

## 26 24 16 PANELBOARDS: SIGNIFICANT (OR TOTAL) DELETION OF EXISTING TEXT

Delete the following current section in its entirety (deletions are shown struck through).

### ~~.01 General~~

- ~~A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.~~
- ~~B. Provide “door-in-door” hinged front cover.~~
- ~~C. Panels shall have complete bus and mounting hardware requiring only the installation of additional breakers for future expansion.~~
- ~~D. Allow 20% spare and another 10% fully provisioned space capacity for future breakers. Critical operations, shops and research facilities may require 50 percent spare capacity, consult with Engineering Services.~~
- ~~— Distribution Panels~~
  - ~~0. Consider second level of SPD, especially if panel feeds sensitive or critical loads or has branch circuits running outside of the building footprint (site lighting, etc.).~~
  - ~~0. When ground fault is provided on the service entrance equipment, specify ground fault sensing and shunt trip for breaker(s) feeding site lighting panel(s). Coordinate setting of ground fault to limit nuisance tripping, but also prevent any overtrip.~~
- ~~E. Branch Circuit Panels~~
  - ~~0. Group installed panelboards shall have separate trim.~~
  - ~~0. All circuit breakers in utilization panelboards shall be of the bolt-on type.~~
  - ~~0. Panelboards serving dedicated computer loads shall be reviewed for 200% neutral bus and feeder application with Engineering Services.~~
  - ~~1. Specify that the electrical contractor shall coordinate final room name and numbering with Engineering Services prior to submitting panel schedules for approval. Circuits feeding exterior lighting shall utilize the 3-letter labeling scheme as directed by Engineering Services.~~
  - ~~1. Panelboard Installation:~~
    - ~~— Panels serving loads in only one room may be located in that room.~~
    - ~~— Panels serving more than one room shall be located in an electrical closet, corridor, or other accessible space.~~
    - ~~— Do not install panelboards in janitor closets or dedicated telecom rooms.~~
    - ~~— Where flush panelboards are used, install a one-inch conduit for every three spare poles to a point above the suspended ceiling.~~
    - ~~— Specify green ground wire with all circuits.~~
- ~~E. Controlled Breaker Panels:~~
  - ~~1. Coordinate with Engineering Services whether to use motorized control circuit breaker panel(s) in lieu of contactor/relay panel(s) for control of~~

- ~~interior and/or night and/or site lighting loads. Panels must have the ability for each type of load to be switched on or off manually.~~
- ~~2. Specify that the outdoor lighting circuits also be controlled via a Hand-Off Auto switch(es) mounted to the side of the panel (for maintenance crews to check for dead lamps/ballasts). Depending on the project, this could include switches for "NIGHT (Building Mount)", "SIGHT (Walkway)", "SIGHT (Parking)" and/or "SIGHT (Roadway)" zones.~~
  - ~~3. Provide any panel feeding exterior loads with SPD.  
—Acceptable manufacturers are Cutler Hammer Pow R Command PRC2000B (BACnet), Siemens i-3 (BACnet) Lighting Panel with I/O controller, or Square D Powerlink G3-3000C Level. Panel shall communicate via the BACnet protocol and includes an astronomic timeclock. The panel will also require a data connection and programming by a manufacturer representative so that if communication is lost, the system operates in a stand-alone mode (site and building mount exterior luminaires "ON" 30 minutes before dusk and then "OFF" 30 minutes after dawn; other lighting schedule as arranged with PSU).~~
  - ~~4. Specify that a compact laptop computer be provided for lighting controls revisions for most new buildings and major renovations (confirm requirement with Engineering Services). Computer shall have lighting control software pre-loaded. Verify hardware and system requirements with Engineering Services.~~
  - ~~5. Refer to Lighting Control Devices in section 20-09-23 and to the BAS Specification for further luminaire control requirements.~~
- ~~E. Lab Panels—limit available short-circuit current to under 10,000 AIC. Discuss current-limiting solution with Engineering Services. Provide main breaker, door with lock, and tamperproof screws.~~

**Replace with following text.**

### **.01 General**

- A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.
- B. Allow 20% spare and another 10% fully provisioned space capacity for future breakers. Critical operations, shops and research facilities may require 50 percent spare capacity, consult with Engineering Services.
- C. Distribution Panels
  1. Consider second level of SPD, especially if panel feeds sensitive or critical loads or has branch circuits running outside of the building footprint (site lighting, etc.).

