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GENERAL INSTRUCTIONS FOR PROPER INSTALLATION, OPERATION AND MAINTENANCE OF PANELBOARDS RATED 600 VOLTS OR LESS

RETAIN FOR USE OF QUALIFIED MAINTENANCE PERSONNEL

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET N.W., WASHINGTON, D.C. 20037

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GENERAL INSTRUCTIONS FOR THE PROPER INSTALLATION, OPERATION, AND MAINTENANCE OF PANELBOARDS RATED 600 VOLTS OR LESS

(Approved as Authorized Engineering Information 5-19-1986)

FOREWORD

This publication is a guide of practical information containing instructions for the proper installation, operation, and maintenance of panelboards rated 600 volts or less. These recommendations of the Panelboard and Distribution Board Section of the National Electrical Manufacturers Association will be found useful by architects, electrical engineers, electrical contractors, electricians, maintenance engineers and others.

It is recommended that work described in this set of instructions be performed only by qualified personnel familiar with the construction and operation of panelboards and that such work be performed only after reading this complete set of instructions.

Further, if the maintenance personnel have specific questions not covered by these instructions, they are urged to contact the manufacturer of the panelboard directly.

These instructions will be reviewed periodically by the Section for the purpose of updating them to reflect advancing technology. Please address any comments or questions you may have on the text to:

Manager, Engineering Department
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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 and/or automatic overload protective devices (fuses or circuit breakers). These units are used in the distribution of electricity for light, heat and power at:

600 volts and less
1600-ampere mains and less
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.

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Section 1

GENERAL

The successful operation of panelboards is dependent upon proper installation, operation, and maintenance. Neglecting fundamental installation and maintenance requirements may lead to personal injury as well as damage to electrical equipment or other property.

QUALIFIED PERSONNEL

Therefore, installation, operation and maintenance of panelboards should be conducted only by qualified personnel.

For purposes of these guidelines, a qualified person is one who is familiar with the installation, construction, and operation of the equipment and the hazards involved. In addition, the person is:

a. Trained and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.

b. Trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing in accordance with established safety practices.

c. Trained in rendering first aid.

WARNING—THERE IS A HAZARD OF ELECTRIC SHOCK OR BURN WHENEVER WORKING IN OR AROUND ELECTRICAL EQUIPMENT. TURN OFF POWER SUPPLYING THE EQUIPMENT BEFORE WORKING INSIDE.

Section 2

INSTALLATION OF PANELBOARD CABINETS (BOXES)

Install the cabinet in a neat and workmanlike manner. Follow the manufacturer's installation instructions.

1. *Location in Building.* Locate the cabinet so that it is readily accessible and not exposed to physical damage.

2. *Flammable Material.* Locate the cabinet well away from flammable material.

3. *Unusual Service Conditions.* Do not locate the cabinet where it will be exposed to ambient temperatures above 40°C (104°F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, mechanical shock, high humidity, tilting, or unusual operating conditions, unless the cabinet/panelboard combination has been designed for these conditions.

4. *Indoor Damp Locations.* Locate or shield the cabinet so as to prevent moisture and water from entering and accumulating therein. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

5. *Wet Locations.* Cabinets should be specifically approved for wet locations. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

6. *Clearance from Ceiling.* Do not locate the cabinet against a non-fireproof ceiling; allow a space of 3 feet between the ceiling and cabinet unless an adequate fireproof shield is provided.

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7. *Space Around the Cabinet.* When selecting a location, provide sufficient access and working space around the cabinet (See NEC Section 110-16*). The width of the working space in front of the panelboard should be at least 30 inches and this space should not be used as storage. The working space should have adequate lighting and a minimum head room of 6-1/4 feet.

8. *Mounting of Cabinet.* The cabinet should be reliably secured to the mounting surface. Do not depend on wooden plugs driven into holes in masonry, concrete, plaster or similar materials. (See Section 110-13 of the National Electrical Code.)

