconnects shall be within sight of motor and shown on the electrical drawings. Indicate the size and number of poles of each disconnect.
- Specify the use of a motor control center if six or more starters are needed in the same room. Consultant shall consider the motor control center's main horizontal and vertical bus amperage, and the short circuit bracing. New MCCs shall be designed and specified to contain at least 20% spare, size-one spaces.
- When necessary for the delayed loading of generators, coordinate with the mechanical engineer so that the Building Automation System (BAS) will sequence the restarting of large motors. Use ON-delay relays only when the BAS is not capable of the delayed sequence restarting of the motors.
- The electrical design shall be responsible for coordination between electrical and mechanical design team for SCCR of equipment.



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**12. Low-Voltage Transformers**

- Transformers utilized for General Purpose distribution applications shall meet the requirements of the Department of Energy (DOE) - Energy Policy and Conservation Act (EPCA), 10 CFR Part 431, Distribution Transformers Energy Conservation Standards.
- A fused disconnect or circuit breaker is required on the secondary of a transformer when the secondary conductor length is more than 25' to the panelboard.
- Transformers rated 75 KVA or less, consideration shall be given to wall/ ceiling mount. Units shall be installed 12" off wall.
- Transformers rated 112.5 KVA or above shall have minimum 12" separation from combustible material and be installed in a minimum 1 hour rated room unless meeting the exceptions of NEC 450.21.
- Transformers rated 50KVA or larger shall not be installed in hollow spaces or above accessible ceilings.
- Special consideration shall be given to locate transformers 100 KVA and above so that normal vibration would not be detected by the occupants. Also, avoid locating transformers where the magnetic fields generated could interfere with TVs and monitors.
- Coordinate structural issues and weights with structural engineer.
- Adequate ventilation/cooling shall be provided for transformers enclosed in closets. Ventilation and cooling requirements shall be coordinated with the architect and mechanical engineer utilizing equipment nameplate listing multiplied by diversity rating.

**13. Panelboards**

Branch Circuit Panelboards

- For all new or replacement panelboards, all pertinent information including the voltage, amperage, and KAIC rating shall be specified on a one-line diagram or in a schedule.
- For all new or replacement panelboards, all pertinent information including voltage, amperage, bus rating, short circuit rating, main lug only or main circuit breaker and source shall be identified in a separate panel specific panel schedule. Schedule shall identify number of circuit breaker spaces for each section and number of sections.
- Panelboards shall typically be located in dedicated electrical rooms, and rooms shall not be shared with tele/data equipment.
- Existing panelboards shall be checked for capacity before adding new equipment. If new circuit breakers will be needed in the panelboards, it shall be noted on the drawings. Indicate actual new circuit breakers needed for existing panels. It is not acceptable to indicate "add circuit breakers as needed." Include existing panelboard manufacturer, type (model number), size, and fault current rating of circuit breaker.
- Consultant shall check structural drawings to determine feeder routings to new panel locations. Check structure to be certain that new panels are not located under or over beams. Panel locations shall be revised if required.
- New branch panelboards shall contain 10% spare circuit breakers and choose the standard size manufactured panelboard.
- When new circuits are being added to existing buildings, the location of the panelboards, or distances to panelboards shall be noted on the drawings.
- Main Lug Only (MLO) panelboards may be used.
- Main circuit breakers shall be provided in new panelboards when serving as secondary overcurrent protection for 600V or less rated transformers.
- University laboratory facilities may require a panelboard for each laboratory room. Consult with DFD, Agency, and campus guidelines for panelboard requirements in laboratories.
- New branch circuit panelboards being served from utility source, shall not be provided with main circuit breakers. A fused disconnect shall be provided ahead of panelboard to serve as service disconnect.

- All new panelboards shall be provided with NFPA 70E Arc Flash labeling. Refer to specification section 26 05 73 for Short Circuit/Coordination Study and Arc Flash Hazard Study.
- **Drawings shall include completed panelboard schedules indicating load for each circuit. Each schedule shall indicate calculations for connected and demand loads. Provide system voltage, amperage, short circuit rating, circuit breaker ampacities, and main breaker/switch or main lug only. Include 10% spare circuit breakers. No single tub shall exceed 42 circuits without approval of DFD staff.**

Power Distribution Panelboards

- For all new or replacement panelboards, all pertinent information including the voltage, amperage, and KAIC rating shall be specified on a one-line diagram or in a schedule.
- For all new or replacement panelboards, all pertinent information including voltage, amperage, bus rating, short circuit rating, main lug only or main circuit breaker and source shall be identified in a separate panel specific panel schedule. Schedule shall identify number of circuit breaker spaces for each section and number of sections.
- Panelboards shall typically be located in dedicated electrical rooms, and rooms shall not be shared with tele/data equipment.
- Distribution Panelboards shall be no larger than 800A bussing. Applications requiring capacity greater than 800A shall utilize switchboards. For specialty applications, i.e. remodel/ retrofit projects, consult with DFD electrical staff.
- Existing panelboards shall be checked for capacity before adding new equipment. If new circuit breakers will be needed in the panelboards, it shall be noted on the drawings. Indicate actual new circuit breakers needed for existing panels. It is not acceptable to indicate “add circuit breakers as needed.” Include existing panelboard manufacturer, type (model number), size, and fault current rating of circuit breaker.
- Consultant shall check structural drawings to determine feeder routings to new panel locations. Check structure to be certain that new panels are not located under or over beams. Panel locations shall be revised if required.
- New panelboards shall contain 4bussed spaces equal to the largest OCPD in the panel.
- New panelboards shall be fully bussed and complete with mounting hardware for entire length of identified panelboard size.
- When new circuits are being added to existing buildings, the location of the panelboards, or distances to panelboards shall be noted on the drawings.
- Main circuit breakers shall be provided in new panelboards when serving as secondary overcurrent protection for 600V or less rated transformers.
- Main breakers shall be individually mounted. Back feed mains shall NOT be utilized.
- All new panelboards shall be provided with NFPA 70E Arc Flash labeling. Refer to specification section 26 05 73 for Short Circuit/Coordination Study and Arc Flash Hazard Study.
- **Drawings shall include completed panelboard schedules indicating load for each circuit. Each schedule shall indicate calculations for connected and demand loads. Provide system voltage, amperage, short circuit rating, circuit breaker ampacities, and main breaker/switch or main lug only. Include 20% bussed spaces.**

**14. Circuit Breakers and Fuses**

- Interrupting capacity of circuit breakers in switchgear or panelboards shall be suitable for the power system feeding them.
- When specifying circuit breakers and fuses, consider the existing electrical system as well as all the changes and additions to the system, so the proper coordination of the overcurrent protection is developed throughout the entire electrical distribution.
- When ground fault protection is required on the main breaker, fully adjustable LSIG circuit breakers with electronic trip units shall be provided for feeder circuit breaker frame sizes 400A and greater. This second level of ground fault protection will improve

1 the ability to coordinate the feeder breakers with the main breaker. The consultant shall  
2 identify all electronic trip circuit breakers on the one-line diagram.