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

#### D. Branch-Circuit Panels

1. Panelboards serving dedicated computer loads shall be reviewed for 200% neutral bus and feeder application with Engineering Services.
2. Circuits feeding exterior lighting shall utilize the 3-letter labeling scheme as directed by Engineering Services.
3. Panelboard Installation:
  - a. Panels serving loads in only one room may be located in that room.
  - b. Panels serving more than one room shall be located in an electrical closet, corridor, or other accessible space.
  - c. Do not install panelboards in janitor closets or dedicated telecom rooms.

- E. Lab Panels – limit available short-circuit current to under 10,000 AIC, this does not supersede the requirements outlined in other sections of the standards. Discuss current-limiting solution with Engineering Services. Provide main breaker, door with lock, and tamperproof screws.

#### **.02 Guide Specifications**

- A. Design Professional shall carefully review and edit the guideline specifications below, adapting them as needed to achieve application-specific, fully developed specifications for each project.
- B. These shall be edited using the process described in the instructions contained at the beginning of the document. Proposed modifications shall be reviewed with OPP Engineering Services.
- C. Finalized version shall be included in the project contract documents. Use of other specifications is not acceptable.

<u>Document</u>	<u>Version Date</u>	<u>Description</u>
<u>Panelboard Guide Specification.docx</u>	<u>June 2016</u>	<u>University's guide specification for Switchboards; to be used by the design professional.</u>
<u>Panelboard Datasheet.docx</u>	<u>June 2016</u>	<u>Typical University Transformer Datasheet for the Professionals use. The datasheet instructions are found in the guide specification and a sample is found in Division 26 00 00.</u>

**END of revision**

**Update Commentary:**

Section was updated primarily for the following reasons:

- 1) Deleted old section and replaced with new section, which includes a new guide specification section and new additional datasheet.*

<b>DATA SHEETS</b>		<b>Equipment Name:</b>	
<b>LOW VOLTAGE PANELBOARDS</b>			
<b>DESCRIPTION</b>	<b>UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Manufacturer	N/A	By Manufacturer	
Model/Catalog No.	N/A	By Manufacturer	
<b>SITE CONDITIONS</b>			
Minimum Ambient Temperature	°C		
Maximum Ambient Temperature	°C		
Site Altitude Above sea Level	Ft		
High Humidity/Corrosive/Salt-Laden	Y/N	N	
<b>PANELBOARD RATINGS</b>			
Nominal System Voltage	V		
Maximum Operating Voltage	V		
No. Phases / No. Wires	Ph/W		
Frequency	Hz		
Bus Continuous Current Rating	A		
Assembly Short Circuit Rating (Minimum Sym. Current)	kA		
Bus System Short Circuit Rating (ANSI 4-cycle Sym)	kA		
Suitable For Service Entrance Equipment	Y/N		
<b>ENCLOSURE</b>			
NEMA Type	NEMA		
Weight as Installed	Lb	By Manufacturer	
Number of Poles	Qty.	By Manufacturer	
Panelboard Dimension (L x W x H)	Inches	By Manufacturer	
Cover Type (Hinged front cover, door-in-door, etc.)	-	By Manufacturer	
Color	ANSI	61 Gray	
<b>BUS</b>			
Material (Bus and Bus Extensions)	-	Copper	
Plating Material (Bus and Bus Extensions)	-	Silver	
100% Rated Neutral Bus	Y/N		
Full Length Ground Bus	-	Y	
Lug Material	-	By Manufacturer	
<b>BREAKERS</b>			
Model	-	By Manufacturer	
Main Breaker or Lugs only	-		
Main Breaker Rating	A		
Main Breaker Trip Unit Sensor Rating	A		
Breaker Short Circuit Rating (Minimum Sym. Interrupting)	kA		
Breaker Options:			
Shunt Trip	Y/N		
Undervoltage Trip	Y/N		
Auxiliary Contacts	Y/N		
Key Interlock Kit	Y/N		
Handle Padlock	Y/N		
<b>TRIP UNITS</b>			
Manufacturer/Model Number	-	By Manufacturer	