9. *Flush Mounting in Wall.* In walls of concrete, tile, or other noncombustible material, install the cabinet so that its front edge will not set back more than 1/4 inch from the finished surface. In walls of wood or other combustible material, cabinets should be flush with or project beyond the finished surface. (See Section 373-3 of the National Electrical Code.)

10. *Unused Openings in Cabinet.* Effectively close unused openings in the cabinet to provide protection which is substantially equivalent to that afforded by the wall of the cabinet.

11. *Grounding of Panelboard Cabinets.* Ground the cabinet or box as specified in Article 250 of the National Electrical Code. When the cabinet or box contains service equipment, it will be necessary to bond the box to the grounded (neutral) supply conductor.

Section 3

INSTALLATION OF CONDUIT AND WIRES

1. Conduits should be installed so as to prevent moisture or water from entering and accumulating within the enclosure. Provision should be made to protect conductors from abrasion in accordance with Article 373 of the National Electrical Code.

2. Knockouts should be removed as follows:

IMPORTANT: Remove knockouts, ONE AT A TIME, alternating INWARD and OUTWARD.

FIRST: Remove center knockout INWARD.

a. Place screwdriver blade against point farthest from tie and strike INWARD (Figure 3-1). Bend back and forth to break tie.

NEXT: Remove rings ONE AT A TIME without straining remaining rings.

b. Pry first ring OUTWARD with screwdriver midway between ties, using pliers flat against box under screwdriver (Figure 3-2). Bend ring sections OUTWARD with pliers, then back and forth to break ties (Figure 3-3).

c. Remove second ring INWARD by striking screwdriver (with blade against point midway between ties) then breaking ring sections inward and back and forth to break ties.

3. Be sure that the lugs are suitable and approved for use with the cable being connected to the panelboard. See Item 7 of Section 4 for making proper connections. Before pulling any cables into the box, make sure that the temperature rating of the wire complies with the job specifications and the panelboard interior marking, if available.

*NFPA Pub. No. 70-1984, available from the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.

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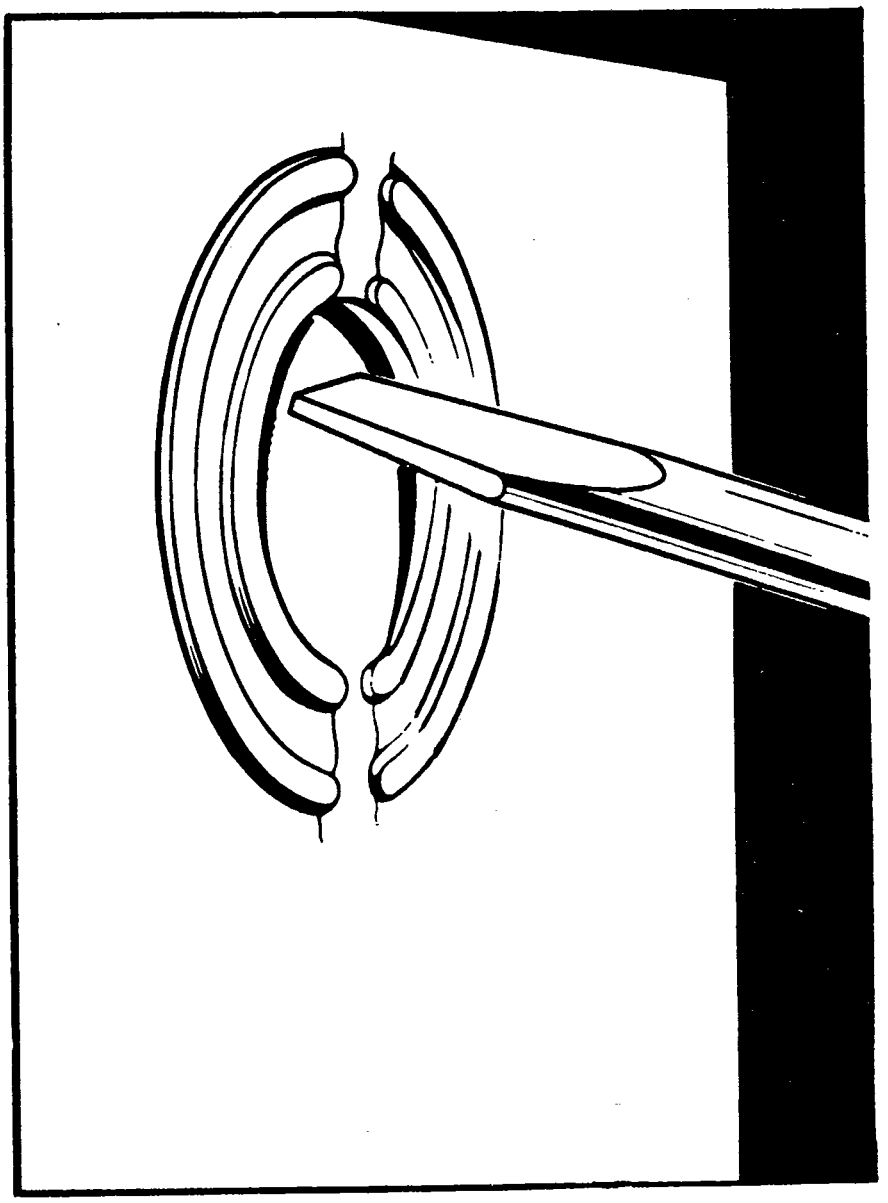