- 3 • When electronic trip circuit breakers or molded case circuit breakers with field adjustable  
4 trip settings are installed, the set points must be addressed. Set points for the distribution  
5 system's overcurrent and ground fault trip adjustments on feeders (long time, short time,  
6 instantaneous and ground fault - LSIG), shall be determined by the Short Circuit  
7 Coordination Study as required by specification section 26 05 73. The system shall be  
8 designed as a fully rated system. Series rated designs and calculations shall not be  
9 approved. The system designer shall approve the set point recommendations and shall  
10 verify that the devices have been properly set.
- 11 • For new circuit breakers being installed in existing switchboards and panelboards,  
12 include make, model number and KAIC rating of the existing equipment.
- 13 • For remodeled areas and building additions, the use of existing spare circuit breakers  
14 shall be discussed with DFD reviewers. Typically, new circuit breakers shall be required  
15 to ensure CB reliability and operation. Relative age and manufacturer of existing  
16 equipment shall be determined prior to contact with DFD.

## 17 18 **15. Lighting**

### 19 General Design

- 20 • The lighting design shall be practical, energy-efficient, easy to maintain, and appropriate  
21 for the intended function of the space.
- 22 • In general, the lighting design shall be based on the guidelines of the Illuminating  
23 Engineering Society of North America (IES) lighting handbook (latest version). The  
24 lighting designer shall use the recommendations given in this handbook for vertical and  
25 horizontal illumination levels required in a given space. The lighting design for new and  
26 renovated buildings with windows and significant daytime occupancies shall comply with  
27 the [DFD Daylighting Standards for State Facilities](#). These daylighting standards require  
28 careful coordination between the lighting designer and the architect. DFD expects the  
29 lighting designer to bring to the architect's attention any opportunity for full compliance  
30 with these standards.
- 31 • The lighting design shall, as a minimum, meet the energy conservation requirements of  
32 the Wisconsin Department of Safety and Professional Services (SPS) Wisconsin  
33 Commercial Building Code SPS 360-366, including the Energy Conservation Code SPS  
34 363. Note: some requirements in the code will be surpassed by DFD guidelines, such as  
35 requirements in the *DFD Daylighting Standards for State Facilities*.
- 36 • Refer to the Architectural Life Safety Plans for Means of Egress illumination locations  
37 and routings.
- 38 • It is the consultant's responsibility to verify specific program or agency lighting  
39 requirements prior to design.
- 40 • Provide detailed schedule on the drawings including lighting source, lamp color  
41 temperature, mounting, poles, ballast/ driver, lamps, reflectors, housings, and colors.

### 42 43 Interior Lighting

- 44 • Lighting of interior areas shall utilize LED light sources. Incandescent, fluorescent, or  
45 HID sources shall be used only for specific isolated applications, justified by program or  
46 usage and approved by DFD staff.
- 47 • For ambient lighting design, utilize LED fixtures as much as possible. For ease of  
48 maintenance, the lighting design should utilize a minimum number of different luminaire  
49 types.
- 50 • Per the *DFD Daylighting Standards for State Facilities* guidelines, task lighting shall be  
51 an essential component of the lighting design. The lighting designer, architect, user  
52 agency, and DFD project manager shall discuss and reach a common understanding as to  
53 the task lighting that will be provided.
- 54 • For high/low bay applications such as gymnasiums, warehouses, swimming pools and  
55 shop areas, use LED fixtures. Also incorporate occupancy sensors as appropriate.

- Consultants shall not specify a lighting fixture that may be proprietary. If there are not at least three manufacturers that can meet the fixture requirement, then another fixture shall be selected. Refer to guidelines on proprietary specifications in the [DFD Policy and Procedures Manual for A/E's](#).
- Proper design provisions shall be made to ensure that adequate support for mounting of lighting fixtures is present. Add fixture mounting details to drawings, as appropriate.

#### Exterior Lighting

- Outdoor lighting shall use Light Emitting Diodes (LED). A different lighting type may be used if needed to match existing lamps. Consult with DFD staff for approval.
- Exterior circuitry serving LED fixtures shall be limited to 50% of the circuit capacity. Consultant shall take into account the factory inrush ratings and THD of each fixture.
- Exterior lighting shall typically be fed from panels in an adjacent building, and shall be controlled by a photocell, time clock, or campus-wide lighting signal system. Consult the User Agency for preference on exterior lighting control.
- Outdoor lighting system design shall utilize full cutoff type fixtures which minimize the amount of source lumens which are emitted above the horizontal plane of the fixture and which minimize the spillage onto adjacent facilities. When specifying exterior fixtures, include the required distribution type of the fixture and/or a foot-candle footprint description. Note: consultant should refer to the International Dark-Sky Association webpage at [www.darksky.org](http://www.darksky.org) for outdoor lighting fixture recommendations and outdoor lighting design recommendations.
- The conductor size for outdoor lighting circuitry shall be a minimum of #10 AWG. Voltage drop calculations shall be made available to DFD review staff. Consult with DFD staff for specialty applications and questions.

#### Lighting Controls

- Lighting controls and switching shall be kept simple, inexpensive, and easy-to-maintain.
- Architectural lighting control systems (scene lighting controls), low-voltage switching systems, digital control systems, or whole-building programmable control systems utilizing multiple control panels, shall be used only when necessary. These systems may be considered only for lighting control in lecture halls, auditoriums, and theaters, for switching of large areas, or for specific energy-saving requirements. Coordinate use with DFD staff.
- Coordinate local dimming controls for LED source fixtures and requirements for 0-100% dimming with compatible 0-10V electronic dimmers.
- Occupancy/vacancy sensors shall be used as much as practical. Occupancy/vacancy sensors shall typically be used for required automatic light shut-off instead of central time-clock control or central energy-management system control. Consider their use in all restrooms, classrooms, conference rooms, open office spaces, individual offices, and corridors.
- Daylighting/photo sensors shall be used to provide continuous dimming of lighting in daylit areas. Refer to DFD *Daylighting Standards for State Facilities* guidelines. Care shall be taken in setting up the control sequence to prevent short cycling of the controls.
- Single offices shall typically be provided with LED fixtures, with continuous dimming of fixtures. Provide vacancy sensors as appropriate. For daylit single offices, photo sensors which provide continuous dimming control shall be considered (vacancy sensor shall over-ride photo sensors).
- Consider digital timer switches for storage areas, closets, and rooms too small for occupancy/vacancy sensors. Electrical and mechanical rooms shall utilize switches with no automatic shut-off for the safety of maintenance personnel. Selective fixtures in electrical/mechanical rooms shall be fed by emergency generator circuits or shall be provided with battery backup power when generators are not applicable to project.

- For campus lecture halls and auditoriums, coordinate lighting design with the audio/visual technology requirements. Speaker/instructor area lighting, projection screen lighting, and note-taking lighting shall be considered.
- Exterior lighting controls for University campuses: Use lighting contactors for control of exterior lighting. For most University campus buildings, the lighting contactors shall be controlled by an input signal from the BAS system via a relay. The relay itself shall have a Hand-Off-Auto switch as well as the lighting contactor. Coordinate with campus staff. Multiple lighting contactors may be used if the exterior circuits originate at various panels within the building.