<b>DATA SHEETS LOW VOLTAGE PANELBOARDS</b>		Equipment Name:	
<b>DESCRIPTION</b>	<b>UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Standard Functions	-	L, S, I	
Instantaneous Defeat Capability	Y/N	Y	
Reduced Energy Let Through (RELT) Switch	Y/N		
Ground Fault Protection	Trip or Alarm	Trip	
Zone Selective Interlocking	Y/N	Y	
Integral Metering	Y/N		
<b>ACCESSORIES</b>			
Accessories Set (Tools and miscellaneous items)	Y/N		
Space Heaters:			
Operating Voltage	VAC	120 VAC	
Separately Mounted Test Cabinet For EO Breakers	Y/N		
Mechanical Interlocks	Y/N		
<b>SPECIAL REQUIREMENTS</b>			

**SECTION 262416 - PANELBOARDS**

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

*General Notes:*

1. *This guide specification is intended to provide the Design Professional with a basic guideline of minimum OPP requirements.*
2. *The guide specification shall be carefully reviewed and edited with respect to application-specific project requirements. Proposed modifications shall be reviewed with OPP Staff.*
3. *Finalized version shall be included in the project contract documents.*

*Editing Notes*

1. *This OPP Guide specification must only be altered by notation (i.e. deleted text with strikethrough and additional text with double underline). This shall be accomplished by using Tools /Track Changes / Highlight Changes, and select "Track changes while editing" in MS Word or equivalent.*
2. *The Review Submittal Specification section shall be provided in electronic form for OPP Review.*
3. *Leave the following Note ("For Construction Document Review, Design Submittal") as part of the Review Submittal, to aid any Reviewer to understand WHY there are strikeouts and underlines. Also, leave any "DESIGNER NOTE" placed in this Guide Spec.*
4. *AFTER comments are received from PSU and incorporated, the strikeouts and underlines shall be removed, and the REVIEWER NOTES deleted, before the spec is issued for Bidding.*
5. *Data Sheet Instructions:*
  - a. *Engineer completes "SPEC DATA" column with information about equipment including but not limited to ratings, features and options. The data sheet is then submitted with completed specifications for bid.*
  - b. *Manufacturer completes "VENDOR DATA" column and returns completed data sheet with bid or submittal.*
  - c. *Engineer verifies that design specifications have been met by checking that specified features match submitted features.*

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code requirements, the contractor shall notify the Architect/Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Load centers.
  - 4. Electronic-grade panelboards.

### 1.3 DEFINITIONS

Retain terms that remain after this Section has been edited.

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. HID: High-intensity discharge.
- D. MCCB: Molded-case circuit breaker.
- E. SPD: Surge protective device.
- F. VPR: Voltage protection rating.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.



- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details.
  2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
  3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  4. Detail bus configuration, current, and voltage ratings.
  5. Short-circuit current rating of panelboards and overcurrent protective devices.

Retain first subparagraph below if SPD is factory mounted in panelboard.

6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.

Retain subparagraph below if final system short-circuit and coordination studies will be performed by designer or assigned to independent consultant. These curves are also beneficial to Owner for future additions or reevaluations of settings of overcurrent protective devices.

10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

## 1.5 INFORMATIONAL SUBMITTALS

Coordinate Qualification Data Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

- A. Qualification Data: For testing agency.

Retain "Panelboard Schedules" Paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 260548.16 "Seismic Controls for Electrical Systems." See SEI/ASCE 7 for certification requirements for equipment and components.

Retain option in "Panelboard Schedules" Paragraph below if retaining "Load Balancing" Paragraph in "Adjusting" Article.

- B. Panelboard Schedules: For installation in panelboards. [**Submit final versions after load balancing.**]

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

Revise this article to include extra materials that Owner may require, such as GFCI circuit breakers or circuit breakers used for switching service, which may fail more frequently due to continuous use.

Coordinate with Section 262813 "Fuses" for quantities of spare fuses and spare-fuse cabinet to be provided.

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: [Two] <Insert number> spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI Types: [Two] <Insert number> spares for each panelboard.
  3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  5. <Insert extra materials>.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

See "Testing and Inspecting" Article in the Evaluations for guidance on which option to select in paragraph below.

- B. Handle and prepare panelboards for installation according to **NECA 407** and **NEMA PB 1**.

#### 1.10 FIELD CONDITIONS

Retain "Environmental Limitations" Paragraph below for panelboards installed in typical environmental conditions. For panelboards installed outdoors, in unconditioned spaces, or in unusual environmental conditions, revise paragraph to indicate maximum ambient temperature and expected humidity range.

- A. Environmental Limitations:
  1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary

HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

In "Ambient Temperature" Subparagraph below, select first option for panelboards with fused switches; select second option for panelboards with circuit breakers.