Figure 3-1
Knockout Removal - Step 1

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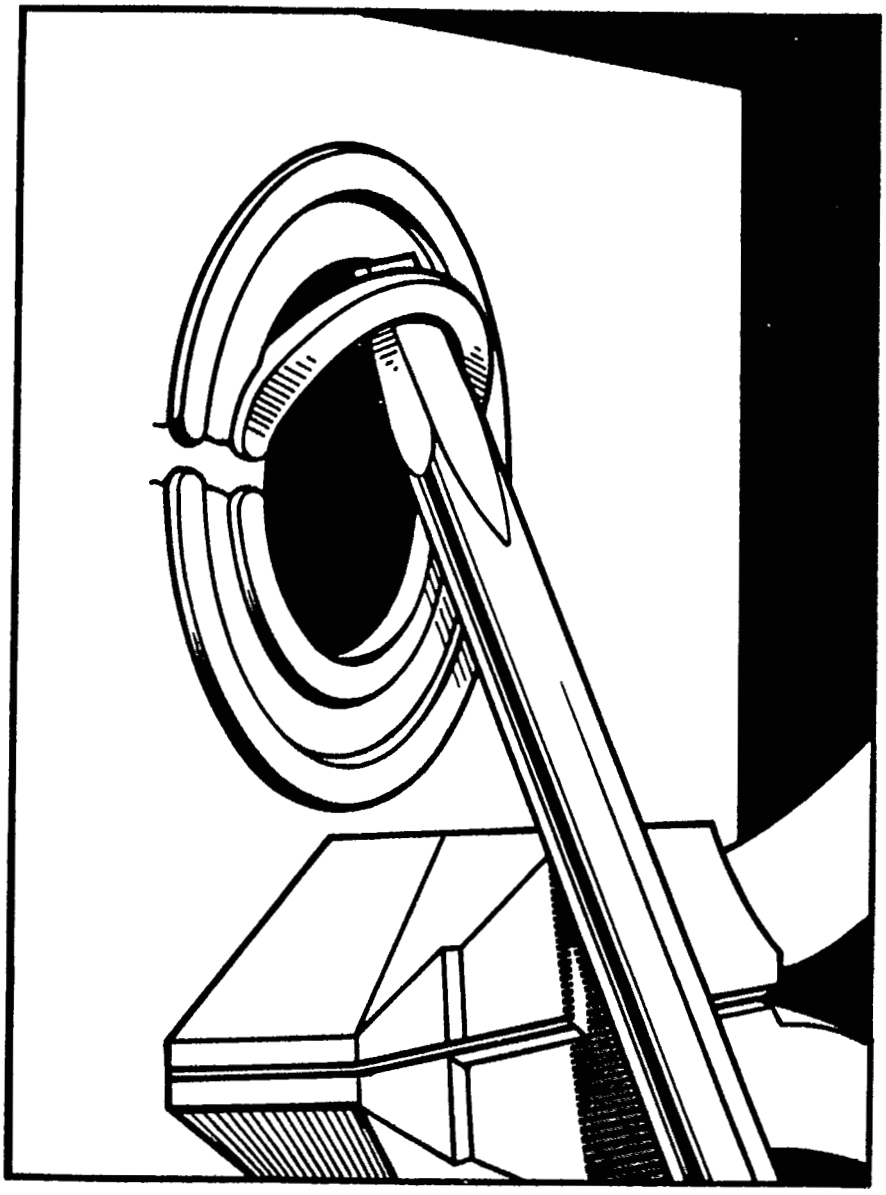