Egress / Emergency / Night Lighting and Maintained Safety Lighting

- Avoid using a single emergency power circuit to power all egress lighting on a floor or even within a large space. With the advent of LED lighting, it is possible to power a lot of emergency luminaires with a single circuit. If something happens to that single circuit, an entire floor or space would be left in total darkness. Provide at least two emergency power circuits to provide some redundancy so that a tripped circuit breaker does not leave an entire floor or space in total darkness.
- Open offices and open spaces with portable furniture typically do not have defined “Paths of Egress” because the furniture can move and thus the path of egress can move. In cases like this, the entire space must be lit to the code-required egress lighting level because the path of egress cannot be defined.
- Emergency lighting shall be powered by circuits from a building’s emergency (generator) system. Battery powered emergency lighting units shall be provided for egress illumination if an emergency generator system is not provided.
- In addition to path of egress, EM lighting circuitry and lighting shall be provided in Fire Command Centers, Fire Pump Rooms, Electrical Rooms, Generator Rooms and exterior enclosures, and Public Rest Rooms greater than 300 sqft.
- In addition, provide battery powered emergency lighting units in Electrical Rooms (normal and emergency), Mechanical Rooms, IT equipment rooms, Public Rest Rooms less than 300 sqft except for single rooms, Generator Rooms, Generator Enclosures or adjacent to enclosure if not accessible. This is a requirement in addition to a generator sourced EM circuit/ lighting serving these spaces.
- In addition, locate battery powered emergency lighting units in medical and correctional institutions where locations left in total darkness are unacceptable. Total darkness includes time period between electrical outage and generator start/ transfer. Coordinate with DFD staff.
- It is the intention of DFD that egress or emergency lighting be illuminated for those portions of a building that are, in fact, occupied. To prevent the illumination of egress or emergency lighting during times that an area is not occupied, DFD recommends the use of occupancy sensors to provide automatic shut-off of this lighting. This may only be utilized if an emergency lighting control unit is utilized (see below). Consult with DFD Staff for further information about accomplishing this.
- The preferred method of controlling emergency lighting is to use an emergency lighting control unit to bypass switching and turn emergency lighting ON automatically in a power outage situation. Unit shall be supplied from both normal and emergency power sources.
- Lighting shall be installed in an un-switched night-lighting mode only when necessary (such as security applications/ high rise). Consult with DFD staff for approval.
- Consider the use of UL-listed photo luminescent exit signs in special applications.
- Exterior emergency illumination utilizing LED fixtures is recommended. Fixtures shall not be required to utilize multiple drivers. Single driver fixtures are acceptable to meet NEC 700.16.
- Refer to the Architectural Life Safety Plans for Means of Egress routing path and needed illumination locations and exit sign locations.
- Means of Egress emergency illumination testing requirements shall be per IBC 1006.4.

- Submit point by point photometric calculations meeting performance requirements of IBC 1006.4 at 100% final review.
- Incorporate Point by Point calculations on separate lighting sheets to Electrical Drawings in Final Review, Bid and Construction documents. Additionally, calculations shall be recalculated utilizing project specific lighting fixtures once final shop drawings are approved.
- Night Lighting and Maintained Safety Lighting shall be defined as additional lighting not identified as part of the Architectural Life Safety egress path but deemed by design team as critical for illumination. These circuits shall be served from the legally required standby branch of the generator system.

## 16. Equipment Connections

- Consultant shall place a schedule on the plans for all equipment connections including HVAC, plumbing, and kitchen equipment connections. The schedule shall include the circuit number and panel source, conduit type and size, the wire size and quantity, starter type/size, disconnect type/size, and final connection type.
- For equipment in open areas, specify on the electrical drawings as to how the electrical connections shall be provided (i.e. served from under floor boxes or cord drops from ceiling cord reels).
- The electrical design shall be responsible for coordination between electrical, mechanical and equipment design team for SCCR of equipment with the available fault current.
- Coordinate with mechanical consultant for integral prewired lighting within walk-in HVAC air handling units. Provide electrical lighting circuit and electrical connection point.
- Hand dryers. Provide circuit breaker handle locks for required disconnect.
- Vending Machines. Provide GFCI per NEC 422.51 as an integral part of attachment plug.
- Drinking fountains and bottle fill fountains. Provide GFCI circuit breaker located in the nearest available branch circuit panelboard.

Freezer and refrigeration drain lines. Provide GFCI for dedicated circuit serving drain line wrap. Elevator Connections

- Provide a power module manufactured by Bussman or similar. Include all contacts for fire alarm interface and unit shunt trip in the power module. Do not provide shunt trip circuit breaker at upstream source.
- If the elevator shaft is sprinkled, provide fire alarm heat detectors within two feet of each sprinkler head, and the receptacle provided adjacent to the elevator motor shall be GFCI type. Installation of all devices and lighting fixtures shall be installed as a wet location.
- Lighting levels shall be a minimum of: 10 fc at the elevator with doors closed, 10 fc in the elevator pits, 19 fc in machine rooms and 1fc in hoistways. Utilize minimum of two 4-foot fixtures in each elevator pit equal to Failsafe FPS with polycarbonate lens.
- Coordinate with plumbing consultant for elevator pit sump pump power requirements. The overcurrent device for the sump pump shall be located in the control/machine room per NEC Article 620.

## 17. Emergency Systems/Generator Sets

- Typically, an engine driven generator with transfer switches shall provide backup power for the emergency systems.
- **Emergency** building loads including exit and egress lighting, fire alarm, emergency voice/alarm communication systems, and elevator car lighting shall be connected to the generator system in accordance with all applicable codes. Lighting identified in Part 15.
- **Legally Required Standby** building loads include fire pumps, smoke control systems, ventilation and automatic detection for smoke proof enclosures, and elevators including required machine room ventilation and/or air conditioning when elevators are part of egress paths required by code.
- **Optional Standby** building loads include research equipment such as incubators, fume hoods, refrigerators and freezers. Critical mechanical equipment such as heating system

1 pumps, condensate return pumps, sewage ejector pumps, sump pumps and building  
2 pneumatic control air compressors shall be connected to avoid building freeze-up or  
3 flooding. In addition, data processing/data center loads, standby receptacle loads and  
4 miscellaneous loads as requested by user groups.

- 5 • Space illumination that is desired to be generator sourced but not identified on the  
6 Architectural Life Safety plans for Means of Egress. Examples of these spaces include;  
7 large laboratories, single hole rest rooms, and mechanical spaces.
- 8 • If one generator is used to supply both emergency and non-emergency (Emergency,  
9 Legally Required Standby and Optional Standby) loads, multiple transfer switches will be  
10 required, minimum one per branch.
- 11 • For small buildings or facilities (ones with minimal emergency loads), a life cycle cost  
12 analysis (including maintenance costs) should be performed to determine if battery pack  
13 sources (emergency unit equipment), central lighting inverter system or a generator set  
14 source would be the most cost effective source for emergency systems.