- a. Ambient Temperature: Not exceeding [**minus 22 deg F (minus 30 deg C)**] [**23 deg F (minus 5 deg C)**] to **plus 104 deg F (plus 40 deg C)**.
- b. Altitude: Not exceeding **6600 feet (2000 m)**.

Retain "Service Conditions" Paragraph below or revise to accommodate unusual service conditions that cannot be eliminated. See the Evaluations for discussion of usual service conditions.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding **6600 feet (2000 m)**.

Retain "Interruption of Existing Electric Service" Paragraph below for Projects that have existing electric service that may be required to be interrupted.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify [**Construction Manager**] [**Owner**] no fewer than two weeks in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without [**Construction Manager's**] [**Owner's**] written permission.
3. Comply with NFPA 70E.

## 1.11 WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods with manufacturers listed in Part 2 articles.

1. Panelboard Warranty Period: [**18**] <**Insert number**> months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods with manufacturers listed in Part 2 articles.

1. SPD Warranty Period: [**Five**] <Insert number> years from date of Substantial Completion.

## PART 2 - PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or ARCOM. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

### 2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

Retain first paragraph below for projects in seismic areas. Coordinate with "Informational Submittals" Article for submittal of manufacturer's seismic qualification certification.

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: [**Flush**] [**and**] [**Surface**]-mounted, dead-front cabinets.
  1. Rated for environmental conditions at installed location.

See "Enclosures" Article in the Evaluations for discussion of enclosure types. Coordinate first five subparagraphs below with Drawings (by identifying the designated areas) or schedules (by including the required enclosure type). Availability of some enclosure types is limited by a panelboard's ampacity rating, included devices, or physical size; consult manufacturers for availability of, and limitations on, other than Type 1 enclosures.

- a. Indoor Dry and Clean Locations: NEMA 250, [**Type 1**] <Insert type>.
- b. Outdoor Locations: NEMA 250, [**Type 3R**] <Insert type>.
- c. [**Kitchen**] [**Wash-Down**] Areas: NEMA 250, [**Type 4X**] <Insert type>, [**stainless steel**] <Insert material>.
- d. Other Wet or Damp Indoor Locations: NEMA 250, [**Type 4**] <Insert type>.

Select first option in first subparagraph below for areas subject to lighter levels of contaminants and second option for areas subject to heavier levels.

- e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: **84 inches** (2.13 m) maximum.

Retain subparagraph below. Verify with manufacturer for availability of "door-in-door" construction in other than NEMA 1 style panelboards.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

Coordinate "Finishes" Subparagraph below with "Enclosures" Paragraph above. Back boxes are also available painted. Revise if required to include special finishes to match, for example, stainless steel, epoxy, and fiberglass-reinforced polyester.

4. Finishes:
  - a. Panels and Trim: **[Steel] [and] [galvanized steel]**, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - b. Back Boxes: Same finish as panels and trim.
5. **<Insert optional features>**.

Retain "Incoming Mains" Paragraph below, and coordinate with Drawings and schedules, if Project requirements include identifying specific entry locations for incoming service or feeder raceways.

G. Incoming Mains:

1. Location: **[Top] [Bottom] [Convertible between top and bottom]**.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

In "Material" Subparagraph below, first option is standard with most manufacturers up to 400 A; second option costs more for 400 A and less but is standard for 600 A and above.

1. Material: Hard-drawn copper, 98 percent conductivity.
  - a. Plating shall run entire length of bus.
  - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

First five subparagraphs below are optional features. Ground and neutral buses in panelboards are also referred to as "bars" in manufacturers' literature. Coordinate with Drawings.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

Retain "Full-Sized Neutral," "Extra-Capacity Neutral Bus," or both subparagraphs below. If retaining both, indicate on Drawings which panelboards have extra capacity neutrals.

4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

Indicate on Drawings which panelboards have split buses, including those with contactors that control a portion of the panelboard.

6. Split Bus: Vertical buses divided into individual vertical sections.
7. <Insert optional features>.

Include instructions in "Conductor Connectors" Paragraph below if special sizing or oversizing of lugs is required, if allowing optional use of aluminum for circuits sized for copper conductors, or when upsizing conductors for voltage drop.