Figure 3-2
Knockout Removal - Step 2

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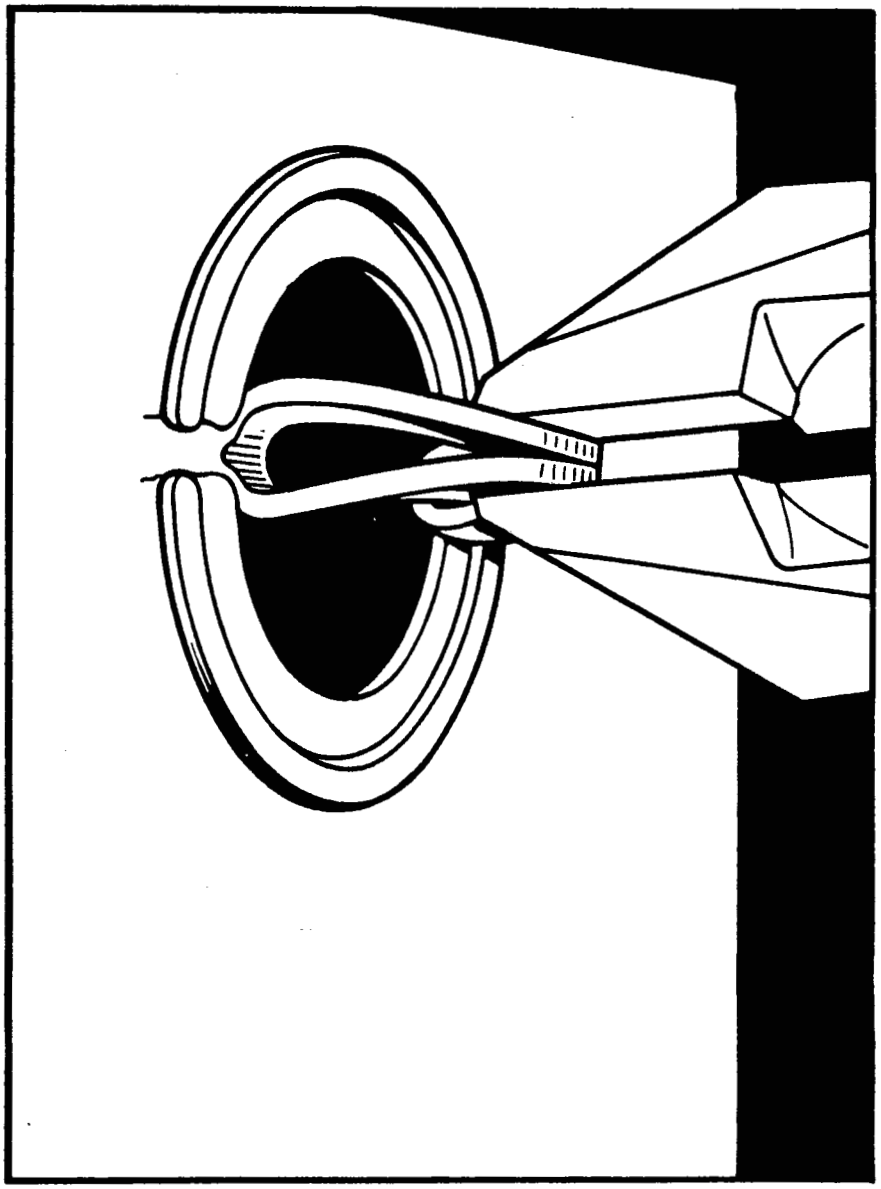