#### 15 Transfer Switches

- 16 • 4-pole type transfer switches are preferred. However, transfer switches shall be 3-pole  
17 type when used on systems where the connection is a non separately derived system. The  
18 generator must be grounded as a separately derived system when 4-pole transfer switches  
19 are utilized.
- 20 • Transfer switches shall be **Open transition** type. **Closed transition** type shall be  
21 considered on Optional Standby if system is determined to serve extremely sensitive  
22 electronic equipment that cannot tolerate the monthly switching outage related to the  
23 generator maintenance testing. Consult with DFD if considering use of closed transition  
24 type. Closed transition shall also be required for NEC 517 healthcare critical care  
25 applications.
- 26 • Closed transition transfer switches have an alarm function if the two sources remain  
27 connected. If this occurs either the emergency or normal source should be shunt tripped.  
28 Coordinate with equipment supplier when closed transition transfer switches are utilized  
29 to include shunt trip accessory for the emergency or normal source overcurrent protective  
30 devices.
- 31 • Transfer switches shall not be located in the same room as the generator.

#### 32 Generator Sets

- 33 • A diesel driven generator with independent cooling system shall be used for units sized  
34 greater than 500KW/625KVA. Natural gas shall be an option for units sized  
35 500KW/625KVA or below. Propane driven generators can be utilized for units 150 KW  
36 or less at remote installation locations. Natural gas generators larger than  
37 500KW/625KVA shall be discussed with DFD electrical staff to verify justification and  
38 project cost increase. Note: Generators utilized for health care occupancies shall be  
39 diesel.
- 40 • An engine-driven generator shall be located in a room designed for the purpose. The  
41 generator sets shall be isolated from other areas as required in the code for the isolation of  
42 hazards. The generator shall be installed in a separated room from the normal electric  
43 service. Allow a minimum of 3-1/2 feet around the generator for service and to ensure  
44 free flow of cooling air.
- 45 • For generator sets installed outdoors, provide as skid frame or walk-in type enclosure  
46 (skid frame type for sizes 350KW or less). Consult with DFD staff for approval. Exterior  
47 packaged units shall have internal branch circuit panelboard or load center to serve  
48 packaged electrical loads including battery charger, engine jacket heater, tank heater,  
49 lighting, receptacle and miscellaneous loads specific installation may require. Skin frame  
50 enclosures shall utilize QO type or equal load centers and walk-in type enclosures shall  
51 utilize branch circuit panelboards. All loads served from and including panelboard or  
52 load center shall be field installed and wired.

- 1 • Provide general purpose receptacle, battery operated emergency lighting source and  
2 remote “E” stop.
- 3 • A diesel driven generator shall be provided with a minimum of **twelve (12)** hours of fuel  
4 in the fuel tank calculated at full load. Healthcare, Corrections and other select projects  
5 will require additional run times and associated fuel. Coordinate with building code  
6 requirements and DFD staff for all proposed installations.
- 7 • An adequate supply of combustion air and cooling air shall be provided for the  
8 emergency generator room. Manufacturer’s recommendations for air supply and exhaust  
9 shall be determined and facilities designed according to these recommendations. Supply  
10 air shall be taken from outdoors. If necessary, provide a heat source such as a unit heater  
11 to keep room at normal room temperature.
- 12 • Exhaust generator into an upright stack well above ground level, not into an area well or  
13 underground pit. Stack should exhaust vertically with no obstructions and clear the  
14 adjacent structure by at least 3 feet. Location of exhaust outlet shall be coordinated with  
15 mechanical consultant to minimize effect on mechanical system(s) intake associated with  
16 building and any adjacent buildings.
- 17 • Indicate on drawings or specifications which contractor furnishes and which contractor  
18 installs the miscellaneous items for a complete generator installation. The mechanical  
19 consultant shall be responsible for sizing and routing of the exhaust, venting, and fuel  
20 piping. Electrical consultant shall coordinate these with the mechanical consultant and  
21 ensure that they are on the mechanical drawings.
- 22 • The required generator enclosure load center for skid frame enclosures shall be  
23 independently mounted to concrete pad or frame on support side of unit isolation, to  
24 reduce vibration. All associated accessory circuitry to be field installed by electrical  
25 contractor.
- 26 • Provide an isolated equipment pad for the generator set in addition to unit mounted  
27 isolators to minimize vibration transfer to building. Coordinate pad depth and size with  
28 structural engineer. Include pad detail on drawings.
- 29 • When removing an existing generator or installing a new one, make sure to note any  
30 access conflicts that the contractor should be aware of such as door frames or walls that  
31 must be removed.

32  
33 Emergency Systems Distribution Equipment

- 34 • Transfer switches and distribution equipment associated with the Emergency System  
35 shall be located in a separate room from Normal power equipment and in separate room  
36 from Emergency engine generator.

37  
38 **18. EMF and Harmonics**

- 39 • Generally, electrical vaults and major electrical equipment rooms containing transformers  
40 larger than 225 kVA shall not be located adjacent to normally occupied workstations.
- 41 • In areas with large amounts of high-harmonic loads (computers, motor drives, laser  
42 printers), consider taking steps to reduce the effect of harmonics. These steps shall  
43 include using separate circuits or restricting the number of receptacles per circuit,  
44 oversizing panelboard neutral buses and feeder neutral conductors, and installing  
45 isolation transformers, k-rated transformers, harmonic filters, or other such equipment.  
46 These steps shall only be specified when necessary; otherwise unneeded expense is added  
47 to the project. Consult with DFD.

48  
49 **19. Surge Suppression**

- 50 • Medium voltage surge arresters and low voltage Surge Protective Devices (SPD’s) shall  
51 be designed into all new or remodeling projects that involve primary or secondary  
52 electrical service equipment.
- 53 • Surge arresters shall be provided on the primary side of all medium voltage transformers.  
54 Fused transformer primary feeder switches (5kV and 15kV) serving transformers do not



1 require a separate surge arrester as long as surge arresters are provided in the medium  
2 voltage transformer.

- 3 • In general, a single SPD device shall be installed on the load side of a building's main  
4 service disconnect, typically at the service entrance switchboard or main distribution  
5 panel. Second-tier SPD devices at branch panelboard locations are typically not specified  
6 for State projects. Consider the use of second-tier devices only when necessary, and after  
7 consulting with DFD. If second-tier SPD devices are to be used, they must be carefully  
8 coordinated with the upstream SPD device. Provide specifications for the second-tier  
9 devices and insert in specifications so that all SPD devices work together to achieve the  
10 desired protection. All SPD devices required in a project shall be indicated on the  
11 drawings, in a one-line diagram.
- 12 • All new surge arresters and SPD devices shall be metal oxide varistor (MOV) type or  
13 combination of MOV's with selenium cells or silicon avalanche diodes. Include  
14 replacement of existing surge arresters and SPD devices in the project design if they are  
15 not MOV type.
- 16 • SPD devices shall be parallel-connected to, and located adjacent to the switchboard or  
17 panelboard being protected. SPD devices shall be connected through a multi-pole circuit  
18 breaker (30A or manufacturer recommended size), not into main lugs. Where circuit  
19 breakers are unavailable, a fused disconnect switch should be specified to connect to the  
20 leads and facilitate servicing of the device. Use schedule 40 PVC conduit between the  
21 SPD device and the switchboard or panelboard. To connect the SPD device to the circuit  
22 breaker or disconnect switch, use #10 conductors or the manufacturer's recommended  
23 conductor size (whichever is larger).