- I. Conductor Connectors: Suitable for use with conductor material and sizes.
  1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Terminations shall allow use of 75 deg C rated conductors without derating.
  3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

See "Mechanical-Type versus Compression-Type Lugs" Article in the Evaluations for guidance on using compression versus mechanical lugs in first four subparagraphs below.

5. Ground Lugs and Bus-Configured Terminators: [**Compression**] [**Mechanical**] type, with a lug on the bar for each pole in the panelboard.

First two subparagraphs below are optional features.

6. Feed-Through Lugs: [**Compression**] [**Mechanical**] type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

In "Subfeed (Double) Lugs" Subparagraph below, NEMA PB 1 allows subfeed lugs to be located on the load or line side of main devices or on main-lugs-only panelboards; however, coordinate with specific manufacturers as some have restrictions on which options are available.

7. Subfeed (Double) Lugs: [**Compression**] [**Mechanical**] type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: [**Compression**] [**Mechanical**] type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
10. <Insert optional features>.

Retain "NRTL Label" Paragraph below for panelboards that incorporate one or more main service disconnecting and overcurrent protective devices and that are used as the service entrance, outside feeder, or separately derived source means of disconnect and overcurrent protection.

- J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting

and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

Retain "Future Devices" Paragraph below if future provisions are required.

- K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  - 1. Percentage of Future Space Capacity: **[Five]** **[Ten]** **[20]** **<Insert number>** percent.

Retain "Panelboard Short-Circuit Current Rating" paragraph below for system that has panelboards and circuit breakers rated for full value of short-circuit current available at location of equipment.

- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  - 1. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 22,000 A rms symmetrical.
- M. Panels shall have complete bus and mounting hardware requiring only the installation of additional breakers for future expansion.

## 2.2 PERFORMANCE REQUIREMENTS

Retain "Seismic Performance" Paragraph for projects requiring seismic design. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Verify requirements of authorities having jurisdiction.

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7]** **<Insert requirement>**.

Retain subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Requirement as shown below only requires the panelboard to not break apart so that it does not damage critical components that must remain operational after an event.

- 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

Retain "Surge Suppression" Paragraph below unless field-mounted SPDs are used. Retain "Type 1" option for service equipment where the device is installed ahead of the service disconnect. Retain "Type 2" option for panelboards on the load side of the service disconnect. Type 1 is preferred and Type 2 to be approved by Owner. Field-mounted SPDs are specified in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD **[Type 1]** **[Type 2]**.

## 2.3 POWER PANELBOARDS

Power panelboards, as specified in this article, fall under requirements of "Distribution Panelboards" in NEMA PB 1.

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. **Eaton.**
  2. **General Electric.**
  3. **Siemens.**
  4. **Square D.**
- B. Panelboards: NEMA PB 1, distribution type.

Power panelboards, as standard, do not have doors; consult manufacturers for availability and types of doors. Retain "Doors" Paragraph below if panelboards have doors.

- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  1. For doors more than [**36 inches (914 mm)**] <Insert dimension> high, provide two latches, keyed alike.

Select one of first two options in "Mains" Paragraph below for panelboards with main overcurrent protective devices; select third option for panelboards with only main lugs for the incoming feeder. Consult manufacturers for limitations on ratings for each type of device selected.

- D. Mains: [**Circuit breaker**] [**Lugs only**].

Retain one of two "branch overcurrent" paragraphs below. Note that plug-in types with a positive-locking feature are available from other manufacturers with some restrictions on size.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Plug-in circuit breakers**] [**Bolt-on circuit breakers**] [**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**].
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: [**Bolt-on circuit breakers**] [**Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal**].

Contactors can be incorporated to switch the entire panelboard or only a portion of the circuits. Coordinate with Drawings and schedules to indicate contactor connections, type, quantity of circuits controlled, current ratings, external control circuits, and number of poles. Verify with manufacturers for their respective limitations on short-circuit ratings and availability of contactors, which may not be available in all sizes or from all manufacturers.

- G. Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**] [**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

Retain "Internal Control-Power Source" or "External Control-Power Source" Subparagraph below. If control-power transformer is used, specify capacity and associated fuses on Drawings. If branch circuit is



used, identify circuit on Drawings. Use of branch circuit also requires a warning sign identifying sources of remote circuit.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: [**120-V branch circuit**] [**24-V control circuit**] <Insert requirement>.

#### 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

Panelboards, as specified in this article, comply with requirements of "Lighting and Appliance Branch-Circuit Panelboards" in NEMA PB 1.

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Eaton
  2. General Electric
  3. Siemens
  4. Square D
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

Retain "Mains" Paragraph below if mains are not indicated on Drawings.

- C. Mains: [**Circuit breaker**] [**or**] [**lugs only**].
- D. Branch Overcurrent Protective Devices: [**Plug-in**] [**Bolt-on**] circuit breakers, replaceable without disturbing adjacent units.

Contactors can be incorporated to switch the entire panelboard or only a portion of the circuits. Coordinate with Drawings and schedules to indicate contactor connections, type, quantity of circuits controlled, current ratings, external control circuits, and number of poles. Consult manufacturers for their respective limitations on and availability of short-circuit ratings for their contactors. Also check for availability of electrically held contactors, which may not be available in all sizes or from all manufacturers.

- E. Contactors in Main Bus: NEMA ICS 2, Class A, [**electrically**] [**mechanically**] held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

Retain "Internal Control-Power Source" or "External Control-Power Source" Subparagraph below. If control-power transformer is used, specify capacity and associated fuses on Drawings. If branch circuit is used, identify circuit on Drawings. Use of branch circuit also requires a warning sign identifying sources of remote circuit.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: [**120-V branch circuit**] [**24-V control circuit**] <Insert requirement>.

Retain one or both "Doors" paragraphs below to describe the type of door required. If retaining both indicate on the Drawings which door type applies to each panel.

- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- G. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
- H. Group installed panelboards shall have separate trim.

## 2.5 LOAD CENTERS

Load centers are not covered by NEMA PB 1; however, they are normally UL listed under either UL 67 or manufacturer's UL File Number.

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Load Centers: Comply with UL 67.

Select first option in "Mains" Paragraph below for load centers with main overcurrent protective devices; select second option for load centers with only main lugs for the incoming feeder.

- C. Mains: [**Circuit breaker**] [or] [**lugs only**].
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

## 2.6 ELECTRONIC-GRADE PANELBOARDS

Electronic-grade panelboards are frequently assembled by integrators or contractors using prefabricated panelboards complying with UL 67 and with SPD modules installed in them.

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. SPD.

UL 1449 distinguishes locations for which an SPD is listed for installation and designates these as Type 1, Type 2, and Type 3. Type-3 SPDs are point of use units; an example would be plug strips with surge protection built in. Type-2 SPDs are permanently installed on the load side of the main service disconnect. Type-1 SPDs are intended for installation on the line side of the main service disconnect, although they can also be installed on the load side. See the Evaluations for Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" for more information on SPD types Consult with PSU on where SPDs are required for panelboards.

1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than **[100 kA]** <Insert value>. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

Retain one of first two subparagraphs below. Verify compatibility of peak surge current rating and clamping voltage. Reference to UL 1449 is to its third edition.

2. Protection modes and UL 1449 VPR for grounded wye circuits with **[480Y/277 V]** **[208Y/120 V]**, three-phase, four-wire circuits shall not exceed the following:
  - a. Line to Neutral: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
  - b. Line to Ground: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
  - c. Neutral to Ground: **[1200 V for 480Y/277 V]** **[700 V for 208Y/120 V]**.
  - d. Line to Line: **[2000 V for 480Y/277 V]** **[1200 V for 208Y/120 V]**.
3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
  - a. Line to Neutral: 700 V.
  - b. Line to Ground: 700 V.
  - c. Neutral to Ground: 700 V.
  - d. Line to Line: 1200 V.

See "UL 1449 Requirements for Surge Protective Devices" Article in the Evaluations for discussion on SCCR selection in "SCCR" Subparagraph below.

4. SCCR: Equal to **[the SCCR of the panelboard in which installed]** **[or exceed 100 kA]** **[or exceed 200 kA]** **[or exceed <Insert value>]**.

See "UL 1449 Requirements for Surge Protective Devices" Article in the Evaluations for discussion on Inominal selection in "Inominal Rating" Subparagraph below. Type 1 SPD should be tested to 20 kA; Type 2 should be tested to either 20 kA or 10 kA.

5. Inominal Rating: **[20 kA]** **[10 kA]**.

G. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

## 2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

Coordinate "MCCB" and "Fused Switch" paragraphs below with Drawings. See the "Circuit Breakers" Article in the Evaluations for guidance on making selections.

- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads.
    - b. Instantaneous magnetic trip element for short circuits.
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic Trip Circuit Breakers:
    - a. RMS sensing.
    - b. Field-replaceable rating plug or electronic trip.
    - c. Digital display of settings, trip targets, and indicated metering displays.
    - d. Multi-button keypad to access programmable functions and monitored data.
    - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    - f. Integral test jack for connection to portable test set or laptop computer.
    - g. Field-Adjustable Settings:

Retain one or more of first four subparagraphs below and coordinate required adjustable settings with Section 260573 "Overcurrent Protective Device Coordination Study." See "Electronic rms Trip versus MCCBs" Paragraph in "Circuit Breakers" Article in the Evaluations for additional guidance on specifying full- or standard-function features.

- 1) Instantaneous trip.
  - 2) Long- and short-time pickup levels.
  - 3) Long and short time adjustments.
  - 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

Retain first subparagraph below for GFCI circuit breakers for personnel ground-fault protection as required by NFPA 70. GFCI and AFCI circuit breakers are only available fully rated up to interrupting ratings of 22 kA. For panelboards subject to fault currents above 22 kA, series ratings must be used.

5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
7. Subfeed Circuit Breakers: Vertically mounted.
8. MCCB Features and Accessories:

Not all accessories and options listed in subparagraphs below are available for every rating and from every listed manufacturer. Verify availability and unique characteristics with manufacturers selected. Indicate on Drawings features that apply to selected overcurrent devices. Refer to design guide or discuss with PSU on where required.

- a. Standard frame sizes, trip ratings, and number of poles.
- b. Breaker handle indicates tripped status.
- c. UL listed for reverse connection without restrictive line or load ratings.

See "Mechanical-Type versus Compression-Type Lugs" Article in the Evaluations for guidance on lugs.

- d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.

Select first option in "Ground-Fault Protection" Subparagraph below for solid-state trip units; select second option for thermal-magnetic units. If selecting second option, also retain "Shunt Trip" Subparagraph below.

- f. Ground-Fault Protection: [**Integrally mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- g. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- h. Communication Capability: [**Circuit-breaker-mounted**] [**Universal-mounted**] [**Integral**] [**Din-rail-mounted**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."

For "Shunt Trip" Subparagraph below, 120-V units trip at 55 percent or more of rated voltage; all other voltages trip at 75 percent or more of rated voltage.

- i. Shunt Trip: [**120-V**] [**24-V**] <Insert voltage> trip coil energized from separate circuit, set to trip at [**55**] [**75**] percent of rated voltage.
- j. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**without intentional**] [**with field-adjustable 0.1- to 0.6-second**] time delay.
- k. Rating Plugs: Three-pole breakers with ampere ratings greater than [**150**] <Insert value> amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- l. Auxiliary Contacts: [**One, SPDT switch**] [**Two, SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- m. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- n. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- o. Multipole units enclosed in a [**single housing with a single handle**] [**or**] [**factory assembled to operate as a single unit**].

Device specified in "Handle Padlocking Device" Subparagraph below can be used as a safety disconnect device if it has fixed attachment and is configured to allow locking in the off position.

- p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [**on**] [**off**] [**on or off**] position.

Some manufacturers offer shunt-trip operators for their fused switches; however, most do not recommend using this feature for providing ground-fault protection on switches rated 1000 A and above in panelboards; they recommend using MCCBs or switches specified in Section 262413 "Switchboards." Consult manufacturers for availability and limitations if this feature is required.

- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
  - 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
  - 2. Fused Switch Features and Accessories:
    - a. Standard ampere ratings and number of poles.
    - b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.

Accessories and options, in addition to the one in "Auxiliary Contacts" Subparagraph below, may be available for some ratings and from some listed manufacturers. Consult manufacturers for availabilities and unique characteristics.

- c. Auxiliary Contacts: **[One]** **[Two]** normally open and normally closed contact(s) that operate with switch handle operation.

## 2.8 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

A circuit directory is required by NFPA 70 for panelboards and load centers. Retain one of two "Circuit Directory" paragraphs below. Retain first paragraph to provide the directory on a manufacturer supplied card that may be housed in one of the two methods indicated. Retain second to provide a directory on a printed sheet protected by plastic and mounted inside door. Computer-generated directories with more detail data to describe circuits are becoming an inexpensive option.

- C. Circuit Directory: Directory card inside panelboard door, mounted in **metal frame with transparent protective cover**].
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
  - 2. Circuit directory shall denote source of power.

## 2.9 ACCESSORY COMPONENTS AND FEATURES

Retain this article for overcurrent protective devices that require items in "Accessory Set" and "Portable Test Set" paragraphs below; delete if these items are specified elsewhere, such as in Section 262413 "Switchboards."

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

Retain "Portable Test Set" Paragraph below for circuit breakers with solid-state trip devices.

- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

Referenced NECA and NEMA standards in first paragraph below include similar requirements. See "Testing and Inspecting" Article in the Evaluations.

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to [NECA 407] [NEMA PB 1.1].
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

Referenced NECA and NEMA standards in first paragraph below include similar requirements. See "Testing and Inspecting" Article in the Evaluations.

- B. Comply with NECA 1.

- C. Install panelboards and accessories according to [NECA 407] [NEMA PB 1.1].
- D. Equipment Mounting:

Even if floor mounted, all panelboard cabinets must still be securely attached to a vertical wall or surface.

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

Retain subparagraph below for projects in seismic areas. Indicate seismic-control device type in supported equipment schedule on Drawings.

2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

Retain "Temporary Lifting Provisions" Paragraph below for large floor-mounted distribution panelboards.

- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

Retain first paragraph below if seismic controls are required for Project. Coordinate with Drawings.

- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

Verify that, whatever height is selected for top of trim in first paragraph below, the operating handle of top-most switch or circuit breaker, in on position, is not higher than 79 inches (2000 mm) above finished floor or grade. Verify with authority having jurisdiction whether maximum breaker height is governed by OSHA regulations, which may require a much lower height for panels.

- G. Mount top of trim [**90 inches (2286 mm)**] <Insert height> above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.

- J. Mount surface-mounted panelboards to steel slotted supports [**5/8 inch (16 mm)**] [**1 1/4 inch (32 mm)**] in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.

First subparagraph below assumes that settings are indicated on Drawings or a coordination report is available for Contractor to use.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.



- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars. Comply with requirements in 260526 “Grounding and Bonding for Electrical Systems”.
- M. Install filler plates in unused spaces.

Retain first paragraph below if panelboards are mounted flush and ceilings are accessible or there are raised floors, or when panelboards are located in spaces that will be finished.

- N. Stub 1 inch conduit for every three spare poles to a point above the suspended ceiling.

Retain option in first paragraph below if retaining "Load Balancing" Paragraph in "Adjusting" Article.

- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties[ **after completing load balancing**].
- P. Mount spare fuse cabinet in accessible location.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

Retain option in first paragraph below if retaining "Load Balancing" Paragraph in "Adjusting" Article.

- B. Create a directory to indicate installed circuit loads[ **after balancing panelboard loads**]; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

Retain "Device Nameplates" Paragraph below if nameplates are required for individual overcurrent devices in power panelboards.

- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

### 3.4 FIELD QUALITY CONTROL

Retain first paragraph below to require Contractor to perform tests and inspections.

- A. Perform tests and inspections.

Retain "Manufacturer's Field Service" Subparagraph below to require a factory-authorized service representative to assist Contractor with inspections, tests, and adjustments.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

Retain "Acceptance Testing Preparation" and "Tests and Inspection" paragraphs below to describe tests and inspections to be performed.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

Retain first and second options in subparagraph below if panelboards with factory-installed SPD are specified.

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers[ **and low-voltage surge arrestors**] stated in NETA ATS, Paragraph 7.6 Circuit Breakers[ **and Paragraph 7.19.1 Surge Arrestors, Low-Voltage**]. [**Do not perform**] [**Perform**] optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Infrared Scanning: After Substantial Completion and building occupancy, perform an infrared scan of panelboard connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of panelboards, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

E. Panelboards will be considered defective if they do not pass tests and inspections.

Retain paragraph below if tests and inspections are performed by Contractor or manufacturer's field-service representative engaged by Contractor.

- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

Select first option in first paragraph below if settings are included in the Contract Documents; select second option if indicated Section is included in the Contract Documents.

- B. Set field-adjustable circuit-breaker trip ranges [**as specified in Section 260573 "Overcurrent Protective Device Coordination Study."**]

Circuit changes made during load balancing may negate color-coding of phases and circuits. If load balancing proves undesirable or is to be performed by others, delete "Load Balancing" Paragraph below.

- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
1. Measure loads during period of normal facility operations.
  2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
  4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

### 3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416