PB 1

Panelboards

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NEMA STANDARDS PUBLICATION PB 1-2000

Panelboards

Published by:

National Electrical Manufacturers Association
1300 N. 17th Street, Suite 1847
Rosslyn, Virginia 22209

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FOREWORD

This standards publication is intended to provide a basis of common understanding within the electrical community by aiding the user and specifier in properly selecting panelboards for specific applications by stating:

a. The general standards for panelboards including the types, insulating requirements, unusual service conditions, service equipment requirements, ampacity, and markings
b. Standard panelboard ratings including short circuit current ratings
c. Test procedures and tests for panelboard design and production
d. Manufacturing standards for panelboards
e. Panelboard application standards to provide proper selection of a panelboard and its components to ensure satisfactory service

PB 1-2000 completely revises and supersedes PB 1-1995.

These standards are periodically reviewed by the Panelboard and Distribution Board Section of NEMA for any revisions necessary to keep them up-to-date with advancing technology. User needs have been considered throughout the development of this publication. Proposed or recommended revisions should be submitted to:

Vice President, Engineering
National Electrical Manufacturers Association
1300 N. 17th Street
Rosslyn, Virginia 22209

This standards publication was developed by the Panelboard and Distribution Board Section. At the time it was approved, the section was composed of the following members:

Adalet-PLM—Cleveland, OH
Cooper B-Line Systems—Portland, OR
Current Technology, Inc.—Richardson, TX
Eaton Corporation—Pittsburgh, PA
The Durham Company—Lebanon, MO
GE—Plainville, CT
Hubbell, Inc.—Bridgeport, CT
Industrial Electric Mfg., Inc.—Fremont, CA
Milbank Manufacturing Company—Kansas City, MO
Penn Panel & Box Company—Collingdale, PA
Post Glover Resistors, Inc.—Erlanger, KY
The Pringle Electrical Mfg. Co.—Montgomeryville, PA
Reliance Controls Corporation—Racine, WI
Siemens Energy & Automation, Inc.—Alpharetta, GA
Square D Company—Palatine, IL
Thomas & Betts Corporation—Memphis, TN

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Section 1
GENERAL

1.1 SCOPE

This standards publication covers single panelboards or groups of panel units suitable for assembly in the form of single panelboards, including buses, and with or without switches or automatic overload protective devices (fuses or circuit breakers), or both. These units are used in the distribution of electricity for light, heat, and power at 600 volts and less with:

a. 1600-ampere mains and less
b. 1200-ampere branch circuits and less

Specifically excluded are live-front panelboards, panelboards employing cast enclosures for special service conditions, and panelboards designed primarily for residential and light commercial service equipment.

1.2 REFERENCED STANDARDS

American National Standards Institute
11 West 42nd Street
New York, NY 10036

ANSI Z535.4-1998 *Product Safety Signs and Labels*

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269

NFPA 70-1999 *National Electrical Code*

National Electrical Manufacturers Association
1300 N. 17th Street, Suite 1847
Rosslyn, Virginia 22209

AB 1-1999 *Molded Case-Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures (UL 489, 9th edition)*

FU 1-1986 *Low-Voltage Cartridge Fuses*

KS 1-1996 *Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)*

250-1997 *Enclosures for Electrical Equipment (1000 Volts Maximum)*

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062

UL 50-1995 *Cabinets and Boxes*

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ANSI/UL 67-1993	*Panelboards*
UL 198B-1995	*Class H Fuses*
UL 198C- 1986	*High-Interrupting-Capacity-Limiting Type Fuses*
UL 198D-1995	*Class K Fuses*
UL 198F-1995	*Plug Fuses*
UL 198L-1995	*DC Fuses for Industrial Use*
UL 248-1-1994	*Low-Voltage Fuses—Part 1: General Requirements*
UL 248-4-1994	*Low-Voltage Fuses—Part 4: Class CC Fuses*
UL 248-8-1994	*Low-Voltage Fuses—Part 8: Class J Fuses*
UL 248-10-1994	*Low-Voltage Fuses—Part 10: Class L Fuses*
UL 248-12-1994	*Low-Voltage Fuses—Part 12: Class R Fuses*
UL 248-14-1994	*Low-Voltage Fuses—Part 14: Supplemental Fuses*
UL 248-15-1994	*Low-Voltage Fuses—Part 15: Class T Fuses*
UL 869A-1998	*Reference Standard for Service Equipment*

1.3 DEFINITIONS

For the purpose of this standards publication, the following definitions shall apply:

ambient temperature: The temperature of the air or other medium where the equipment is to be used.

ampacity: The current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

asymmetrical current: An alternating current having a waveform that is offset with respect to the zero axis due to a transient condition. The offset occurs at the initiation of a short circuit or other change in current. The offset usually decays quickly until steady-state conditions are reached and the current becomes symmetrical. Asymmetrical current is composed of the symmetrical and direct current components. It is expressed in rms total amperes or rms asymmetrical amperes at a specific time (normally $^1/_2$ cycle) after initiation of a short circuit or other change in current.

auxiliary switch: Switches which are mechanically operated by a main switching device or switching, interlocking of other purposes. Auxiliary switch contacts shall be permitted to be designated as "a" or "b" as indicated below, but other contact arrangements shall be permitted to be used.

a. Contacts designated "a" are open when the switching device contacts are open or tripped and closed when the switch contacts are closed.

b. Contacts designated "b" are closed when the switching device contacts are open or tripped and open when the switch contacts are closed.

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available short circuit current: The maximum current in rms symmetrical amperes that a circuit is capable of delivering at the system terminals ahead of the apparatus being supplied.

barrier: A partition for the insulation or isolation of electric circuits or electric arcs.

bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

bonding jumper: A reliable conductor to assure the required electrical conductivity between metal parts required to be electrically connected.

bonding screw: A screw that is used as a bonding jumper or to attach a bonding jumper to a metal part of a grounding circuit.

bus: A conductor, or group of conductors, that serves as a common connection for two or more circuits.

cabinet: An enclosure designed for either surface or flush mounting and provided with a frame, matte, or trim in which a swinging door or doors are or may be hung.

cartridge fuse: A fuse consisting of a current responsive element inside a fuse body with contacts on both ends.

circuit breaker: A device designed to open and close a circuit by non automatic means, and to open the circuit automatically on a predetermined overcurrent, without injury to itself when properly applied within its rating.

clearing I^2t: The measure of heat energy developed as a result of current flow between the time that current begins to flow and until the overcurrent protective device clears the circuit. "I^2" stands for the square of the effective (rms) let-through current, and "t" stands for the time of current flow in seconds.

clearing time: Total time measured from the beginning of the specified overcurrent condition until the interruption of the circuit at rated voltage.

compression wire connector: A non-reusable connector in which the pressure to affix the connector to the electrical conductor is applied by deformation of the connector and conductor by an application tool that is removed before service.

continuous duty: Operation at a substantially constant load for an indefinitely long time.

continuous load: A load where the maximum current is expected to continue for three hours or more.

current-limiting device: An overcurrent protective device that, when interrupting currents in its current-limiting range, will reduce the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having a comparable impedance.

current-limiting range: The range of symmetrical rms available currents equal to and less than the interrupting rating of the device in which the total clearing time at rated voltage and frequency is less than $^1/_2$ cycle.

current rating: The designated maximum direct or alternating current in rms amperes at rated frequency that a device can carry continuously under specified conditions.

device: A unit of an electrical system that is intended to carry or control, but not utilize, electrical energy.