## 24 25 **20. Security Electronics Systems**

- 26 • The following security electronics systems shall be considered, and implemented into  
27 each applicable project as required to meet project program:
  - 28 - **Security Door/Intercom Control and Monitoring with Graphic User Interfaces.**  
29 An industrial type PLC-based door control and monitoring system shall be provided.  
30 The system shall be software driven to allow changes in the control or sequencing of  
31 doors by a change in software program.
  - 32 - **Public Address / Facility-Wide Paging.** System shall be zoned with speakers  
33 located indoors and outdoors. System shall have the ability to be interfaced with the  
34 telephone system.
  - 35 - **Duress Alarms / Emergency Phones.**
  - 36 - **Access Control Systems / Biometrics Identification.**
  - 37 - **Video Surveillance Systems.**
  - 38 - **Personal Body Alarm.**
  - 39 - **Intrusion Detection** (Use of motion sensors, video motion detectors, glass-break  
40 sensors, etc.).
  - 41 - **Perimeter Detection.** Shaker-type fence system or non-lethal impulse-type power  
42 fence system shall be considered.

43  
44  
45 Note: For a particular project, some of the above systems may be purchased by the state  
46 under a separate contract. These systems shall be incorporated into the main project  
47 design, so that supporting equipment such as power provisions, conduits, pathways, and  
48 boxes can be coordinated and installed.

- 49
- 50 • State-of-the-art systems shall be specified to meet project program. Specific review of  
51 these systems will be made during design development.
- 52 • A consultant with expertise in the area of security electronics shall do the security  
53 electronics design. This consultant shall be responsible for coordination of all system  
54 requirements with the electrical consultant.

- The design of security systems shall include a riser diagram of each system to illustrate the system distribution and the interactive relationship of the components. Typical field devices and all system backbone devices shall be shown. Cabling and conduit requirements shall be indicated.
- Final security drawings shall include typical wiring diagrams for the types of electrically operated locks which are to be used in the project.
- Security systems which utilize graphic user interface screens shall have specifications written which incorporate a “Security Control Point Schedule” and “Function Description Sheets” to specify how the user interface screens/icons and the controlled security field devices will functionally operate, in order to provide the intended security.
- Statewide DOA-managed buildings and other agency buildings that receive security from the Wisconsin State Capitol Police shall have their security and access control systems connected to and compatible with the Capitol Police central alarm reporting system in the State Capitol Building. DFD and the Capitol Police shall be consulted for security system specifications and connection requirements
- Uninterruptible power shall be provided for backup of all security system head end equipment, controllers, and field devices in order to keep the security system operable. Ideally, UPSs shall receive their power from the emergency power distribution system. UPS battery supply shall provide for 15 minutes of power supply when the UPS is fed from an emergency generator and a minimum of 2-hour power supply if the UPS is not fed from an emergency generator.
- For any project involving security electronics systems installation, the consultant shall ensure that a system verification has taken place which meets the following requirements:
  1. A point-by-point checkout of the entire system shall be conducted and results tabulated and documented on a systems point checklist. Each security point and operation shall be verified as working properly. If not, action must be specified to achieve proper security point operation. Verification shall be repeated for failed security points until proper operation is achieved.
  2. System verification shall be done on a building by building interval, when buildings have been completely constructed and secured. System verification shall be included up front in the project’s construction schedule.
  3. During the verification, it is recommended to include agency personnel who will be involved in the security operation of the facility, the security electronics contractor to insure proper operation of equipment, and the detention equipment contractor to adjust and repair locks as required.
- **Security design work done on UW-Madison buildings shall coordinate with the UW-Madison technical guidelines.**
- **Note for Agency: At a building project’s programming stage, it is important to indicate the required security electronics systems, and the need for security systems verification as described above. This is especially critical for all design/build projects.**

**21. Fire Alarm Systems**

- Refer to separate DFD guideline for fire alarm systems entitled [Division of Facilities Development Fire Alarm System Guidelines](#).
- In general, all fire alarm system wiring shall be installed in conduit.

**22. Telecommunications**

General

- For cabling and equipment information, refer to separate guideline available on the DFD website under [Master Specification/Design Guidelines, Division 27 \(Communications\)](#). Pertinent documents found there include:

- Telecommunications Guidelines for Structured Building Wiring Systems
- Data, Voice, Coaxial, Fiber Cabling Policy
- Division 27 (Communications) – Specification Sections
- In the project’s programming stage, it is important to indicate the required telecommunications systems and the infrastructure requirements related to these systems. This is especially critical for all design/build projects. Note that these guidelines and referenced documents are dynamic and subject to change. Designers are strongly encouraged to confer with the DFD Engineer to confirm content.
- Division 26 work relating to telecommunications includes pathways (raceway, boxes, cable tray, etc.) and grounding infrastructure.
- Telecommunications cabling and equipment shall be located in dedicated room(s) and not share a room with panelboard(s) or other distribution equipment unless this equipment is related to the telecommunications function.
- No piping or ductwork will pass over or through a Telecommunications Equipment Room unless used to provide services to the room itself. Coordinate piping and ductwork used to provide services to these rooms with the anticipated equipment layout within the rooms.

#### Telecommunications Equipment Room Lighting

- Provide fixtures to illuminate the areas in front of and behind the row of equipment racks.
- Illumination shall be a minimum of 50 foot-candles measured 3 ft. above the finished floor, in the middle of all aisles between cabinets and racks.
- The lighting shall be controlled by an occupancy sensor switch located near the entrance door(s) to the room.
- Fixtures shall be fluorescent-type with acrylic diffuser similar to Lithonia AW-series (surface mount).
- Fixture placement and support should not impede cable pathways.

#### Telecommunications Equipment Room Power

- At the Main [Telecommunications] Equipment Room (ER) serving a building, electrical power requirements for the room are dependent upon the equipment load and should be coordinated with the Agency. For large applications, a separate panelboard may be needed to serve the room. At minimum, the room shall be equipped with a minimum of two dedicated 20 ampere, 120V duplex receptacles for equipment power.
- A typical Telecommunication Room (TR) shall be equipped with a minimum of two dedicated 20 ampere, 120V duplex receptacles for equipment power.
- Main [Telecommunications] Equipment Room and Telecommunications Room(s) shall be equipped with 20 ampere, 120V duplex receptacles spaced at 6 ft. intervals around the perimeter walls, at a height of 15 in. above the floor. A minimum of two such receptacles shall be provided. Receptacles for convenience and miscellaneous use may be on shared circuits.
- If a standby power source is available in the building, the panels serving Telecommunications Equipment Rooms should be connected to the standby supply. Note the requirement for emergency voice/alarm communication systems to be on the Emergency supply and not standby.
- Additional circuits may be required depending on equipment populating the room. Examples include circuits required for security equipment, fire alarm and other system.
- Configuration and number of receptacles for equipment power shall be coordinated with the user agency. In larger installations, placement of receptacles on equipment racks rather than on the wall should be considered to keep cord lengths short.

