

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 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.

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 416 (1974; R 1981) Filters for Radio Interference

EIA/IS 46 (1987) Test Procedure for Resistance to Soldering (Vapor Phase Technique) for Surface Mount Devices

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA PB 1 (2006; Errata 2008) Panelboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; TIA 11-1; Errata 2011) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

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

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

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

UNDERWRITERS LABORATORIES (UL)

UL 489 (2009) Molded-Case Circuit Breakers,
Molded-Case Switches, and Circuit-Breaker
Enclosures

UL 67 (2009; Reprint Sep 2010) Standard for
Panelboards

1.2 GENERAL REQUIREMENTS

NOTE: If Section 26 00 00.00 20 BASIC ELECTRICAL
MATERIALS AND METHODS is not included in the project
specification, applicable requirements therefrom
should be inserted and the following paragraph
deleted.

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to
work specified in this section.

Submit [Detail Drawings](#) for the panelboards consisting of fabrication and
assembly drawings for all parts of the work in sufficient detail to enable
the Government to check conformity with the requirements of the contract
documents. Include within drawings details of bus layout.

Ensure [Outline Drawings](#) for panelboards indicate overall physical features,
dimensions, ratings, service requirements, and weights of equipment.

[Statements](#) signed by responsible officials of a manufacturer of a product,
system, or material attesting that the product, system or material meet
specified requirements. Statements must be dated after the award of this
contract, name the project, and list the specific requirements which it is
intended to address.

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions
in Section 01 33 00 SUBMITTAL PROCEDURES and edit
the following list to reflect only the submittals
required for the project. Submittals should be kept
to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the
submittal requires Government approval. Some
submittals are already marked with a "G". Only
delete an existing "G" if the submittal item is not
complex and can be reviewed through the Contractor's
Quality Control system. Only add a "G" if the
submittal is sufficiently important or complex in
context of the project.

For submittals requiring Government approval on Army
projects, a code of up to three characters within
the submittal tags may be used following the "G"
designation 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.

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

SD-02 Shop Drawings

Submit [Detail Drawings](#) and [Outline Drawings](#) for panelboards in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

[Panelboards](#)

[Directory Card and Holder](#)

[Filtered Panelboard](#)

SD-04 Samples

Ensure that [Keys](#) are properly tagged and delivered to the Contracting Officer.

SD-06 Test Reports

Submit test reports for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Do not energize panelboards until the recorded test data has been submitted to and approved by the Contracting Officer.

[Continuity Tests](#)

[Insulation Tests](#)

SD-07 Certificates

Submit [Statements](#) in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for **Panelboards** including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

1.4 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/or 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/or 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**

Totally enclose power-distribution panelboards and lighting and appliance branch-circuit panelboards in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Ensure panelboards conform to **NEMA PB 1** and **UL 489**. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. Provide a center door for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Provide four-wire distribution panelboards and lighting and appliance branch-circuit panelboards with an isolated full-capacity neutral bus. Ensure panelboards are rated for [240-volt (maximum), single-phase] [120/208-volt, three-phase] [277/480-volt, three-phase], 60-hertz current.

Provide three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Provide panelboards with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Ensure panelboards and main lugs or main breaker have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be 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. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

[Boxes shall have the manufacturer's standard knockouts and shall be galvanized code-gage sheet steel. Fronts shall be of code-gage sheet steel furnished with hinged doors with adjustable trim clamps for securing the fronts to the boxes.

] [Panelboard box shall be [galvanized] [rust-resistant] code-gage sheet steel without knockouts. Ensure entire panelboard front is hinged on one side with a piano hinge for the full height and has captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces. Ensure that the color of the finished coat of trim and front matches the adjacent walls except when the box is installed in electrical closets or equipment rooms, the gray finish as specified is acceptable.

] Panelboard enclosures shall be NEMA 250, Type 1. Provide enclosures with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Key locks alike and provide two keys for each enclosure.

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

2.2 CIRCUIT BREAKERS

NOTE: Include Section 26 05 70.00 40 HIGH VOLTAGE
OVERCURRENT PROTECTIVE DEVICES and Section
26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE
DEVICES in the project specification or include the
requirements herein.

