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USACE / NAVFAC / AFCEC / NASA UFGS-26 24 16.00 40 (August 2013)  
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Preparing Activity: NASA Superseding  
UFGS-26 24 16.00 40 (August 2010)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2016

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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 if the latter have an interrupting rating of more than 10,000 amperes rms symmetrical.

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 items(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).

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## PART 1 GENERAL

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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.

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

## 1.1 REFERENCES

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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 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.

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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 (2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA PB 1 (2011) Panelboards

### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

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 489 (2013; Reprint Mar 2014) Molded-Case  
Circuit Breakers, Molded-Case Switches,  
and Circuit-Breaker Enclosures

UL 67 (2009; Reprint Apr 2015) Standard for  
Panelboards

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 to reflect only the submittals  
required for the project.

The Guide Specification technical editors have  
designated 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 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.

An "S" following a submittal item indicates that the  
submittal is required for the Sustainability  
Notebook to fulfill federally mandated sustainable  
requirements in accordance with Section 01 33 29  
SUSTAINABILITY REPORTING.

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

item for Army projects.

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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.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings[; G[, [\_\_\_\_]]]

Outline Drawings[; G[, [\_\_\_\_]]]

SD-03 Product Data

Panelboards[; G[, [\_\_\_\_]]]

Directory Card and Holder[; G[, [\_\_\_\_]]]

Filtered Panelboards[; G[, [\_\_\_\_]]]

SD-06 Test Reports

Continuity Tests[; G[, [\_\_\_\_]]]

Insulation Tests[; G[, [\_\_\_\_]]]

SD-07 Certificates

Statements[; G[, [\_\_\_\_]]]

SD-08 Manufacturer's Instructions

Panelboards[; G[, [\_\_\_\_]]]

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

Ensure the manufacturer of the assembly is the manufacturer of the major components within the assembly and has produced similar electrical equipment for a minimum period of five years.

Provide statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Ensure statements are dated after the award of this contract, with the project name, and a list of the specific requirements which it is intended to address.

## 1.5 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

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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.

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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 COMPONENTS

#### 2.1.1 Panelboards

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.

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. Provide branch circuit panels with buses fabricated for bolt-on type circuit breakers.

Provide an outer door or cover, hinged on one side, 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 is 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. Ensure grounding bus is a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Ensure each panelboard, as a complete unit, has 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 are the "distributed phase" or "phase sequence" type. 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. Three-phase, four-wire 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. Mains ratings are as shown.

For mechanical lugs furnished with panelboards, use cast copper or copper alloys of sizes suitable for the conductors indicated.

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

] [Panelboard box is [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 are 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.

] Ensure panelboard enclosures are NEMA 250, Type 1. Provide enclosures with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks.

Key the locks alike and properly tagged. Provide two keys for each enclosure to the Contracting Officer.

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

## 2.1.2 Circuit Breakers

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**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.

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Provide molded-case breakers 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 are as indicated.

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

Use bolt-on type breakers. Plug-in type is not acceptable.

Provide shunt trips where indicated.

In branch circuit panelboards, ensure branch circuit breakers feeding convenience outlets 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]. 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.

#### 2.1.3 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. The directory card identifies each branch circuit with its respective and numbered circuit breaker.



#### 2.1.4 Filtered Panelboards

##### 2.1.4.1 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 are available only on classified projects to approved companies and individuals.)

Provide panelboard cabinet with [2.7] millimeter [12]-gage [\_\_\_\_\_] steel minimum, corrosion-resistant finish and four external mounting brackets welded to the case. Front door and trim is code gage steel, with 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.

##### 2.1.4.2 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. 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.

##### 2.1.4.3 Circuit Breaker Actuators

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

##### 2.1.4.4 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.

##### 2.1.4.5 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 as measured by a Government-approved laboratory.

##### 2.1.4.6 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. Each filter is capable of withstanding a [100] [\_\_\_\_\_] -percent overload for [30] [\_\_\_\_\_] seconds without damage.

#### 2.1.4.7 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.

#### 2.1.4.8 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.

#### 2.1.4.9 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.]

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

Ensure fluid impregnant conforms to UL nonflammable classification. Ensure internal components are 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.

#### 2.1.4.10 Filter Discharge Unit

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

#### 2.1.5 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.

### 2.2 FACTORY TESTING

Test complete panelboards in accordance with UL 67.

## 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.

Ensure directory-card information is typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit

and is mounted in holders behind protective covering.

### 3.2 SITE TESTING

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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.  
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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  
tests as specified. Conduct continuity tests using a dc device with [bell]  
[buzzer] [\_\_\_\_\_].

Demonstrate each panelboard enclosure key operates the enclosure locks in  
the presence of the Contracting Officer.

Conduct continuity and insulation tests on the panelboards after the  
installation has been completed and before the panelboard is energized.

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.

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

-- End of Section --