Preparing Activity: NASA Superseding
UFGS-26 24 16.00 40 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

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PANELBOARDS

08/19

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USACE / NAVFAC / AFCEC / NASA **UFGS-26 24 16.00 40 (August 2019)**

Preparing Activity: NASA **Superseding**
UFGS-26 24 16.00 40 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 26 24 16.00 40

PANELBOARDS
08/19

****
NOTE: This guide specification covers the requirements for power-distribution panelboards and lighting and appliance branch-circuit panelboards.

Indicate on drawings the ampere rating of panelboards, the number of bus bars, and the voltage characteristics of the system to which they are connected. Indicate frame size, trip rating, number of poles, and class of molded-case branch-circuit breakers. Show interrupting rating for power distribution panelboards and also for lighting and appliance branch-circuit panelboards.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA RS-416	(1974; R 1981) Filters for Radio Interference
ECIA/IS 46	(1987) Test Procedure for Resistance to Soldering (Vapor Phase Technique) for Surface Mount Devices

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA PB 1	(2011) Panelboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-HDBK 232	(1987; Rev A; Notice 1 1988; Notice 2 2000; Notice 3 2014) Red/Black Engineering - Installation Guidelines

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint May 2023) UL Standard for Safety Panelboards
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 943	(2016; Reprint Feb 2018) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1283	(2017) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1699	(2017; Reprint Feb 2022) UL Standard for Safety Arc-Fault Circuit-Interrupters

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" Classification only in SD-11 Closeout Submittals. The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Panelboards; G[, [____]]

[Filtered Panelboards; G[, [____]]

] SD-06 Test Reports

Acceptance Tests; G[, [____]]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

1.3 QUALITY CONTROL

1.3.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Ensure equipment, materials, installation, and workmanship are in accordance with the

mandatory and advisory provisions of NFPA 70, IEEE C2 unless more stringent requirements are specified or indicated.

1.3.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. Ensure the 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer.

Products manufactured more than 3 years prior to date of delivery to site are not to be used, unless specified otherwise.

1.3.3 Predictive Testing and Inspection Technology Requirements

****

NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS are MANDATORY for all NASA assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS for additional information regarding cost feasibility of PT&I.

****

This section contains systems and equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

PART 2 PRODUCTS

2.1 PANELBOARDS

Provide panelboards in accordance with NEMA PB 1, UL 67, and UL 50. Ensure panelboards for use as service equipment are also in accordance with UL 869A. Ensure panelboards have current rating, number of phases, and number of wires as indicated or specified herein. Ensure panelboards are rated for [240-volt (maximum), single-phase] [120/208-volt, three-phase] [277/480-volt, three-phase], 60-hertz. Ensure each

panelboard, as a complete unit, has a short-circuit current rating equal to or greater than the integrated equipment rating indicated, but in no case less than 10,000 amperes symmetrical.

Provide panelboards with bolt-on circuit breakers only. Use of plug-in style breaker is not permitted. Ensure panelboards are designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining required clearance. Provide main lugs or main circuit breakers mounted["above"][or]["below"] branch breakers with current ratings as indicated. Use of sub-feed breakers is not acceptable unless specifically indicated otherwise. Where "space only" is indicated, make provisions for future installation of breakers.

Submit detail drawings and manufacturer's standard product data for panelboards. Detail drawings consist of fabrication and assembly drawings for all parts of the work in sufficient detail to verify conformity with all requirements. Ensure drawings for panelboards indicate details of bus layout, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

2.2 COMPONENTS

2.2.1 Enclosure

Ensure panelboard enclosures are NEMA 250, Type [1][3R][_____] as indicated and in accordance with UL 50 and NEMA PB 1.