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dielectric withstand tests: Tests to determine the ability of the insulating materials and spacings to withstand overvoltages.

distribution (feeder or power) panelboard: A panelboard having circuit switching and overcurrent protective devices used primarily for two purposes: (1) to supply distribution circuits to lighting and appliance branch circuit panelboards or to other distribution panels, or (2) to feed a group of circuits other than the lighting and appliance type or both.

double-lug panelboard: A panelboard that has two sets of main line terminals, each set having sufficient current-carrying capacity to supply the panelboard. (See Figures 1-1 and 1-2.)

dummy fuse; test link: A current-carrying part made of copper and having dimensions such that it will fit its fuse mounting means with the same conditions of pressure, contact, and cross-sectional areas as are obtained on terminals of the fuse that it is intended to replace. A dummy fuse is not a protective device and is intended for use only in design tests.

enclosed panelboard: A panelboard that is mounted in a suitable cabinet or enclosure.

enclosure: A surrounding case constructed to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specified environmental conditions.

feed-through lugs: Terminals that are connected to the main bus bars at the end opposite from the incoming line terminals and that provide for connection to outgoing cables. (See Figure 1-3.)

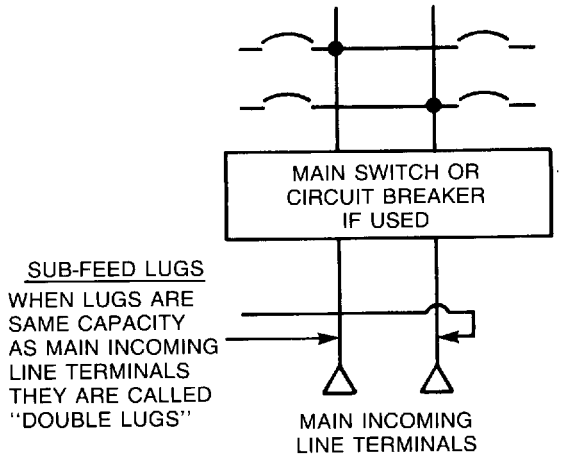


Figure 1-1
DOUBLE-LUGS OR SUB-FEED LUGS CONNECTED TO MAIN INCOMING LINE TERMINALS

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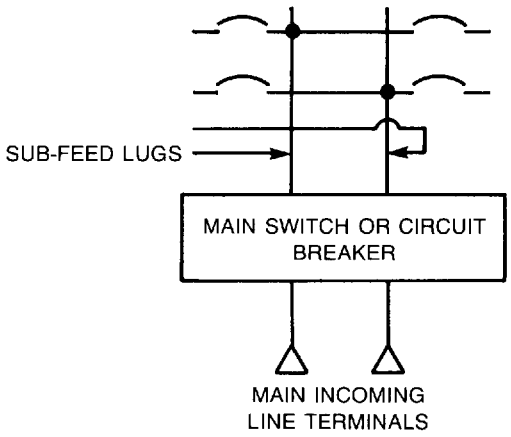


Figure 1-2
SUBFEED LUGS CONNECTED TO BUS BARS PROTECTED BY AN OVERCURRENT PROTECTIVE DEVICE IN THE PANELBOARD

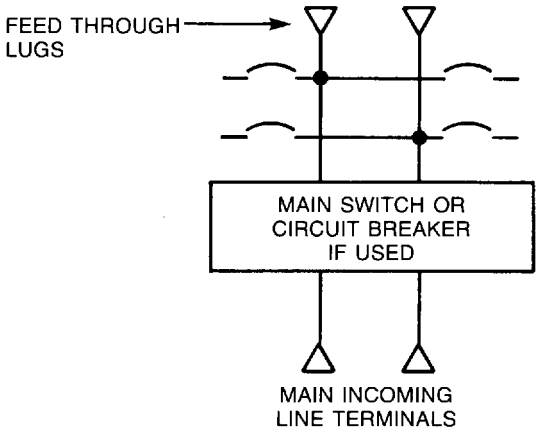


Figure 1-3
FEED-THROUGH LUGS FOR A SEPARATE CIRCUIT EXTERNAL TO THE PANELBOARD

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flush mounted (type): A device designed to be set into and secured to a flat surface, with a minimal front projection.

frame size: Applies to a group of molded case circuit breakers that are physically interchangeable with each other. Frame size is expressed in amperes and corresponds to the largest ampere rating available in the group. Groups may or may not be physically interchangeable with each other whether furnished by one manufacturer or various manufacturers.

fuse: A protective device that opens by the melting of a current-sensitive element during specified overcurrent conditions.

fuse clips: The contacts of the fuseholder that support the fuse and connect the fuse terminals with the circuit.

fusible switch: A switch in which one or more poles have a fuse in series in a composite unit.

fuseholder: An assembly of a base, fuse clips, and necessary insulation for the mounting and connecting of a fuse into a circuit.

grounded: Connected to earth or to some conducting body that serves in place of the earth.

grounded conductor: A system or circuit conductor that is intentionally grounded.

ground-fault protector (GFP): A ground-fault protector is a device or system that provides protection for equipment (not for personnel) by opening the circuit in case of a predetermined ground-fault current. A ground-fault protector includes a ground-fault current sensing device and relaying equipment, or a combination of a ground-fault current sensing device and relaying equipment, that will operate to cause a disconnecting means to function at a predetermined value of ground-fault current.

grounding conductor: A conductor used to connect equipment or the grounded circuit of a wiring system to the grounding electrode or electrodes.

grounding conductor, equipment: The conductor used to connect noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor, the grounding electrode conductor, or both, at the service equipment or at the source of a separately derived system.

gutter tap lugs: Terminals that are located in a wiring gutter of a panelboard cabinet and that provide for (1) the connection of the incoming and outgoing conductors and panelboard mains, or (2) the connection of two sets of outgoing conductors to a branch or other outgoing circuit. (See Figures 1-4 and 1-5.)

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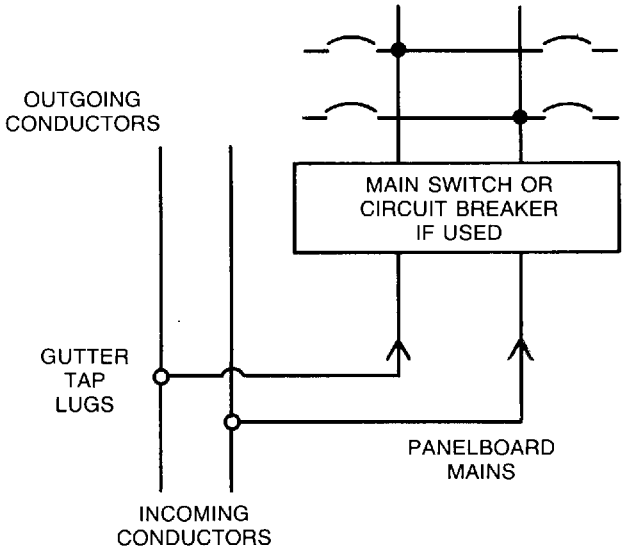