Figure 3-3
Knockout Removal - Step 3

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4. Keep conductor lengths to a minimum within the wiring gutter. Excessive cable lengths will result in additional heating and may result in overheating. However, cables should be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.

5. Exercise care to maintain the largest practical bending radius of conductors; otherwise the insulation may be damaged or terminal connections may become loosened.

Section 4

INSTALLATION OF PANELBOARD

1. *Proper Storage.* Store the panelboard in a clean, dry place located so that mechanical damage from work personnel in the area is not likely to happen.

2. *Unpacking.* Care should be exercised in unpacking the panelboard to prevent damage.

3. *Inspection.* Check for shipping damage and check to make sure that the panelboard is the correct one for installation in the cabinet.

WARNING—BE SURE THAT ALL POWER IS TURNED OFF AND REMAINS OFF DURING THE FOLLOWING INSTALLATION PROCEDURES.

4. *Cleaning.* Clean the cabinet of all foreign materials prior to installation of the panelboard. If parts at connection points are spattered with cement, plaster, paint or other foreign material, remove the foreign materials with great care to avoid damaging plated surfaces.

5. *Manufacturer's Instructions.* Carefully follow the manufacturer's instructions and labels.

6. *Installation*

   a. Adjust the alignment devices where provided.

   b. Install the panelboard, finalize its alignment, and tighten it securely in the cabinet.

   c. Unless otherwise instructed by the manufacturer, adjust the panelboard so that the return flange of the deadfront shield is no more than 3/16 inch from (1) the front of the box for surface mounting or (2) the surrounding wall surfaces for flush mounting.

7. *Connect Line and Branch Conductors*

   a. *Conductors.* Use care in stripping insulation from conductors so as not to nick or ring the conductor. For aluminum, clean all oxide from the stripped portion and apply a joint compound.

   b. Distribute and arrange conductors neatly in the wiring gutters. (See Section 3.)

   c. Be sure that the lugs are suitable and approved for use with the cable before being connected to the panelboard.

   d. Tighten all lugs. Use the manufacturer's torque values, if furnished.(See Section 5, Item 1.)

8. *Ground Panelboard.* (See Section 384-27 of the National Electrical Code.)

   a. *Cabinet.* Ground the panelboard cabinet in accordance with Item 11 of Section 2.

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b. *Equipment Grounding Conductors.* Prepare equipment grounding conductors in accordance with Item 7.a and connect them to the equipment grounding terminal bar. Check to be sure that the terminal bar is securely bonded to the cabinet or panelboard frame and that it is not connected to the neutral bar except at service equipment as permitted in Section 250-52 of the National Electrical Code.

9. When installing circuit breakers or fuses, ensure that they are of the proper type or class and rating.

10. Clean the cabinet of all debris which has accumulated during the panelboard installation.

11. In order to protect the panelboard before completion of the job, cut and install a piece of cardboard to fit the outline of the box. If the job is complete, perform the steps in Section 5 and then install the cabinet front, per Section 6.

Section 5

STEPS TO BE TAKEN BEFORE ENERGIZING

1. Tighten all accessible electrical connections to the manufacturer's torque specifications. If such information is not provided with the equipment, consult the manufacturer.

2. Make certain that all blocks used for shipment have been removed from all component devices and the panelboard.

3. Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain that they operate freely.

4. To make sure that the system is free from short circuits and grounds, conduct an insulation resistance test phase to ground and phase to phase with the switches or circuit breakers in both the open and closed positions. If the resistance reads less than 1 megohm while testing branch circuit devices in the open position, the system may be unsafe and should be investigated.