Circuit breakers shall be the molded-case type as specified in Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCORRECT PROTECTIVE DEVICES. Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in [120/208] [_____] -volt panelboards shall be not less than [10,000] [_____] amperes rms symmetrical, and that for breakers in [277/480] [_____] -volt panelboards shall be not less than [25,000] [_____] amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type is not acceptable.

Provide shunt trips where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall 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. Single-pole 15- and 20-ampere circuit breakers shall be UL listed as "Switching Breakers" at [120 volts ac] [277 volts ac]. Provide UL Class A (5-milliampere sensitivity) ground fault circuit protection on 120-volt ac branch circuit as indicated. This protection is an integral part of the branch circuit breaker that also provides overload and short-circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption is not to disturb the feeder circuit to the panelboard. A single-pole circuit breaker with integral ground fault circuit interruption requires no more panelboard branch circuit space than a conventional slide pole circuit breaker.

Ensure connections to the bus are bolt-on type.

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.

2.3 DIRECTORY CARD AND HOLDER

Mount a directory card on the inside of hinged fronts and doors [under glass] [0.76 millimeter 0.030-inch thick minimum plastic] in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Where hinged fronts or doors are not required, provide the directory card [under glass] [0.76 millimeter 0.030-inch thick minimum plastic] in a metal frame mounted on the left-hand side of the front trim. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FILTERED PANELBOARDS

2.4.1 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. (Portions of MIL-HDBK 232 are classified and will be available only on classified projects to approved companies and individuals.)

Panelboard cabinet shall be [2.7] millimeter [12]-gage [____] steel minimum, with corrosion-resistant finish and four external mounting brackets welded to the case. Front door and trim shall be of code gage steel, with gray finish, equipped with directory, holder, adjustable trim clamps, hinges, self-latching catch, tumbler lock and key and shall bear the UL label. Provide a red diagonal strip across the outside surface of door and trim.

2.4.2 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. Case seams shall be continuous inert gas welded. Fit removable circuit breaker actuator faceplate and the filter compartment cover with corrosion-resistant RF gasketing material and 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.

2.4.3 Circuit Breaker Actuators

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

2.4.4 Terminals

Filter terminals shall be of high-temperature alumina ceramic, continuously brazed to filter case. Do not use soft solder. Ceramic terminal shall incorporate a permanently attached flexible lead, with a suitable electric lug. Incoming service connections shall be made to the filter lead at a UL-approved, flame-retardant standoff insulator, mounted in the filter compartment.

2.4.5 Attenuation

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

2.4.6 Current

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

2.4.7 Voltage

Each filter unit shall be capable of continuous operation at its full rated voltage and withstanding an initial voltage test of twice its rated voltage without damage.

2.4.8 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.

2.4.9 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 EIA 416.

Filter cases shall be made of steel, 1.6 millimeter [16]-gage [_____] minimum, corrosion-resistant finish with a blue lacquer over zinc chromate primer. Conductive grounding surfaces shall be either plated or made of corrosion-resistant steel. Hermetic seams are to be continuous inert gas welded; do not use soft solder. Firmly mount internal components to withstand applicable shock and vibration test requirements without damage.

Fluid impregnant shall conform to UL nonflammable classification. Internal components shall be fully impregnated and intimately 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 impregnant.

2.4.10 Filter Discharge Unit

Install a filter discharge unit for three-filtered circuits on the panelboard. Unit shall meet applicable requirements of EIA/IS 46, and be installed in accordance with NFPA 70.

2.5 FACTORY TESTING

Test complete panelboards in accordance with UL 67.

2.6 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked 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.

PART 3 EXECUTION

3.1 INSTALLATION

Install panelboards as indicated and 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 millimeter [72]-inches [_____] above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

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.

Each panelboard enclosure key shall be shown to operate the enclosure locks
in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the
installation has been completed and before the panelboard is energized.

Provide test equipment, labor, and personnel as required to perform the
tests as specified. Conduct Continuity tests using a dc device with [bell]
[buzzer] [_____].

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. Resistance between
phase conductors and between phase conductors and ground shall be 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. Resistance
between phase conductors and between phase conductors and ground shall be
not less than 25 megohms.

Record test data and include the location and identification of panelboards
and megohm readings versus time.

-- End of Section --