Figure 1-4
GUTTER TAP LUGS CONNECTED TO PANELBOARD MAINS

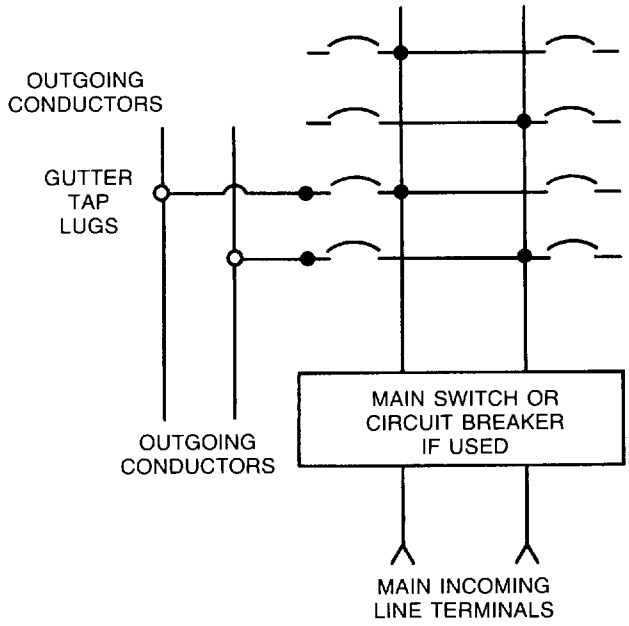


Figure 1-5
GUTTER TAP LUGS CONNECTED TO A BRANCH CIRCUIT

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hinged-cover switch: A switch that disconnects the circuit when the hinged cover is manually operated and in which suitable means are provided for reclosing the cover without reestablishing the circuit.

interlock: An electrical or mechanical component actuated by the operation of a device or other means with which it is directly associated to govern succeeding operations of the same or allied devices.

interrupting rating: The highest current at rated voltage that a device is intended to interrupt under standard test conditions.

knockout: A portion of the wall of a box or enclosure that may be removed readily at the time of installation in order to provide an unthreaded hole for the attachment of raceway, cable assemblies, or their fitting.

lighting and appliance branch circuit panelboard: A panelboard having more than 10 percent of its overcurrent devices rated 30 amperes or less, for which neutral connections are provided. Not more than forty-two overcurrent devices (other than those provided for in the mains) of a lighting and appliance branch circuit panelboard shall be installed in any one cabinet or cutout box.

lugs: Terminals that provide for the connection of conductors to a panelboard or for connections between component parts of a panelboard.

mains (main terminals): The terminals, or main device, that are provided for the connection of the main incoming line conductors.

meter loop: A form of split-bus construction in which each set of bus bars has terminals to provide for the metering of a portion of the panelboard.

neutral (assembly); solid neutral: An assembly consisting of an appropriate number of terminals to provide for the connection of the grounded (neutral) line and load conductors. When used as a component of service equipment, the neutral also includes (1) a means for making the required bonding connection between the neutral and the enclosure and (2) a terminal for the service grounding conductor.

neutral conductor: A conductor that is connected to the midpoint of a three-wire single-phase system, the center point of a wye-connected three-phase system, or the midpoint of one side of a delta-connected three-phase system.

overcurrent protective device: An individual fuse or circuit breaker pole.

panelboard: A single panel or a group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices; equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition; and accessible only from the front.

peak let-through current (AC): The maximum instantaneous current through an overcurrent device during the total clearing time.

plug fuse: A fuse consisting of a current-responsive element inside a housing with coaxial terminals on one end, with one terminal being a threaded metal ring or shell on the outside of the housing.

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pressure wire connector: A reusable connector into which the conductor (wire) is secured by mechanical pressure applied by an integral screw, cone, or other mechanical parts.

pullout switch: A switch, enclosed or non-enclosed, that is operated to open a circuit by manually separating the movable contact from the stationary contact, and is operated to close a circuit by manually reconnecting the movable contact and the stationary contact.

rating: A designated limit of operating characteristics based on defined conditions.

service: The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

service equipment: The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the supply.

short circuit current rating (equipment): The rating that indicates the ability of equipment to withstand the effects of short-circuit current without exceeding specified damage criteria.

split-bus panelboard: A panelboard in which two or more sets of bus bars supplying groups of overcurrent protective devices are fed from separate circuits or subfed one from another.

sub-feed lugs: Terminals that provide for the connection of cables in one of the following ways: (1) to busbars that are connected directly to the panelboard main incoming line terminals (see Figure 1-1), or (2) to bus bars fed by an overcurrent protective device in the panelboard. (see Figure 1-2.)

switch: A device, manually operated unless otherwise designated, for opening and closing or for changing the connection of a circuit.

symmetrical current: Symmetrical current is alternating current having no offset or transient component and, therefore, having a wave form essentially symmetrical about the zero axis. Symmetrical current is expressed in terms of rms amperes.

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Section 2
PANELBOARDS

2.1 TYPES OF PANELBOARDS

Panelboards shall be of the lighting and appliance branch-circuit or power and feeder distribution type.

2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

Lighting and appliance branch-circuit panelboards shall be constructed or designed for application on one or more of the voltage systems indicated in Table 2-1.

Table 2-1
STANDARD LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARD VOLTAGE SYSTEMS

Type of Branch Circuit Device	Voltage Ratings		Type of Overcurrent Device
	Alternating Current	Direct Current	
Switch and fuse	120V 1∅ 2W 120/240V 1∅ 3W 120V 3∅ 3W* 208Y/120V 3∅ 4W	125/250V 3W	Plug fuse
Switch and fuse	120V 1∅ 2W 120/240V 1∅ 3W 120V 3∅ 3W* 208Y/120V 1∅ 3W 208Y/120V 3∅ 4W 240/120V 3∅ 4W∆ 277V 1∅ 2W 480Y/277V 1∅ 3W 480Y/277V 3∅ 4W 600Y/347V 3∅ 4W	125V 2W 125/250V 3W	Cartridge fuse
Molded case circuit breaker	120V 1∅ 2W 120/240V 1∅ 3W 120V 3∅ 3W* 208Y/120V 1∅ 3W 208Y/120V 3∅ 4W 240/120V 3∅ 4W∆ 277V 1∅ 2W 480Y/277V 1∅ 3W 480Y/277V 3∅ 4W 600Y/347V 3∅ 4W	125V 2W 125/250V 3W	Molded case circuit breaker

*Normally for marine application.

2.3 DISTRIBUTION PANELBOARDS

Distribution panelboards shall be constructed or designed for application on one or more of the voltage systems indicated in Table 2-2.

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Table 2-2
STANDARD DISTRIBUTION PANELBOARD VOLTAGE SYSTEMS

Type of Branch Circuit Device	Voltage Ratings		Type of Disconnect	Type of Overcurrent Device
	Alternating Current	Direct Current		
Switch and fuse	120/240V 1∅ 3W 240V 3∅ 3W 208Y/120V 3∅ 4W 208Y/120V 3∅ 3W* 240/120V 3∅ 4W∆ 480V 3∅ 3W 480Y/277V 3∅ 3W* 480Y/277V 3∅ 4W	125/250V 3W 250V 2W	Pullout	Cartridge fuse
Switch and fuse	120/240V 1∅ 3W 240V 1∅ 2W 240V 3∅ 3W 208Y/120V 3∅ 4W 208Y/120V 3∅ 3W* 240/120V 3∅ 4W∆ 480V 3∅ 3W 480Y/277V 1∅ 3W 480Y/277V 3∅ 3W* 480Y/277V 3∅ 4W 600V 3∅ 3W 600Y/347V 3∅ 4W	125/250V 3W 250V 2W	Dead front operated	Cartridge fuse
Molded case circuit breaker	120V 1∅ 2W 120/240V 1∅ 3W 240V 3∅ 3W 208Y/120V 1∅ 3W 208Y/120V 3∅ 3W* 208Y/120V 3∅ 4W 240/120V 3∅ 4W∆ 277V 1∅ 2W 480V 3∅ 3W 480Y/277V 1∅ 3W 480Y/277V 3∅ 3W* 480Y/277V 3∅ 4W 600V 3∅ 3W 600Y/347V 3∅ 4W	125V 2W 125/250V 3W 250V 2W	Molded case circuit breaker	

* Derived from 3-phase, 4-wire system.