5. Check to determine that all grounding connections are properly made. If the panelboard is used as service equipment, make certain that the neutral is properly bonded to the enclosure.

6. Remove all debris, scrap wire, etc., from the panelboard and cabinet before installing the cabinet front. Make certain that all deadfront shields are properly aligned and tightened. Install the cabinet front in accordance with Section 6.

Section 6

INSTALLATION OF CABINET FRONT

The cabinet front or trim package is designed to prevent damage to the front during shipment and handling.

1. *Unpacking.* Care should be used when unpacking and handling the cabinet front.

2. *Touch-up.* A suitable paint or other corrosion-resistant finish should be applied to those places where the finish is damaged.

3. *Front Alignment.* The cabinet front may be provided with an adjusting means to align it squarely with the building even though the box may be slightly out of plumb with the building.

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Section 7

ENERGIZING EQUIPMENT

1. Energizing a panelboard for the first time after initial installation or maintenance is potentially dangerous. Therefore, qualified electrical personnel should be present when the equipment is energized for the first time. If short circuits caused by damage or poor installation practices have not been detected in the procedures specified in Sections 1-6, serious damage can occur when the power is turned on.

2. There should be no load on the panelboard when it is energized. Turn off all of the downstream loads, including those such as other panelboards and devices which are remote from the panelboard.

3. The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the main devices, then the feeder devices, and then the branch-circuit devices. Turn the devices on with a firm positive motion. Protective devices which are not quick-acting should not be "teased" into the closed position.

4. After all main, feeder, and branch circuit devices have been closed, loads such as lighting circuits, contactors, heaters, and motors may be turned on.

Section 8

CARE AND MAINTENANCE

A care and maintenance program for panelboards should be conducted on a regularly scheduled basis in accordance with the following:

1. A panelboard which has been carrying its regular load for at least 3 hours just prior to inspection should be field tested by feeling the deadfront surfaces of circuit breakers, switches, interior trims, doors, and enclosure sides with the palm of the hand. If the temperature of these surfaces does not permit you to maintain contact for at least 3 seconds, this may be an indication of trouble and investigation is necessary.

WARNING—BEFORE PERFORMING ANY OF THE FOLLOWING OPERATIONS, TURN OFF ALL POWER SUPPLYING THE PANELBOARD. CHECK THE VOLTAGE OF ALL INCOMING LINE TERMINALS TO POSITIVELY ASCERTAIN THAT THE EQUIPMENT IS TOTALLY DEENERGIZED.

2. Inspect the panelboard once each year or after any severe short circuit.

   a. Look for any moisture or signs of previous wetness or dripping inside the panelboard. Condensation in conduits or dripping from outside sources is one known cause of malfunction.

      (1) Seal off any conduits which have dripped condensate, and provide a means for further condensate to drain away from the panelboard.

      (2) Seal off any cracks or openings which have allowed moisture to enter the enclosure. Eliminate the source of any dripping on the enclosure and any other source of moisture.

      (3) Replace or thoroughly dry and clean any insulating material which is damp or wet, or shows an accumulation of deposited material from previous wettings.

   b. If there is an accumulation of dust and dirt, clean out the panelboard by using a brush, vacuum cleaner, or clean lint-free rags. Avoid blowing dust into circuit breakers or other components. Do not use a blower or compressed air.

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c. Carefully inspect all visible electrical joints and terminals.

(1) Tighten bolts and nuts at bus joints if there is any sign of overheating or looseness. (See Section 5, Item 1.) If joints appear to be badly discolored, corroded, or pitted, the parts should be disassembled and replaced or cleaned.

CAUTION: DO NOT REMOVE PLATING ON ALUMINUM PARTS IN JOINTS. REPLACE DAMAGED ALUMINUM PARTS.

(2) Examine all wire or cable connections for evidence of looseness or overheating. Torque if necessary. (See Section 5, Item 1.) If major discoloration or cable damage is apparent, replace the damaged parts and remove the damaged portion of the cable.

(3) Closely examine fuse clips. If there is any sign of overheating or looseness, check the spring pressure, tightness of clamps, etc. Replace the fuse clips if the spring pressure compares unfavorably with that of other identical fuse clips in the panelboard.

(4) Retighten plug fuses.

(5) Look for signs of deterioration in insulating material or melting of sealing compound. Replace such insulating parts, and assemblies where sealing compound has melted.

(6) BE SURE THAT THE CONDITION WHICH CAUSED THE OVERHEATING HAS BEEN CORRECTED.

d. Check the operation of all mechanical components.

(1) Exercise switch operating mechanisms and external operators for circuit breakers to determine that they operate freely to their full on and off positions.

(2) Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms.

(3) Whenever practical, check all devices for missing or broken parts, proper spring tension, free movement, corrosion, dirt, and excessive wear.

(4) Adjust, clean, and lubricate or replace parts as required.

e. After a severe short circuit, examine all devices and bus supports for cracks or breakage. Replace as required.

3. Lubricate the operating parts of switch mechanisms, etc., according to the manufacturer's instructions which are usually printed on diagrams or labels.

a. Use *clean*, nonmetallic, light grease or oil as instructed.

b. Do *not* oil or grease parts of molded case circuit breakers.

c. If no instructions are given on the devices, sliding copper contacts, operating mechanisms, and interlocks may be lubricated with clean, light grease.

d. Wipe off excess lubrication to avoid catching dirt.

4. Operate each switch or circuit breaker several times to ensure that all mechanisms are free and in proper working order. Replace as required.

5. Check circuit breakers and fuses to ensure they have the proper ampere and interrupting ratings. Ensure that noncurrent-limiting devices are never used as replacements for current-limiting devices. Never attempt to defeat rejection mechanisms which are provided to prevent the installation of the incorrect class of fuse.

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6. Check insulation resistance:

   a. If a severe short circuit has occurred.

   b. If it has been necessary to replace parts or clean insulating surfaces.

   c. If the panelboard has been exposed to high humidity, condensation or dripping moisture.

Section 9

PERMISSIBLE LOADING OF PANELBOARDS

The ratio of load current to the ampere rating of the overcurrent protective device determines its operating temperature. In compliance with Section 384-16 of the National Electrical Code, the continuous loads of panelboard circuits should be not more than 80 percent of the rating of the overcurrent protective device, unless the marking of the device indicates that it is suitable for continuous duty at 100 percent of its rating.

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September 1984

NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status are set forth in certain clauses of the NEMA Bylaws, which are quoted below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for its particular need. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

(Bylaw—Art. V, Sec. 1)

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Bylaw—Art. V, Sec. 2, Subsection A)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the standards publication may be capable of otherwise equivalent performance.

(NEMA Policy Memorandum 84-2, dated June 7, 1984)

Classes of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Bylaw—Art. V, Sec. 2, Subsection B)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design.

(Bylaw—Art. V, Sec. 6, 1st Sentence)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment and/or approval.

(Bylaw—Art. V, Sec. 4, Subsection A)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

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PANELBOARD AND DISTRIBUTION BOARD SECTION

OF THE

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

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Crouse-Hinds Distribution Equipment
A Division Cooper Industries
Earlysville, VA 22936

Custom Switchgear and Controls, Inc.
Santa Clara, CA 94051

Eaton Corp. / Cutler Hammer Products
Milwaukee, WI 53216

Erickson Electrical Equipment Co.
Chicago, IL 60630

General Electric Company
Plainville, CT 06062

Anchor Electric, A Unit of General
Signal Corporation
Manchester, NH 03105

Harvey Hubbell, Inc.
Orange, CT 06477

Milbank Manufacturing Co.
Kansas City, MO 64141

Nix and Miller, Inc.
Buford, GA 30518

Penn Panel and Box Company
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Commerce, CA 90040

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Palatine, IL 60067

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