#### Grounding System

- The DFD standard for Grounding infrastructure for telecommunications systems is based on the ANSI/TIA Joint Standard “J-STD-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications”. This standard specifies

1 the requirements for a dedicated telecommunications grounding and bonding  
2 infrastructure. The DFD guidelines deviate from the standard in that the grounding  
3 system is to be configured with only one ground point. Key design requirements include:

- 4 • Telecommunications Main Grounding Busbar (TMGB) at the Building Entrance /  
5 Main Equipment Room. The TMGB shall be bonded to the building common  
6 grounding electrode system (electrical service entrance for building) via a minimum  
7 3/0 AWG copper conductor.
- 8 • Telecommunications Bonding Backbone (TBB) conductor(s) from the TMGB to  
9 Telecommunications Grounding Busbar (TGB) at each Telecommunications  
10 Equipment Room. The TBB size shall be 3/0 AWG. The TBB shall be continuous  
11 and not connected through Telecommunications Grounding Busbars (TGBs). The  
12 TGBs shall be bonded to the TBB via a tap-off conductor the same size as the TBB.  
13 The tap-off connection shall be irreversible type. Do not bond TBB or TGB to  
14 building steel at TGB location(s).
- 15 • Attachment of ground conductor to busbar shall utilize a listed compression two-hole  
16 lug or irreversible compression-type bus bar connector.
- 17 • For large buildings with multiple TBBs, a Grounding Equalizer (GE) shall be run  
18 between the TBBs at every third floor. Consult with DFD.

19  
20 Telecommunications Grounding Busbar (TGB)

- 21 • Tin-plated solid copper; 0.25” thick.
- 22 • Predrilled; hole diameter and spacing per ANSI J-STD-607-B.
- 23 • Incorporate insulators and stand-off brackets that electrically isolate busbar from  
24 mounting surface and allow access to the rear of the busbar.
- 25 • Busbar size (minimum) shall be as below. Length should be increased where  
26 required to meet the requirements of the project and in consideration of future  
27 growth.
  - 28 - TMGB – 4” x 12”
  - 29 - TGB – 2” x 10”

30  
31 Pathways

- 32 • Rough-in for Telecommunications Outlets shall consist of a 4-11/16” square by 2-1/8”  
33 deep box ringed to a single-gang opening. In general, one 1” EMT conduit shall extend  
34 from the box to an accessible location above a suspended ceiling (minimum). Further  
35 extending this pathway to the adjacent corridor or to a cable tray should be considered  
36 depending on the nature of the site. In correctional environments, cabling shall be in  
37 conduit along its entire length from the outlet box to the termination location. Individual  
38 pathways may be consolidated into larger conduits.
- 39 • Exceptions to the requirement for 1” conduit include locations identified for minimal  
40 cabling such as wall-mounted telephone locations, wireless access points, mechanical  
41 system diagnostics, elevator phones, etc.
- 42 • Raceways should be sized based on a maximum fill of 40% (cable area / raceway area)  
43 and include spare capacity for future cable additions. Designers responsible for pathways  
44 and for cabling shall coordinate early in the design process and confirm design  
45 assumptions with the DFD Engineer and with the Agency.
- 46 • Size and locate pull boxes for communications, security and other low-voltage  
47 applications per TIA-569-B “Commercial Building Standard for Telecommunications  
48 Pathways and Spaces”. Provide pull and junction boxes for telecommunications and  
49 other low-voltage applications as follows:
  - 50 - In any section of conduit longer than 100 feet.
  - 51 - Where there are bends totaling more than 180-degrees between pull points or pull  
52 boxes.
  - 53 - Wherever there is a reverse bend in run.

1           **23. Audiovisual Systems**

- 2           • Audiovisual (AV) systems shall be designed and specified to meet project program.  
3           These systems often have unique electrical requirements. Confer with AV system  
4           designer and DFD Engineer during design development.  
5           • State-of-the-art systems shall be designed and specified to meet project program.  
6           Specific review of these systems shall be made during design development.  
7           • Coordinate pathway design and routing to facilitate routing of cabling or fiber in conduit  
8           or cable tray.  
9           • Provide required power per manufacturer’s requirements at equipment rack locations and  
10          at remote devices to support equipment.  
11          • Provide grounding system per manufacturers requirements.  
12          • For large AV applications, provide dedicated AV panelboard(s) served from isolation  
13          transformer(s) to serve equipment racks and remote devices.  
14          • Provide isolated ground receptacles for the AV loads when isolation transformers are  
15          used.

16  
17           **III. Engineering Requirements**

18  
19           Backup data shall be furnished on request to support basic design decisions related to selection of  
20           distribution system voltage and configuration, sizing of equipment and materials, selection of  
21           economic alternatives, and performance of specific systems or equipment. Calculations may be  
22           performed by manual or computer procedures.

23  
24           For the typical project, engineering backup data shall be documented and furnished on request for  
25           the following:

- 26  
27           1. Sizing of electrical equipment including building service, transformers, feeders, engine  
28           generators, panelboards and branch circuits.

29  
30           Building service, transformer, MCCs and panelboard sizes shall be based on estimated  
31           maximum demand plus known or reasonably anticipated future loads. Estimated maximum  
32           demand calculations shall utilize appropriate NEC demand factors, diversity factors, and  
33           historical data as allowed in the Wisconsin Electrical Code. Typically, transformers shall be  
34           sized for 60-80% peak loading of the non-fan rated load.

35  
36           Feeder and branch circuit sizes shall be based on the feeder and branch circuit breaker size  
37           and voltage drop. Assume estimated maximum demands will be continuous and size circuit  
38           breakers a minimum 125 percent of estimated maximum demand.

- 39  
40           2. Voltage drop determination

41  
42           The secondary distribution system shall be examined for voltage drop from the service  
43           transformer downstream to the branch level panelboard, and on to the branch circuits.  
44           Calculations shall be sufficient to encompass the application range of the project. Secondary  
45           distribution and branch circuit system design shall be based on a maximum of 5% voltage  
46           drop from the transformer to the utilization equipment (3% for branch circuits and 2% for  
47           feeders).

- 48  
49           3. Illumination and lighting power calculations

50  
51           Data shall identify target and calculated illumination levels for all areas. Data shall also  
52           identify calculated lighting power and lighting power allowance as required per the Wisconsin  
53           Department of Safety and Professional Services (SPS) Wisconsin Commercial Building Code  
54           SPS 360-366. Interior lighting power densities shall be calculated for each separate area (as  
55           defined in SPS 363) of a building.