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2.4 PANELBOARD CIRCUIT PROTECTIVE DEVICES—NEMA STANDARDS

For additional information on panelboard circuit protective devices, refer to the following NEMA standards publications:

a. AB 1
b. KS 1
c. FU 1

2.5 UL REQUIREMENTS

Panelboards shall comply with UL 67. Enclosures for panelboards shall comply with UL 50.

2.6 USUAL SERVICE CONDITIONS

Panelboards conforming to this standards publication shall be suitable for operation:

a. Where the altitude does not exceed 6600 feet (2000 meters).

b. Where the temperature of the air surrounding the panelboard does not exceed the usual ambient temperature limits of devices commonly mounted in panelboards as indicated in Table 2-3.

Table 2-3
USUAL AMBIENT LIMITS OF DEVICES COMMONLY MOUNTED IN PANELBOARDS

Device	Ambient Temperature Limits	Reference Publication No.
Molded case circuit breakers	-5°C through 40°C	NEMA AB 1
Enclosed switches	-30°C through 40°C	NEMA KS 1
Low-voltage cartridge fuses	see applicable standards	UL 198B, UL 198C, UL 198D, UL 198F, UL 198L, UL 248-1, UL 248-4, UL 248-8, UL 248-10, UL 248-12, UL 248-14, UL 248-15, NEMA FU 1

2.7 UNUSUAL SERVICE CONDITIONS

The use of panelboards in ambient temperatures lower or higher than the temperature limits of the devices mounted therein or at altitudes greater than 6600 feet (2000 meters) requires further consideration.

There are other service conditions that may also require further consideration. Where such conditions exist, it is recommended that they be brought to the manufacturer's attention. Panelboards for use in such cases may require additional construction or protective features. Among such unusual conditions are exposure to corrosive or explosive fumes, high humidity, dust, vapors, abnormal vibration, mechanical shock, tilting, unusual operating duties, nuclear radiation, or conditions that can lead to internal condensation.

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2.8 SUITABILITY FOR USE AS SERVICE EQUIPMENT

Panelboards that are intended to be suitable for use as service entrance equipment shall meet the requirements of UL 67 and UL 869A and have provisions for:

a. Connecting to the neutral terminal a grounding electrode conductor the size of which is in accordance with UL 869A.
b. Bonding the enclosure to the grounded conductor (neutral).
c. Disconnecting all ungrounded load conductors from the source of supply by the operation of not more than six service disconnecting means. (For lighting and appliance panelboards, see 2.9.1.)
d. Disconnecting the grounded service conductor when a neutral is provided.

2.8.1 Ground-Fault Protection

Service disconnecting means rated 1000 amperes or more, mounted in a panelboard intended for use as service equipment on a solidly grounded wye electrical system of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, shall be provided with ground-fault protection.

The maximum setting of the ground-fault protection equipment shall be 1200 amperes, and the maximum time delay shall be one second for ground-fault currents equal to or greater than 3000 amperes.

When a ground-fault of a magnitude greater than the ground-fault protection setting occurs, the ground-fault protection equipment shall operate to cause the service disconnecting means to open all ungrounded conductors of the circuit.

2.9 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARD MAINS

2.9.1 Each lighting and appliance branch-circuit panelboard shall be protected on the supply side by not more than two main circuit breakers or two sets of fuses having a combined rating not greater than the rating of the panelboard.

2.9.2 The standard current ratings of main bus, main switches, main fuseholders, and main circuit breakers (trip-unit rating of breaker with interchangeable trip units) shall be in accordance with 2.10.

2.10 STANDARD MAIN BUS, SWITCH, AND BREAKER RATINGS

2.10.1 Standard ratings of main bus shall be 30, 40, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 800, 1000, 1200, or 1600 amperes.

2.10.2 Standard ratings for main switches and their fuse holders used in panelboards shall be 30, 60, 100, 200, 400, 600, 800, or 1200 amperes.

2.10.3 Standard ratings of main circuit breakers used in panelboards shall be 30, 40, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 800, 1000, 1200, or 1600 amperes.

2.11 PRODUCT SAFETY LABELS

2.11.1 To make persons aware of immediate or potential hazards in the application, installation, use, maintenance, or inspection of panelboards, each panelboard shall be conspicuously marked on the trim or deadfront shield with a product safety label that complies with ANSI Z535. If the panel is supplied with a door, this label shall be visible when the door is in the open position. This label shall comply with ANSI Z535. (see Figure 2-1.)

2.11.2 These requirements are not intended to rule out the use of other labels or markings that are required to comply with other nationally recognized standards or applicable laws or regulations or that may be deemed necessary by the manufacturer.

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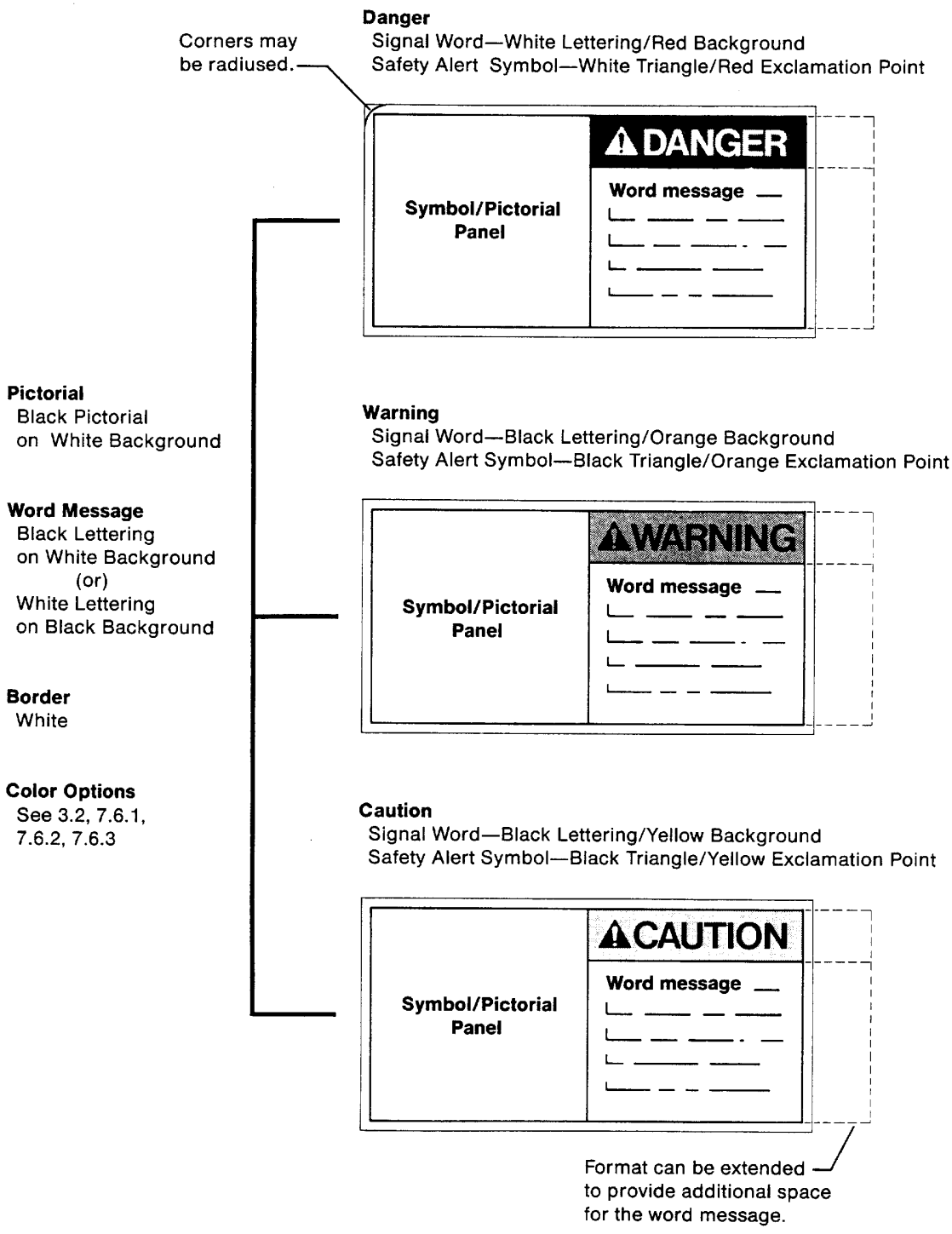