Provide [flush-mounted][[and][or]][surface mounted] panelboard cabinets[as indicated]. Ensure cabinets are constructed of 2 millimeter 12 gauge sheet steel and hot-dipped galvanized after fabrication. Ensure front of cabinet is form-flanged or fitted with structural shapes welded or riveted to the sheet steel for supporting the panelboard front. Provide panelboard cabinets fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 3 mm 1/8 inch.[Provide holes in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 13 mm 1/2 inch clear space between the back of the cabinet and the wall surface.]

[Provide front cover with center door for access to circuit breakers.][Provide door-in-door style cover where entire front is hinged on one side with a piano hinge for the full height and has [captive screws][keyed latch mechanism] opposite the hinged side. Provide side gutters in enclosure measuring minimum 145 millimeters 5.75 inches for routing of wiring. Where panelboards are installed flush with the walls, ensure that the hinged front can be opened without damage to the adjacent wall surfaces.] Ensure circuit breaker access doors are equipped with pin-tumbler cylinder locks. Ensure all locks provided[, including locks for hinged covers,] are identically keyed and properly tagged. Provide two keys for each enclosure.

Finish panelboards with [baked] [fast drying] enamel. Finish color is ASTM D1535 No. 61 gray conforming to FED-STD-595.[

Where indicated, provide panelboards with circuit breakers rated for use on 400 Hz systems and labeled "400 Hz."]

2.2.2 Panelboard Buses

Provide[[tinned] copper][aluminum] buses of the rating indicated, with main lugs or main circuit breaker. Provide all panelboards for use on grounded ac systems with a separate grounding bus in accordance with UL 67 bonded to the panelboard enclosure. [Ensure grounding bus is a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.][In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.]Provide three-phase, four-wire and single-phase, three-wire panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breaker switches and spaces indicated as spare.

Provide bus bar connections to the branch circuit breakers that are the "distributed phase" or "phase sequence" type. Ensure single-phase, three-wire panelboard busing is such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Ensure that three-phase, four-wire panelboard busing is such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Ensure current-carrying parts of the bus assembly are plated.

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping.

****

NOTE: Select the bracketed option below only if the non-linear loads are expected to be a majority of the downstream loads.

****

[2.2.2.1 Panelboard Neutrals for Non-Linear Loads

Where indicated, provide panelboard specifically listed for use on non-linear loads. Ensure panelboards are heat rise tested in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing. [Provide verification of testing procedure.]Two neutral assemblies paralleled together with cable is not acceptable. Ensure panel is marked "SUITABLE FOR NON-LINEAR LOADS" with field fabricated nameplate and provide a neutral label with instructions for wiring of panelboard.

]2.2.3 Circuit Breakers

****

NOTE: Include Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES in the project specification or include the requirements herein.

****

Provide circuit breakers that conform to UL 489 and NEMA AB 3 [and as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCORRECT PROTECTIVE DEVICES]with frame a trip ratings as indicated.

Provide bolt-on type, molded-case, manually operated, trip-free circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection. Completely enclose circuit breakers in

a molded case, with a factory-sealed, calibrated sensing element to prevent tampering. Plug-in type, tandem, and half-size circuit breakers are not permitted.

Provide inverse-time-delay thermal-overload protection and instantaneous magnetic short-circuit protection. Provide an instantaneous [thermal-magnetic][electronic][solid-state] tripping element that is adjustable and accessible from the front of the breaker on frame sizes larger than [100][250][_____] ampere.[Provide circuit breakers with frame sizes [100][250][_____] ampere and larger with [electronic] [solid-state] [trip units equipped with adjustable long-time][,][short-time][and][ground-fault] settings in addition to instantaneous.]

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Provide circuit breaker interrupting capacities with a minimum of 10,000 A and that conform to NEMA AB 3. Series rating of circuit breakers or overcurrent protective devices to achieve indicated interrupt rating is [not]permitted.

Provide the common-trip-type multipole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 40 degrees C 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective-type tripping (time delay, magnetic, thermal, or ground fault).

Provide a phenolic-composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required to meet lock-out/tag-out requirements of NFPA 70E.

Provide shunt trips where indicated.

Ensure branch circuit breakers supplying convenience receptacle circuits have sensitive instantaneous trip settings of not more than [10] [_____] times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Provide UL listed single-pole 15- and 20-ampere circuit breakers as "Switching Breakers" at [120 volts ac] [277 volts ac].

When multiple wires per phase are specified, furnish the circuit breakers with connectors made to accommodate multiple wires.

Ensure circuit breaker spaces called out on the drawings are complete with mounting hardware to permit ready installation of the circuit breakers.

2.2.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.2.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with "push-to-test" button, visible

indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A ground-fault circuit interrupter. Tripping of a branch circuit breaker containing ground fault circuit interruption is not to disturb the feeder circuit to the panelboard.

2.2.3.3 Circuit Breakers for HVAC Equipment

Provide circuit breakers for HVAC equipment having motors (group or individual) marked for use with HACR type and UL listed as HACR type.

2.2.3.4 Arc-Fault Circuit Interrupters

****

NOTE: NFPA 70 requires that all branch circuits that supply 120 volt, single phase, 15 and 20 ampere outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas are protected by an arc-fault circuit interrupter to provide protection of entire branch circuit.

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****

NOTE: The one pole arc-fault circuit-interrupter is not designed for use on circuits in which the neutral conductor is shared with other circuits (defined as a multiwire branch circuit in NFPA 70) and will nuisance trip on shared neutral circuits. Provide and indicate on the drawings one pole arc-fault circuit-interrupter breakers for each circuit, and do not use shared neutral for these circuits in new construction projects. Where wiring is existing and not replaced and where a shared neutral exists, a two pole, 120/240 volt arc-fault circuit-interrupter for shared neutral circuits may be required. It may also be required in new construction if 120/240 volt equipment or circuit is located in the bedroom. Coordinate the requirement with the cognizant Activity.

****

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

2.2.4 Directory Card and Holder

Provide a directory card on the inside of hinged fronts and doors [under glass][under non-flammable plastic][in a metal frame], with spaces for circuit numbers and load supplied. Where hinged fronts or doors are not required, provide the directory card [under glass][under plastic][in a metal frame] mounted on the left-hand side of the front trim. Ensure the directory card includes type written designations identifying each branch circuit with its respective and numbered circuit breaker.

[2.2.5 Filtered Panelboards

2.2.5.1 General

[Design panelboards for the distribution, control, and protection of electrical circuits, providing filtering and shielding performance and, when specified, conforming to MIL-HDBK 232.

] Provide panelboard cabinet with [two (2)][_____] millimeter [12][_____]-gauge steel minimum, corrosion-resistant finish and four external mounting brackets welded to the case. Provide code-gauge steel front door and trim, with ASTM D1535 No. 61 gray finish, equipped with directory, holder, adjustable trim clamps, hinges, self-latching catch, tumbler lock and key and bears the UL label. Provide a red diagonal strip across the outside surface of door and trim.

2.2.5.2 RF Shielding

Ensure circuit breaker and filter compartments are completely radio-frequency (RF) shielded and in compliance with specified shielding requirements with front door open. Ensure case seams are continuous inert gas welded. Fit removable circuit breaker actuator faceplate and the filter compartment cover with corrosion-resistant RF gasketing material. Install in place with suitable fasteners having a maximum spacing of [75] [_____] millimeter [3] [_____] inches on center. Mount RF filter units to the internal shield wall with similar RF gasketing to ensure RF shielding integrity.

2.2.5.3 Circuit Breaker Actuators

Design circuit breaker operating mechanisms to maintain RF shielding effectiveness without limit to time or number of operations.

2.2.5.4 Terminals

Ensure filter terminals are high-temperature alumina ceramic, continuously brazed to filter case. Do not use soft solder. Provide ceramic terminals that incorporate a permanently attached flexible lead, with a suitable electric lug. Make incoming service connections to the filter lead at a UL-approved, flame-retardant standoff insulator, mounted in the filter compartment.

2.2.5.5 Attenuation

Ensure each filter provides a minimum insertion loss of [100] [_____]dB over the frequency range of [14 kilohertz (kHz) to 10 gigahertz (GHz)] [_____]. Ensure each filter provides a full rated load insertion loss of [100] [_____]dB in the frequency range [14 kHz to 20 megahertz (MHz)], to [14] [_____]kHz as measured by a Government-approved laboratory.

2.2.5.6 Current

Ensure each filter unit is capable of carrying its full rated current continuously without heat rise exceeding 50 [_____] degrees C 122 [_____] degrees F above ambient temperature. Ensure each filter is capable of withstanding a [100] [_____]-percent overload for [30] [_____] seconds without damage.

2.2.5.7 Voltage

Ensure each filter unit is capable of continuous operation at its full rated voltage and withstanding an initial voltage test of twice its rated voltage without damage.

2.2.5.8 Circuit Breakers

Ensure circuit breakers are rated a minimum 10,000 amperes asymmetrical ac interrupting capacity, 5,000 amperes dc, and are in accordance with UL 489.

2.2.5.9 RF Filters

Design RF filter units to suppress and reduce the amplitude of undesired RF energy conducted by power service lines.[Design RF filter units in compliance with the applicable requirements of ECIA RS-416.]

Provide filter cases made of steel, 1.2 [_____] millimeter [16][_____]-gaugeminimum, corrosion-resistant finish with a blue lacquer over zinc chromate primer. Use conductive grounding surfaces that are either plated or made of corrosion-resistant steel. Use continuous inert gas welds for hermetic seams; do not use soft solder. Firmly mount internal components to withstand applicable shock and vibration test requirements without damage.

Ensure internal components are fully impregnated and immersed in the fluid to obtain the full benefit of cooling by convection flow through the liquid medium to filter case. Completely fill filter case with the fluid. Ensure fluid conforms to UL nonflammable classification.

2.2.5.10 Filter Discharge Unit

Provide a filter discharge unit for three-filtered circuits on the panelboard. Install in accordance with NFPA 70.[Ensure unit meets applicable requirements of ECIA/IS 46]

][2.2.6 Surge Protective Devices

****

NOTE: Surge protection should be provided for the following types of facilities: Medical facilities; Air navigation aids and facilities; Petroleum, oil and lubricant (POL) storage and dispensing facilities; Critical utility plants and systems; Communication facilities and telephone exchanges; Fire stations, including fire alarm, fire control and radio equipment; Critical computer automatic data processing facilities; Air traffic control facilities; Base weather stations; Surveillance and warning facilities; Command and control facilities; Weapon systems; Security lighting systems; Mission, property and life support facilities at remote and not readily accessible sites.

Consider surge protection for all types of facilities located in regions with a high lightning strike probability (refer to IEEE C62.41.1 and C62.41.2) and facilities located near commercial utility systems with routine substation capacitor

switching.

Refer to UFC 3-520-01 for additional criteria.
****

****
NOTE: Whenever possible, connect surge protectors to a spare circuit breaker in the associated panel. Locate the surge protectors immediately adjacent to the protected equipment.

It is not necessary to provide surge protection on all panelboards; the selection of which panelboards should have surge protective devices depends on the importance of the loads served and the sensitivity of electronic equipment connected to the circuits.

Switching loads such as motor control centers should have surge protection to limit the transmission of switching transients to the rest of the facility.

HVAC equipment usually contain electronic controls that are sensitive to surges.
****

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the [service entrance][, load centers] [, panelboards] [and] [_____]. Provide surge protectors in a NEMA[1][_____] enclosure per NEMA ICS 6. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker. Ensure SPDs are of the Metal Oxide Varistor (MOV) type and rated have fault current rating equal to or greater than the rating of the device to be protected. Where internal fuses are used, ensure fuses will allow maximum rated surge to pass without operating fuse.

Provide SPDs that are [external to][factory installed and integrated with] the equipment to be protected. [Ensure factory installed SPDs are supplied through a dedicated circuit breaker or are directly connected to the bus with no wire between bus bare and SPD.][Ensure SPDs are installed with external protective device sized in accordance with manufacturer's recommendations. Install SPD parallel to equipment to be protected and as close as possible to minimize wire length between SPD and equipment to be protected.]

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase (L-L)
Each phase to neutral (L-N)
[Neutral to ground (N-G)]
[Phase to ground (L-G)]

[
FOR DELTA CONNECTIONS-
Phase to phase (L-L)
Phase to ground (L-G)

] SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G)[and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G)].

****

NOTE: Select the first bracketed section below when surge protection is installed as part of a lightning protection system per NFPA 780. Select the second bracketed option below if the surge protection is not part of a lightning protection system; the second bracketed option values are based on manufacturers' standard products and are not as restrictive as NFPA 780.

****

[Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, L-G, and N-G Voltage Protection Rating:

[600V for 120V, single phase system]
[600V for 120/240V, single phase system]
[600V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-L Voltage Protection Rating:

[1,200V for 120V, single phase system]
[1,200V for 120/240V, single phase system]
[1,200V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

][Provide SPDs. Maximum L-N, L-G, and N-G Voltage Protection Rating:

[700V for 120V, single phase system]
[700V for 120/240V, single phase system]
[700V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-L Voltage Protection Rating:

[1,200V for 120V, single phase system]
[1,200V for 120/240V, single phase system]
[1,200V for 208Y/120V, three phase system]
[2,000V for 480Y/277V, three phase system]

] The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120% of nominal voltage for 240 volts and below; 115% of nominal voltage above 240 volts to 480 volts.

****

NOTE: Provide EMI/RFI filtering when required by project documents.

****

[Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

]]2.2.7 Precautionary Label

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, conspicuously mark each panelboard on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a

door, ensure the label is visible when the door is in the open position.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Provide panelboards in compliance with UL 67.

PART 3 EXECUTION

3.1 INSTALLATION

Install panelboards in accordance with the manufacturer's instructions. Fully align and mount panels so that the height of the top operating handle does not exceed [1800][2000][_____]millimeter [72][79][_____]inches above the finished floor.

Ensure directory-card information is typewritten in capital letters to indicate loads served by each circuit and is mounted in holders behind protective covering.

3.2 FIELD QUALITY CONTROL

****
NOTE: If the specified system is identified as critical, configured, or mission essential, use Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS to establish predictive and acceptance testing criteria, above and beyond that listed below.
****

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Do not energize panelboards until the recorded test data has been submitted to and approved by the Contracting Officer.

Provide test equipment, labor, and personnel as required to perform the acceptance tests as specified. Record and submit test data. Include the location and identification of panelboards and megohm readings versus time.

Conduct continuity tests using a dc device with [bell] [buzzer] [_____]. Document results as pass-fail.

Conduct continuity and insulation tests on the panelboards after the installation has been completed and before the panelboard is energized. Document results as pass-fail.

Conduct insulation tests on 480-volt panelboards using a 1,000-volt insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been obtained. Ensure resistance between phase conductors and between phase conductors and ground is not less than 50 megohms.

Conduct insulation tests on panelboards rated 300 volts or less using a 500-volt minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Ensure resistance between phase conductors and between phase conductors and ground is not less than 25 megohms.

Conduct phase-rotation tests on all panelboards using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment in a clockwise direction, facing the source.

3.3 CLOSEOUT ACTIVITIES

Submit manufacturer's instructions for panelboards including special provisions required to install equipment components and system packages. Provide special notices details impedances, hazards and safety precautions.

-- End of Section --