1  
2 4. Short circuit evaluation  
3

4 It is the designer's responsibility to analyze the distribution system and perform short circuit  
5 calculations to ensure that new equipment is adequately protected against the effects of short  
6 circuits. System components shall be specified with adequate short circuit ratings and/or  
7 protective devices or components shall be specified that will reduce fault current levels or  
8 durations. It is preferred that higher rated equipment be specified if data on available fault  
9 current is questionable, if utility substation or line capacity is projected to increase, or if  
10 calculated fault values fall near a standard equipment rating. Minimum equipment standard  
11 interrupting ratings shall be identified on a one-line diagram or in schedules.  
12

13 For new building projects, the maximum possible fault current at the service transformer  
14 secondary shall be calculated using infinite bus calculations. If the fault level is 10,000 A.I.C.  
15 or less, no additional documentation is necessary. If the theoretical fault levels would exceed  
16 50,000 A.I.C., an extensive analysis should be performed based on actual fault current levels  
17 available upstream of the service transformer. Short circuit calculations shall continue  
18 downstream until calculated fault levels are attenuated to 10,000 A.I.C. or less.  
19

20 5. Protective coordination analysis.  
21

22 For projects which include electronic trip circuit breakers or protective relays, the set points  
23 for the overcurrent and ground fault trip adjustments shall be addressed. The consultant shall  
24 review and approve the set points resulting from short circuit/coordination study and arc flash  
25 hazard study per specification section 26 05 73 and verify that the devices have been properly  
26 set.  
27

28 If a third party or equipment manufacturer is to provide the set points, that requirement shall  
29 be indicated in the specifications. The consultant shall then provide information as required  
30 for the third party or manufacturer to perform the coordination study. The consultant shall  
31 approve the set point recommendations and verify that the devices have been properly set.  
32 Note: This does not remove the responsibility of the consultant from performing short circuit  
33 calculations and a preliminary coordination analysis.  
34

35 6. Special applications.  
36

37 Engineering backup shall be provided to justify any major design decisions, including design  
38 of normal or emergency distribution system elements which deviate from DFD guidelines, use  
39 of harmonic-rated equipment, use of isolated grounds or second-tier SPD devices, and special  
40 grounding or lightning protection accommodations.  
41

42 7. Lightning Protection.  
43

44 Remodeling of or additions to existing facilities with existing lightning protection systems  
45 shall have existing systems extended to serve new additions. For new buildings, consult with  
46 DFD.  
47

48 **IV. Drawing Requirements**  
49

50 Electrical construction drawings shall show all necessary electrical installations and equipment for  
51 the project. The electrical construction drawings shall be designed so that the contractor is able to  
52 use the proper combination of materials, techniques, and manpower to accomplish the overall  
53 installation.  
54

- 55 1. Electrical construction drawings shall include the following applicable elements at a  
56 minimum:

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a. Symbols and Abbreviations

Include only symbols for equipment actually installed on the project. Edit out all other symbols.

b. Electrical Site Plans

Show primary service equipment locations with all underground or overhead services, ductbanks, manholes, and other important features. Show all site lighting. Include all existing underground and aboveground conduits and cables and light poles etc., within or directly adjacent to the construction area, whether they are reused or not. Service entrance arrangements made with the service utility, easements on State or Municipal property, and any agency contracts with Diggers Hotline to locate utilities shall be noted or located on the drawings.

Show routing of signal/low voltage services. Include all conduit requirements from signal manholes to telecom entry points for services such as fire alarm reporting, security reporting, voice/data/video service, campus automation system connection, multi-conductor exterior lighting control, etc.

c. Lighting Floor Plans

Show lighting fixture layout with switching, occupancy sensor, and special controls layout. With each fixture indicate branch circuit (panel designation and circuit breaker number), fixture type, and switch/control designations. Branch circuiting may be indicated either by lines or text.

d. Power Floor Plans

Show primary and secondary system layout. Power system layout shall show all electrical rooms and equipment, including unit substations, transformers, switchgear, generators, panelboards, motor starters, disconnects, receptacles, grounding plans, etc.

Show mechanical equipment power requirements and physical locations, including special information as to who mounts, connects and tests equipment. Show required power circuits and provisions for security, telecommunications, and other miscellaneous systems required by project program.

Show branch circuiting, indicated either by lines or text. Do not show circuits without specifying panel breakers. Show circuit numbers, wire size, and conduit size for all equipment that requires power.

e. Signal / Low Voltage Systems Floor Plans

Show all signal and low voltage systems rooms and equipment layout. For telecommunications, show all voice, data and video outlets, closets/rooms, backboards/racks, floor sleeves, and cable tray. For security electronics, show all major components, panels, door contacts, card readers, cameras, etc.

f. One-Line Diagrams and Risers

**DFD requires that one-line diagrams be provided to depict the electrical power distribution arrangement for a project. One-line diagrams shall be required for all new building distribution systems or additions/changes to existing building distribution systems. Riser diagrams will not be acceptable.**

1  
2 One-line diagrams shall meet the following requirements (modeled after ANSI/IEEE  
3 standard 141-1993:  
4

- 5 • All major components should be shown, including but not limited to medium voltage  
6 switching equipment, step-down transformers, secondary switchboards/switchgear,  
7 generators, transfer switches, electrical meters, main and distribution panels, branch  
8 circuit panelboards, motor control centers, and service and feeder conductors.
- 9 • All major components shall be identified with voltage ratings, ampere ratings,  
10 available fault currents, and required short circuit / interrupting ratings.
- 11 • Service and feeder conductor information including number of conductors, size of  
12 each conductor, and conduit sizes shall be shown either on the one-line diagram or in  
13 a separate feeder schedule.
- 14 • All electronic trip circuit breakers and circuit breakers with ground fault protection  
15 shall be identified on the one-line diagram. Electronic trip circuit breakers shall  
16 include the required frame sizes and rating plug sizes.
- 17 • Switchboards and switchgear shall have all circuit breakers, fusible switch  
18 assemblies, and fuses shown and sized on the one-line diagram. Main distribution  
19 panelboards shall have all circuit breakers shown and sized. All main breakers in  
20 branch circuit panelboards shall be shown and sized. Any panelboard circuit breaker  
21 which sub-feeds another panelboard shall be shown and sized.
- 22 • All medium voltage fuses shall be shown and sized on the one-line diagram.
- 23 • Include room numbers next to the major equipment, indicating their location.
- 24 • All metering shall be included, both utility and customer-owned. Indicate required  
25 current transformer ratios.
- 26 • Show all three phase motors on the Motor/ Equipment Schedule and not on one-line  
27 diagram. Include the motor horsepower and functional name(s) (HVAC or plumbing  
28 designation). Show all starters and disconnects for the motors on floor plans and in  
29 the Motor/Equipment Schedule, and identified as to the Division that will furnish  
30 them.
- 31 • Motor control centers shall be depicted on the riser diagram indicating sections and  
32 individual tubs. Include section ampacity, starter size and OCPD, incoming section  
33 and quantity of spares.
- 34 • Transformer information on the one-line diagram shall include primary voltage,  
35 secondary voltage, dry-type or liquid-filled, KVA rating and impedance rating.
- 36 • Show all surge arresters and SPD devices on the one-line diagram.
- 37 • When ground fault protection is provided in the system, 3-pole or 4-pole transfer  
38 switches are used, or multiple transfer switches are served from one emergency  
39 generator, the grounding requirements shall be noted in the one-line diagram.
- 40 • Include the manufacturer, model number, and KAIC rating of existing panelboards  
41 and switchgear for which new breakers are being added.