Figure 2-1
PRODUCT SAFETY LABEL

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Section 3
RATING STANDARDS

3.1 STANDARD VOLTAGE RATINGS

The standard voltage ratings of panelboards shall be as shown in Table 3-1. (For system voltage ratings, see 2.3.)

Table 3-1
STANDARD PANELBOARD VOLTAGE RATINGS

System		Voltage Ratings, Volts	
Number of Phases	Number of Wires	Alternating Current	Direct Current
1 (or direct current)	2	120, 240, or 277	125 or 250
1 (or direct current)	3	120/240	125/250
3 (derived from 3-phase, 4-wire system)	3	208Y/120, or 480Y/277	...
3 ...	3	120, 240, 480, or 600	...
3 ...	4 wire delta with the neutral at midpoint of one phase	240/120	...
3 ...	4 wire wye with neutral	208Y/120, 480Y/277, or 600Y/347	...

3.2 CURRENT RATING

The current rating of a panelboard shall be no more than the smaller of the following:

a. The ampacity of the main bus bars

b. The current rating of the main switch and fuseholders or the current rating (trip rating) of the main circuit breaker

3.2.1 Panelboards Using a Snap Switch

If a panelboard uses a snap switch rated at 30 amperes or less in any branch circuit, the rating of the panelboard shall be not more than 200 amperes unless there is overcurrent protection rated at 200 amperes or less within the panelboard on the line side of such a switch.

3.3 FREQUENCY RATING

The frequency rating of AC panelboards shall be 50, 60, or 50/60 Hz.

For applications at other than 50, 60, or 50/60 Hz, the manufacturer should be consulted.

3.4 BASIS OF SHORT-CIRCUIT CURRENT RATING OF PANELBOARDS

The short-circuit rating assigned to a panelboard shall not exceed the short-circuit current rating of any component of that panelboard that is installed in its intended manner (see 5.2.3).

Exception: A higher rating may be assigned to a panelboard for a specific combination of components provided the combination has passed short-circuit current testing, qualifying it for its assigned short circuit current rating.

The short-circuit current rating of a panelboard shall be in rms symmetrical amperes.

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3.5 STANDARD SHORT-CIRCUIT CURRENT RATINGS OF PANELBOARD DEVICES

3.5.1 Circuit Breakers

The standard short-circuit current rating of a circuit breaker used as a device in a panelboard shall be its interrupting current of 5000; 7500; 10,000; 14,000; 18,000; 20,000; 22,000; 25,000; 30,000; 35,000; 42,000; 50,000; 65,000; 85,000; 100,000; 125,000; 150,000; or 200,000 rms symmetrical amperes. The manufacturer should be consulted for interrupting current ratings at specific voltages.

3.5.2 Fusible Switches

The short-circuit rating of a fusible switch used as a device in a panelboard shall be the interrupting rating of the installed fuses or the short-circuit current rating of the switch, whichever is the smaller. The ratings of fuses and switches used in combination shall be 10,000; 50,000; 100,000; or 200,000 rms symmetrical amperes.

Fusible switches that are not marked with a short-circuit withstand rating shall be suitable for use on circuits having a maximum available short-circuit current of 10,000 amperes.

3.5.3 Other Devices

The manufacturer should be consulted for rating information for other devices or combinations of devices used in panelboards.

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Section 4
CONSTRUCTION

4.1 GENERAL

4.1.1 Marking Information

Panelboards shall be clearly marked with the following information:

a. Manufacturer's name or trademark
b. Catalog number or type designation
c. Current rating
d. Voltage rating
e. Number of phases (if AC rated)
f. Short-circuit rating
g. Conductor temperature rating

These markings shall be located where they will be visible if a front or trim is removed.

4.1.2 Other Markings

The markings requirements specified in 4.1.1 are not intended to rule out the use of other labels or markings that are required to comply with other nationally recognized standards or applicable laws or regulations, or which may be deemed necessary by the manufacturers.

4.2 UNINSULATED LIVE METAL PARTS

Uninsulated live metal parts, other than lugs and pressure wire connectors (see 4.4.4), shall be so secured to the base or mounting surface that they will not turn or shift in position. This must be accomplished by some method other than friction between the surfaces.

4.3 WIRING TERMINATIONS

4.3.1 Conductor Terminals

The manufacturer shall specify, or provide, suitable terminals such as pressure wire connectors, compression connectors, or wire binding screws for the connection of each conductor that is intended to be installed in the panelboard in the field except for those main connections that are specifically designed to be made to bus bars.

4.3.2 Main Terminal Kits

The main terminals shall be permitted to be in the form of a main terminal kit if the panelboard is specifically designed for use interchangeably with either the main terminals or with a main circuit breaker or switch. A main terminal kit shall consist of individual terminals or an assembly of the following: (1) terminals, (2) bus bars that provide connections between those terminals and the main bus bars of the panelboards, and (3) a mounting means for those components. The kit shall be connectable to the main bus bars by either bolting or plugging in.

The main terminal kit shall be so constructed that (1) installation can be readily accomplished without the use of a special tool, (2) live parts will be suitably supported after being assembled, and (3) reliable connection to the main bus bars will be afforded.

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4.3.3 Main and Branch-Circuit Terminals

4.3.3.1 Main Terminals

Main terminals shall be capable of securing the smallest standard size single or multiple conductor having a current-carrying capacity adequate for the current rating of the panelboard as determined from the considerations set forth in 4.3.3.4.

4.3.3.2 Branch-Circuit Terminals

Terminals for standard size branch-circuit conductors shall be capable of securing the smallest single or multiple conductor having a current-carrying capacity adequate for the application as determined from the considerations set forth in 4.3.3.3 and 4.3.3.4.

4.3.3.3 Wire Connection To Terminals

In 4.3.3.2, it is assumed that the current-carrying capacity of a wire or wires to be connected to a terminal:

a. A fuseholder shall be of a value within the range of current ratings of the fuses that the fuseholder will accommodate and for the wire temperature rating for which it or the panelboard is marked.
b. An interchangeable trip type circuit breaker shall be suitable for the rating of the installed trip units and for the wire temperature rating for which it or the panelboard is marked.
c. A noninterchangeable circuit breaker shall be suitable for the current rating of the breaker and for the wire temperature rating for which it or the panelboard is marked.

4.3.3.4 Field-Installed Conductors

In 4.3.3.1 and 4.3.3.2, it is assumed that field-installed conductors shall be:

a. Of current-carrying capacities given in UL 67.
b. Copper or aluminum wire at any terminal identified on a wiring diagram or the like as being suitable for use with such wire.
c. Of the temperature rating for which the panelboard is marked.

4.3.4 Connectors

The requirements of 4.3.3 do not preclude the use of connectors that will also accommodate a wire(s) of a size(s) different from that specified in 4.3.3.

4.4 SPACINGS

4.4.1 Minimum panelboard spacings shall be according to Table 4-1 except as indicated in 4.4.3.

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Table 4-1
MINIMUM PANELBOARD SPACING, INCH (mm)*

Voltage Involved	Between Uninsulated Live Parts of Opposite Polarity		Through Air or Over Surface † Between Uninsulated Live Parts and Grounded Dead Metal
	Through Air	Over Surface ** †	
125 or less	1/2 (12.7)	3/4 (19.1)	1/2 (12.7)
126–250	3/4 (19.1)	1-1/4 (31.8)	1/2 (12.7)
251–600	1 (25.4)	2 (50.8)	1 (25.4) ††

* An isolated dead metal part, such as a screw head or washer, interposed between uninsulated live parts of opposite polarity, or between uninsulated live parts and grounded dead metal, is considered to reduce the spacing by an amount equal to the dimension of the interposed part along the path of measurement.

** An air space of 0.013 inch (0.33 mm) or less between a live part and an insulated surface is to be disregarded, and the part is to be considered in contact with the insulating material when measuring spacings.

† In measuring over-surface spacings, any slots, grooves, and so forth, 0.013 inch (0.33 mm) wide or less in the contour of insulating material are to be disregarded.

†† A through-air spacing of not less than 1/2 inch (12.7 mm) is acceptable (1) at a circuit breaker or a switch other than a snap switch and (2) between grounded dead metal and the insulated neutral of a 480Y/277 volt, 3-phase, 4-wire panelboard.

4.4.2 Insulating Material Other Than Air

A liner, barrier, or the like of suitable insulating material used to supplement a space through air which would otherwise be insufficient shall be considered as meeting the requirements of 4.4.1.

4.4.3 Screw Shells

The spacings between screw shells of plug fuseholders, which are protected by surrounding walls of insulating material and between such screw shells and a metal cover plate, may be less than those indicated in Table 4-1, but not less than 1/4 inch (6.35 mm) in any case, if the depth of the receptacle as measured from the top of the wall to the plane of the center contact is not less than 3/4 inch (19.1 mm).

4.4.4 Wire Connectors (Lugs)

Wire connectors (lugs) shall be prevented from turning so that spacings will not be reduced to less than those given in Table 4-1. If such spacings are maintained when connectors (lugs) are turned 30 degrees toward each other, or toward other uninsulated live metal or grounded dead metal parts, no means to prevent turning need be provided.

4.5 GROUNDING AND INSULATING

4.5.1 Operating Handle

An operating handle that is fabricated of a conductive material shall be either insulated or in electrical connection with the panelboard enclosure.

4.5.2 Grounding and Bonding

There shall be provision for permanently and effectively grounding any metal plate that covers uninsulated live parts unless the plate is provided with means for effectively and adequately insulating it from live parts or unless the plate is so located that it is unlikely to become energized.

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4.5.3 Size of Grounding Conductors

A panelboard that is marked as being suitable for use as service equipment and provided with a neutral shall have provision for connecting the service grounding conductor to the neutral terminal in accordance with 4.5.5. The connection shall not depend upon solder for securing the grounding conductor.

4.5.4 Equipment Grounding Terminals

Terminals for equipment grounding conductors shall either be provided or be available in the field for connecting all feeder and branch-circuit equipment grounding conductors when the panelboard is used with a nonmetallic raceway or cable wiring. Means shall be provided to bond the equipment grounding terminal bar to the panelboard cabinet. This bar shall not be connected to the insulated neutral bar except at service equipment as permitted in the *National Electrical Code*.

4.5.5 Size of Grounding Electrode Conductors and Main Bonding Jumper

Grounding electrode conductors and main bonding jumpers shall be sized according to Table 4-2.

Table 4-2
SIZE OF GROUNDING ELECTRODE CONDUCTORS AND MAIN BONDING JUMPER

Ampere Rating Not Exceeding	Size of Main Bonding Jumper (Minimum) *, †, §§ Copper AWG or kcmil	mm	Aluminum AWG or kcmil	mm	Cross-Section of Main Bonding Jumper (Minimum) †, § Copper Square Inches	mm^2	Aluminum Square Inches	mm^2	Size of Grounding Electrode Conductor (Minimum) † Copper AWG or kcmil	mm	Aluminum AWG or kcmil	mm
90	8	(8.4)	6	(13.3)	0.013	(8.4)‡	0.021	(13.6)‡	8	(8.4)	6	(13.3)
100	6	(13.3)	4	(21.2)	0.021	(13.6)‡	0.033	(21.3)‡	6	(13.3)	4	(21.2)
125	6	(13.3)	4	(21.2)	0.021	(13.6)‡	0.033	(21.3)‡	6	(13.3)	4	(21.2)
150	6	(13.3)	4	(21.2)	0.021	(13.6) §	0.033	(21.3) §	6	(13.3)	4	(21.2)
200	4	(21.2)	2	(33.6)	0.033	(21.3) §	0.052	(33.6) §	4	(21.2)	2	(33.6)
225	2	(33.6)	0	(53.5)	0.052	(33.6)**,‡‡	0.083	(53.5)**,††	2**,††	(33.6)	0	(53.5)
400	0‡‡	(53.5)	3/0‡‡	(85.0)	0.083	(53.5)††,‡‡	0.132	(85.0)	0‡‡	(53.5)	3/0‡‡	(85.0)
500	0	(53.5)	3/0	(85.0)	0.083	(53.5)	0.132	(85.0)	0	(53.5)	3/0	(85.0)
600	2/0	(67.4)	4/0	(107.2)	0.105	(67.7)	0.167	(107.7)	2/0	(67.4)	4/0	(107.2)
800	2/0	(67.4)	4/0	(107.2)	0.105	(67.7)	0.167	(107.7)	2/0	(67.4)	4/0	(107.2)
1000	3/0	(85.0)	250	(127)	0.132	(85.2)	0.196	(127.0)	3/0	(85.0)	250	(127)
1200	250	(127)	250	(127)	0.196	(127.0)	0.196	(127.0)	3/0	(85.0)	250	(127)
1600	300	(152)	400	(203)	0.236	(152.0)	0.294	(189.7)	3/0	(85.0)	250	(127)
2000	400	(203)	500	(253)	0.314	(203.0)	0.393	(253.0)	3/0	(85.0)	250	(127)

* The cross-section shall be permitted to be reduced to 12.5 percent of the total cross-section of the largest main service conductor(s) of the same material (copper or aluminum) for any phase on a panelboard rated 1200 amperes and above. This applies when the cross-section of the service conductors is limited by the wire terminal connectors provided.

† For a panelboard rated 1200 amperes or more and that has wiring terminals intended to connect service conductor wires sized larger than 600 kcmil copper or 750 kcmil aluminum, the cross-section of the main bonding jumper shall be at least 12.5 percent of the total cross-section of the largest main service conductor(s) of the same material (copper or aluminum) for any phase.

‡ A No. 8 or larger brass or No. 10 or larger steel screw shall be permitted to be used.

§ A No. 10 or larger brass or steel screw shall be permitted to be used.

** A No. 10 or larger brass screw shall be permitted to be used.

†† A 1/4 inch (6.4mm) diameter or larger brass or steel screw shall be permitted to be used.

‡‡ When the ampere rating is 400 and the wire terminal connectors for the main service conductors are acceptable for two No. 3/0 AWG copper or two No. 250 kcmil aluminum conductor but will not accept a 600 kcmil conductor, these values may be reduced to No. 2 AWG (0.52 square-inch) copper or No. 0 AWG (0.083 square-inch) aluminum.

§ § These are also sizes for the grounding service conductor mentioned in Section 2.8.

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4.5.6 Grounding of Three-Phase Delta Systems

4.5.6.1 Panelboards intended for use on three-phase three-wire delta systems with one phase grounded (corner grounded delta system) shall have the B phase grounded (see 6.7).

4.5.6.2 Panelboards intended for use on three-phase four-wire delta systems with the midpoint of one phase grounded shall have the B phase the higher voltage to ground.

4.6 CABINETS, GUTTERS, AND WIRING SPACE

4.6.1 Cabinet

The cabinet (box, tub, or can), when made from sheet metal, shall be protected against corrosion by such means as painting, galvanizing, plating, or other equivalent means and shall provide minimum gutter spacings and wiring space in accordance with 4.6.2, 4.6.3, 4.6.5, and 4.6.6. The end walls shall be permitted to be removable.

The front (trim and frame) shall be protected against corrosion by such means as painting, galvanizing, plating, or other equivalent means and designed for either surface or flush mounting. When a door is furnished, it shall be provided with a locking means. A directory frame or equivalent means to identify the units shall be provided.

4.6.2 Distance Between End of Wiring Lugs and Opposite Wall

The distance between the end of any wire connector or lug and the wall of the enclosure toward which the conductor is directed or through which the connected conductor may normally pass shall be as shown in Articles 373 and 384 of the *National Electrical Code* and UL 67.

4.6.3 Enclosed Panelboard

An enclosed panelboard shall have one or more side or end wiring gutters or spaces.

4.6.4 Knockouts

When provided, knockouts shall be so located as to provide adequate space for the turning of lock nuts or bushings that may be used for securing conduit or armored cable connectors. Multiple knockouts shall be so constructed that any size knockout may be removed without disturbing the next larger size.

4.6.5 Wiring Gutters and Terminal Compartments

A panelboard that has provision for the connection of more than four ungrounded conductors, other than main supply conductors, at any one side, top, or bottom shall be provided with wiring gutters and terminal compartments to prevent contact between insulating conductors and bare live parts.

4.6.6 Wiring Space

The space within the enclosure of a panelboard shall be sufficient to provide ample room for the installation of wire and cables.

The minimum areas of the clear wiring space shall be in accordance with UL 67.

4.7 FUSE AND CIRCUIT BREAKER LOCATION

4.7.1 Fuse

If both switches and fuses are provided in either mains or branches, the fuses shall be placed on the load side of the switches.

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4.7.2 Circuit Breakers with Interchangeable Trip Units

A circuit breaker using an interchangeable trip unit shall be connected so that the trip unit will be de-energized when the circuit breaker is in the open position.

4.8 ENCLOSURES

Panelboards are typically furnished in the following enclosure types.

4.8.1 Types of Enclosures

4.8.1.1 Type 1

Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment in locations where unusual service conditions do not exist. The enclosures shall meet the rod entry and rust-resistance design tests. (See NEMA Standards Publication 250.)

4.8.1.2 Type 3R

Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain, sleet, and external ice formation. They shall meet rod entry, rain, external icing, and corrosion protection design tests. They are not intended to provide protection against conditions such as dust, internal condensation, or internal icing. (See NEMA Standards Publication 250.)

4.8.1.3 Type 5

Type 5 enclosures are intended for indoor use primarily to provide a degree of protection against settling airborne dust, falling dirt, and dripping non-corrosive liquids. They shall meet drip, settling airborne dust, and rust resistance design tests. They are not intended to provide protection against internal condensation. (See NEMA Standards Publication 250.)

4.8.1.4 Type 12

Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids. They shall meet drip, indoor dust, and rust-resistance tests. They are not intended to provide protection against conditions such as internal condensation. (See NEMA Standards Publication 250.)

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Section 5
TEST STANDARDS

5.1 CLASSIFICATION OF TESTS

5.1.1 Design Tests

Design tests shall be considered to be those tests that are made to determine the adequacy of the design of a particular type, style, or model of panelboard to meet its assigned ratings and to operate satisfactorily under normal service application conditions or under special application conditions if specified.

Design tests are made only on representative new panelboards to substantiate ratings assigned to all other panelboards of a similar design and are not contemplated under normal production.

5.1.2 Production Tests

Production tests are those tests that are made to check the quality and uniformity of the workmanship and materials used in the manufacture of panelboards.

5.2 DESIGN TESTS

Design tests for a panelboard shall include the following:

a. Temperature rise test—5.2.1
b. Dielectric test—5.2.2
c. Short-circuit test—5.2.3
d. Environmental test—5.2.4
e. Strength of insulating base and support test—5.2.5

5.2.1 Temperature Rise Tests

A temperature rise test shall be made unless the bus bars are of a size sufficient to provide a current density not more than that indicated in UL 67.

Under any conditions, a temperature rise test shall be made if a panelboard uses one or more switches, fuseholders, or circuit breakers having plug-in connections to the bus bar.

When temperature rise tests are made, they shall be conducted in accordance with requirements of UL 67.

5.2.2 Dielectric Tests

A panelboard shall withstand for 1 minute without breakdown the application of a 60 Hz sinusoidal potential of 1000 volts plus twice rated voltage:

a. Between live metal parts and dead metal parts with all switching devices closed
b. Between live metal parts of opposite polarity with all switching devices closed

During the test, overcurrent devices (such as fuses, the trip units of circuit-breaker frames designed for use with interchangeable trip units, and so forth) shall be in place wherever provision is made for their use. A transformer, coil, or other device normally connected between lines of opposite polarity shall be disconnected from one side of the line during the test specified in item b.

The test potential shall be supplied from a suitable adjustable voltage output 500 volt-ampere or larger testing transformer, unless the transformer to be used is provided with a suitable voltmeter to directly measure the

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applied output potential. The applied potential shall be applied spontaneously or be increased gradually from zero until the required test value is reached.

5.2.3 Short-Circuit Tests

5.2.3.1 Test Procedure

To determine the capability of a panelboard(s) to withstand a short-circuit current interruption by its main or branch-circuit overcurrent protective devices, short-circuit tests shall be conducted in accordance with the provisions of UL 67.

5.2.3.2 Test Samples

A representative number of types and ratings of panelboards shall be tested to adequately determine the satisfactory performance of all sizes.

5.2.4 Environmental Tests

Environmental tests on panelboard enclosures shall be conducted in accordance with the applicable requirements of UL 50.

5.2.5 Strength of Insulating Base and Support Test

The insulating base of a panelboard shall not be damaged when wire connectors securing short lengths of conductors of rated ampacity are torqued to 110 percent of the value marked on the panelboard.

Damage is considered to have occurred if the base insulating material cracks or rotates; bosses, recesses, or other means to prevent turning do not perform their intended function; straps or bus bars bend or twist; or members move at electrical joints. Minor chipping or flaking of brittle insulating material is acceptable if the performance is not otherwise impaired. Momentary flexing of metallic members without permanent deformation is acceptable.

5.3 PRODUCTION TESTS

Production tests for a panelboard containing ground-fault sensing equipment shall include a ground-fault-sensing test as described in 5.3.1.

5.3.1 Ground-Fault-Sensing Test

When a panelboard contains ground-fault-sensing equipment, it shall be tested in the following manner to ensure proper operations:

With the primary of the control circuits supply transformer, if used, energized at 57 percent of its voltage rating, a simulated ground-fault current shall be supplied and shall cause the breaker or switch to open. The pickup point of the relay shall be permitted to be set at any convenient level.

Following this test, with no simulated ground-fault current flowing, an attempt shall be made to close the breaker or switch without performing a reset operation. If the breaker or switch will stay closed, the simulated ground-fault current shall be applied again and the ground-fault protection system shall function.

Exception: The test voltage shall be permitted to be rated voltage if the particular combination of transformer ground-fault-sensing and relaying equipment and disconnecting means has been previously tested at 57 percent of rated voltage.

One method of simulating a ground-fault current is by wrapping a number of turns of wire through the sensor. A current approximately 125 percent of the pickup setting of the relay divided by the number of turns is passed through the wire to simulate the ground-fault current.

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Section 6
APPLICATION STANDARDS

6.1 SELECTION OF APPARATUS

Panelboards should be properly selected to ensure satisfactory service. Panelboards conforming to these standards should be suitable for operation in accordance with their ratings under usual service conditions (see 2.6). Where panelboards are subjected to unusual service conditions (see 2.7), the manufacturer should be consulted.

6.2 VOLTAGE RATINGS

The voltage of the system to which a panelboard is connected shall not exceed the voltage rating of the panelboard.

6.3 CONTINUOUS-CURRENT-CARRYING RATINGS

6.3.1 Panelboard Without Main Overcurrent Protective Devices (Main Lug Panelboard)

The total continuous load current on a panelboard without an integral main overcurrent protective device shall not exceed the current rating of the panelboard.

6.3.2 Panelboard Having One or More Main Overcurrent Protective Devices

The total continuous load current on a main overcurrent protective device in a panelboard shall not exceed 80 percent of the current rating of the main overcurrent protective device, unless the main overcurrent protective device is rated to carry 100 percent of its continuous load current when mounted in a panelboard.

6.3.3 Branch-Circuit Devices

The continuous load current on each branch-circuit device in a panelboard shall not exceed 80 percent of the current rating of the branch-circuit device, unless the branch-circuit device is rated to carry 100 percent of its continuous load current when mounted in a panelboard.

6.3.4 Panelboards With Feed-Through or Sub-Feed Lugs

Feed-through lugs, sub-feed lugs, and diversity of loads should be considered in determining panelboard ampacity.

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6.4 CALCULATION OF AVAILABLE SHORT-CIRCUIT CURRENT

IEEE Standard 141 contains detailed information for the calculation of short-circuit currents. Information on such calculations and tables showing the short-circuit current available at various distances from transformers may also be found in NEMA Standards Publication AB 1.

6.5 SHORT-CIRCUIT CURRENT RATINGS

6.5.1 A panelboard shall have a short-circuit current rating not less than the available short-circuit current at its incoming line terminals. See 3.5 for short-circuit current ratings and 5.2.3 for short-circuit test methods.

6.5.2 Examples For Application

6.5.2.1 For determination of panelboard short-circuit current rating, refer to Figure 6-1 for typical panelboard schematic.

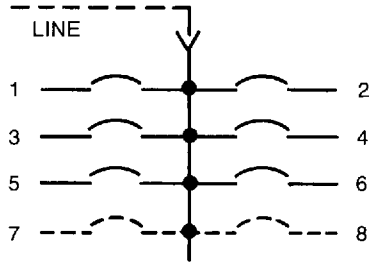


Figure 6-1
TYPICAL PANELBOARD SCHEMATIC

6.5.2.1.1 Assume: 20,000 rms symmetrical amperes short-circuit current are available at the line terminals of the panelboard.

Overcurrent protective devices 1, 2, 3, 4, and 5 have rms symmetrical interrupting current ratings of 42,000 amperes at the voltage rating of the system.

Overcurrent protective device 6 has an rms symmetrical interrupting current rating of 25,000 amperes at the voltage rating of the system.

Spaces 7 and 8 are unused.

The maximum short-circuit current rating assigned to the panelboard by the manufacturer is 50,000 rms symmetrical amperes.

CONCLUSION: The rms symmetrical short-circuit current rating of the panelboard is 25,000 amperes as this is the lowest rating of a device installed in the panelboard (see 3.4.). The panelboard is satisfactory for application on the system because its rating exceeds the short-circuit current available from the system.

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6.5.2.1.2 Assume: The same situation as detailed in 6.5.2.1.1.

Spaces 7 and 8 are filled with devices having an rms symmetrical interrupting current rating of 10,000 amperes at the system voltage.

CONCLUSION: The short-circuit rating of the panelboard now becomes 10,000 amperes (see 3.4). The panelboard is not suitable for this application because its short-circuit current rating is lower than the short-circuit current available from the system.

6.5.2.1.3 Assume: The same situation as detailed in 6.5.2.1.1 with devices having rms symmetrical interrupting current ratings of 25,000 amperes at the voltage of the system installed in locations 7 and 8, and a 25,000 ampere rms symmetrical short-circuit current available at the terminals of the panelboard.

CONCLUSION: Considering the presently available short-circuit current, this would be a satisfactory application because the short-circuit current rating of the panelboard is as great as the available short-circuit current at the panelboard terminals.

6.5.2.1.4 Assume: The supply transformer or other features of the system are changed.

The change increases the available short-circuit current at the panelboard to 40,000 rms symmetrical amperes.

CONCLUSION: The panelboard is no longer satisfactory for this system. There are several methods available to correct this situation:

a. Since the maximum short-circuit current rating of the panelboard is sufficient (50,000 amperes), overcurrent protective devices having rms symmetrical interrupting current ratings of at least 40,000 amperes may be installed.

b. The panelboard may be replaced with one having a short-circuit current rating of at least 40,000 amperes.

c. The panelboard may be protected with an appropriate current-limiting device. It is recommended that the panelboard manufacturer be consulted.

6.6 FIELD-INSTALLED CONDUCTORS

6.6.1 Wires used for a panelboard installation shall have ampacities based on 60°C (140°F) or 75°C (167°F) insulation, according to the marking on the panelboard, and shall be within the range of wire sizes for which the terminals are marked. See NEC 110-14-(c).

6.6.2 Higher temperature-rated conductors shall be permitted to be used if the size of the conductors is determined on the basis of the 60°C ampacity or 75°C ampacity within the range of wire sizes for which the terminals are marked and temperature ratings for which the panelboard is marked.

6.6.3 Only wires made of the conductor material for which the panelboard terminals have been marked shall be used.

6.6.4 Conductors installed in a panelboard should be kept as short as practical to reduce heating within the cabinet.

6.6.5 When permitted by the National Electrical Code, a common neutral conductor should be used for multi-wire circuits to reduce heating within the panelboard cabinet. (See National Electrical Code, Section 210-4.)

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6.7 CORNER-GROUNDED (GROUNDED B PHASE) THREE-PHASE DELTA APPLICATIONS

Two-pole circuit breakers intended to be installed on corner-grounded (grounded B phase) delta systems to supply three-phase loads shall be marked 1 phase – 3 phase.

6.8 MOUNTING OF ENCLOSURE

Flush-mounted panelboard enclosures used in walls of concrete, tile, or other noncombustible material shall be installed so that the front edge of the enclosure will not be set back of the finished surface more than 1/4 inch. In walls of wood or other combustible material, cabinets shall be flush with the finished surface or shall project therefrom.

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