42  
43 For all signal / low voltage systems, including all security and telecommunications  
44 systems, provide riser diagrams illustrating the system distribution, and the interactive  
45 relationship of the components. Riser shall include typical field devices, and all  
46 backbone devices. Cabling and conduit requirements shall be indicated.  
47

48 g. Construction Details  
49

50 Provide electrical construction details on drawings to specify electrical construction  
51 requirements. Provide plan view, elevation and/or detail drawings to cover all medium  
52 voltage equipment, motor control centers, primary vault grounding, generator sets, large  
53 switchboards, unit substations, and light pole bases. Provide cross sections, profiles, and  
54 details of the manholes and ductbanks.  
55



- 1 h. Equipment Schedules – Provide detailed electrical equipment schedules for motors and  
2 controllers (HVAC, Elevators, Plumbing), special outlets and connections, lighting  
3 fixtures, and connections for equipment (Kitchen, Laundry, etc.).  
4  
5
- 6 i. Panelboard Schedules - Individual branch circuit breakers shall be identified on  
7 panelboard schedules. Each new panel shall have a panelboard schedule including  
8 calculations for connected and demand loads. Provide system voltage, amperage, number  
9 of poles, short circuit rating, main breaker or main lug only, circuit sizes, 10% spare  
10 circuit breakers in branch panelboards and 20% spare spaces in power distribution  
11 panelboards/switchboards. Schedules shall be incorporated into drawing set.  
12
- 13 2. Undefined phrases on the drawings such as “properly seal”, “locations to be determined”, “by  
14 others”, and “as required” shall be avoided.  
15
- 16 3. Include all electrical details, diagrams, schedules, etc. in the drawings, not in the  
17 specifications. Often just the drawings will be at the job site.  
18
- 19 4. On each floor plan sheet, show graphic scale, compass point, room names and numbers, and  
20 key plan corresponding to the architectural drawings. Refer to the [DFD CAD Standards](#)  
21 [Manual](#) for sheet numbering and other drawing requirements.  
22
- 23 5. For large alteration projects, separate demolition drawings are required for all areas involved  
24 in the project. Remodeling project drawings shall indicate all removal and disconnection of  
25 existing electrical equipment, and shall indicate required repair of finishes.  
26
- 27 6. For areas such as transformer vaults, generator rooms, switchgear rooms, electrical  
28 rooms/closets, signal/communication closets and mechanical equipment rooms, larger scale  
29 plans shall be used for improved clarity.  
30
- 31 7. For medium and large projects, provide separate floor plans for lighting, power, fire alarm  
32 systems, telecommunication systems, A/V systems, and security systems. Combining of  
33 systems drawings is allowed if clarity of design can be maintained. The drawings shall be  
34 combined on smaller projects.  
35
- 36 8. The electrical drawings shall be coordinated and actively crosschecked with the drawings of  
37 all other disciplines. Consultant may be asked to provide a ¼” scale drawing of selected  
38 electrical and mechanical rooms (showing both electrical and mechanical equipment),  
39 generator rooms, and elevator equipment rooms to ensure that coordination is being achieved.  
40
- 41 9. On projects where medium voltage changes or additions are being made, consultant is to  
42 contact the DFD electrical section to discuss the proposed concept design.  
43

#### 44 **V. Specification Requirements**

45

- 46 1. DFD Master Electrical Specifications (Division 26) are mandatory for use on all electrical  
47 projects, for each piece of electrical equipment used in the project. The consultant is required  
48 to use the latest edition available at the beginning of the design. The latest edition can be  
49 accessed on the DFD Internet website.  
50
- 51 2. DFD Master Electrical Specifications have been developed for most electrical work. They  
52 shall be edited to meet the specific project needs. All bracketed items in the specifications  
53 shall be edited, with all brackets and non-applicable items deleted. Specifications shall be  
54 checked carefully with the drawings to be sure that everything required by the drawings is  
55 included, and that the inapplicable subject matter in the specifications is deleted.  
56

3. The designer shall prepare supplementary material when the DFD master specifications are not sufficient to adequately define the electrical work. If the resultant supplementary material is not extensive, it may be inserted at appropriate locations into the master specification section; otherwise, as many new sections as necessary shall be developed in the same format as the master specifications.
4. Trade names or other indications tending to identify a product of an individual manufacturer shall not be used on any project, unless specifically approved, except as follows:
  - a. Where necessary to identify existing equipment.
  - b. Where an existing system is to be extended and competitive manufacturers cannot meet performance requirements.
  - c. Where required by a public utility or municipal system as a condition of its services.
  - d. Lighting fixtures in the lighting fixture schedule.

## VI. Preliminary (35%) Review Stage Requirements

Preliminary electrical drawings shall include the following:

1. Provide a complete set of floor plans showing all rooms with room names and numbers. North arrow(s) and keyed building locations must be on all sheets and details.
2. Show all panelboards, cable trays, and mechanical, electrical, and communication rooms/closets on floor plans.
3. Show layouts for all switchboards, switchgear, generator rooms and vaults.
4. Show preliminary one line-diagram for normal and emergency power systems. (Note: DFD may have an electronic record of the existing medium voltage power distribution system and can furnish that to the consultant on request. If this electronic record is available, it shall be used as the basis for the project power one-line diagram).
5. Show typical riser diagrams for signal/low voltage systems.
6. Provide engineering calculations and data on request. Provide data and analysis regarding any consideration of alternative Division 26 systems or solutions.
7. Show typical room layouts with all receptacles, switches, lighting, speakers, alarms, communication devices, other equipment, etc. in the room. Each different room type shall have a layout. Examples of room types are classroom–small, classroom–large, auditorium, toilet, janitor closet, kitchen, each laboratory type, corridor, stairwell, patient room, cell, etc.
8. Include lighting fixture schedule.
9. Provide schedules for motors, special outlets and connections, kitchen equipment, etc., including equipment with sizes, voltages, and circuitry as a minimum.
10. Provide site plans showing ductbanks, manholes, and typical lighting layouts. Include typical ductbank cross section detail. Include existing utilities and routing of new power and signal conduits/ductbanks.
11. For projects involving tele/data/video, include locations of telecommunication closets on floor plans, locations and quantities of jacks on floor plans, and a preliminary riser diagram for the systems.

Preliminary Master Specifications should include the following:

12. Provide a complete Table of Contents. This shall indicate master specification sections not being used on this project (indicate by strikeout), sections being used on this project edited by the consultant, and sections added by the consultant.
13. Provide a marked-up copy of the latest version of the master specifications. Markups may be by computer or by hand. Cross out unused portions. Show additions by consultant. Do not include unused sections. Do not edit out the DFD Master Specification revision date located under the section name at the beginning of each specification section.

Supplemental Submissions for Preliminary Review Only:

