MAINTENANCE INSTRUCTIONS

STORE BEHIND DIRECTORY CARD IN PANELBOARD AFTER CONSTRUCTION.

NEMA STANDARDS PUBLICATION PB 1.1-1991

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 8-28-1991)

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 instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency regarding installation, operation, or maintenance.

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. For specific information not covered by these instructions, you are urged to contact the manufacturer of the panelboard directly.

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. They 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:

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SCOPE

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

600 volts or less
1600—ampere mains or less
1200—ampere branch circuits or 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

1.1 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.

1.2 Installation, operation, and maintenance of panelboards should be conducted only by qualified personnel.

1.3 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:

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

1.3.2 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, is

1.3.3 Trained in rendering first aid.

WARNING: HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. UNLESS OTHERWISE SPECIFIED, INSPECTION AND PREVENTIVE MAINTENANCE SHOULD ONLY BE PERFORMED ON PANELBOARDS AND EQUIPMENT TO WHICH POWER HAS BEEN TURNED OFF, DISCONNECTED AND ELECTRICALLY ISOLATED SO THAT NO ACCIDENTAL CONTACT CAN BE MADE WITH ENERGIZED PARTS.

SAFETY RELATED WORK PRACTICES, AS DESCRIBED IN NFPA 70E*, PART II SHOULD BE FOLLOWED AT ALL TIMES.

CAUTION: HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE COMPONENTS DURING INSTALLATION OR MAINTENANCE.

SECTION 2
INSTALLATION OF PANELBOARD CABINETS (BOXES)

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

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

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

2.4 *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 and so identified by the manufacturer for these conditions.

2.5 *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.

2.6 *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.

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2.7 *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.

2.8 *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 feet 3 inches.

2.9 *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.)

2.10 *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.)

2.11 *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.

2.12 *Grounding of Panelboard Cabinets.* Ground the cabinet as specified in Article 250 of the National Electrical Code. When the cabinet contains service equipment, it is necessary to bond the cabinet to the grounded (neutral) service conductor.

SECTION 3
INSTALLATION OF CONDUIT AND CONDUCTORS

3.1 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.

3.2 Knockouts should be removed as follows:

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

3.2.1 FIRST: Remove center knockout INWARD.

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

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

3.2.2.1 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).

3.2.2.2 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.

3.3 Refer to the National Electric Code, Article 300 for proper wiring methods. See 4.7 for making proper connections.

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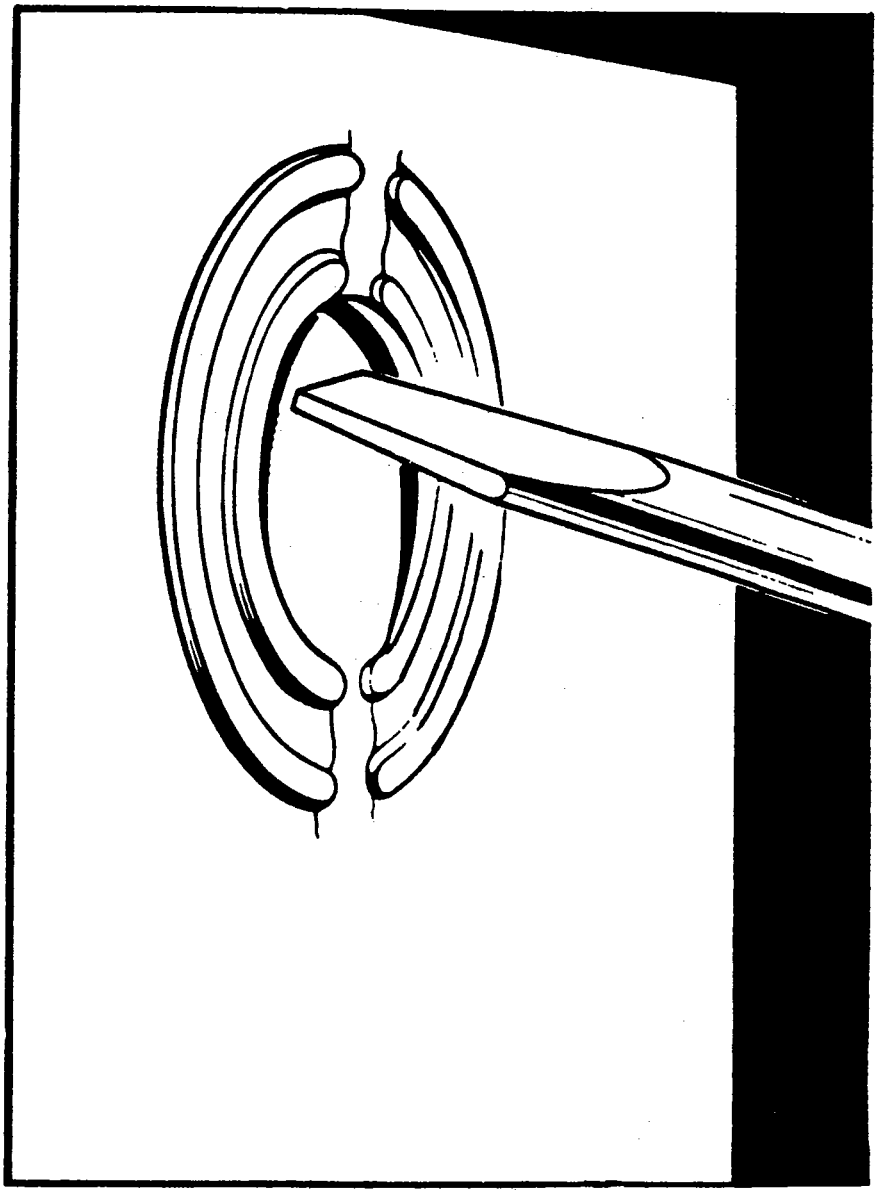


Figure 3-1
Knockout Removal - Step 1

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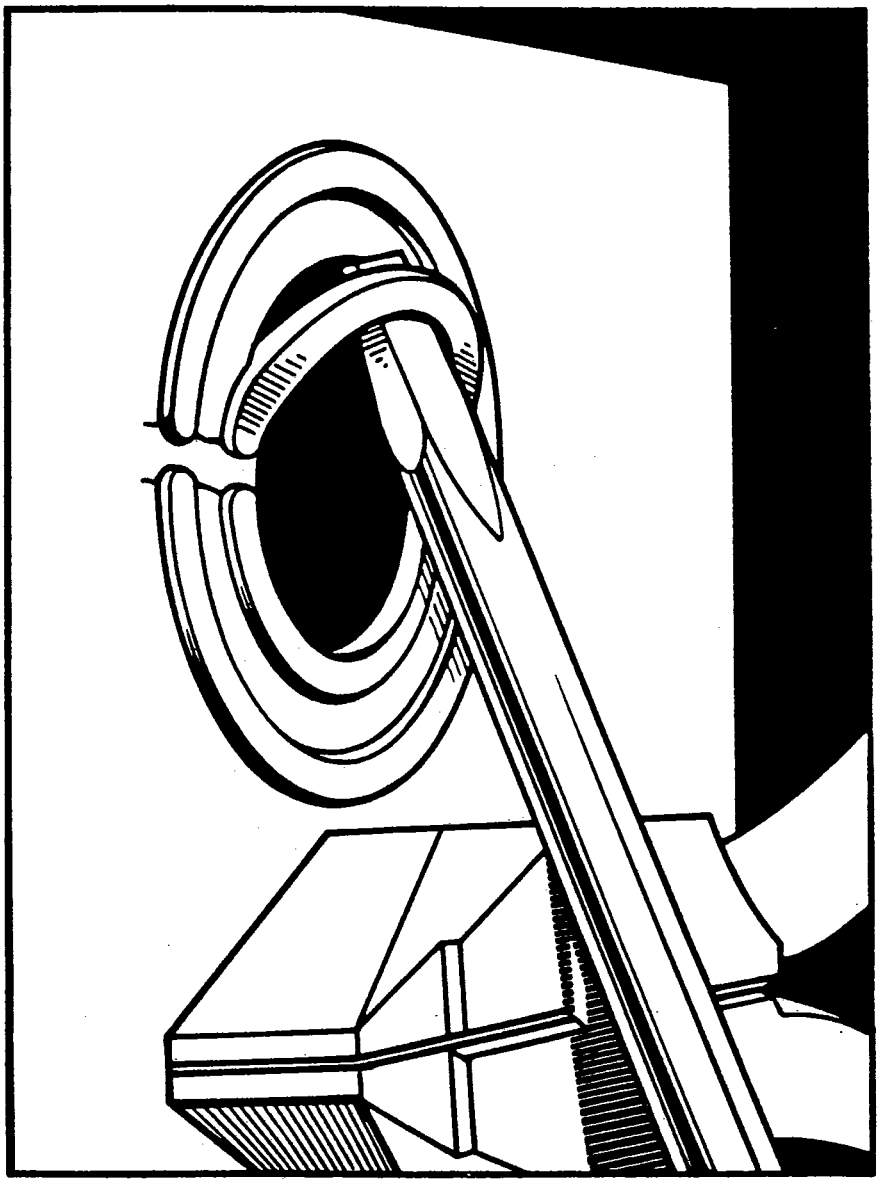


Figure 3-2
Knockout Removal - Step 2

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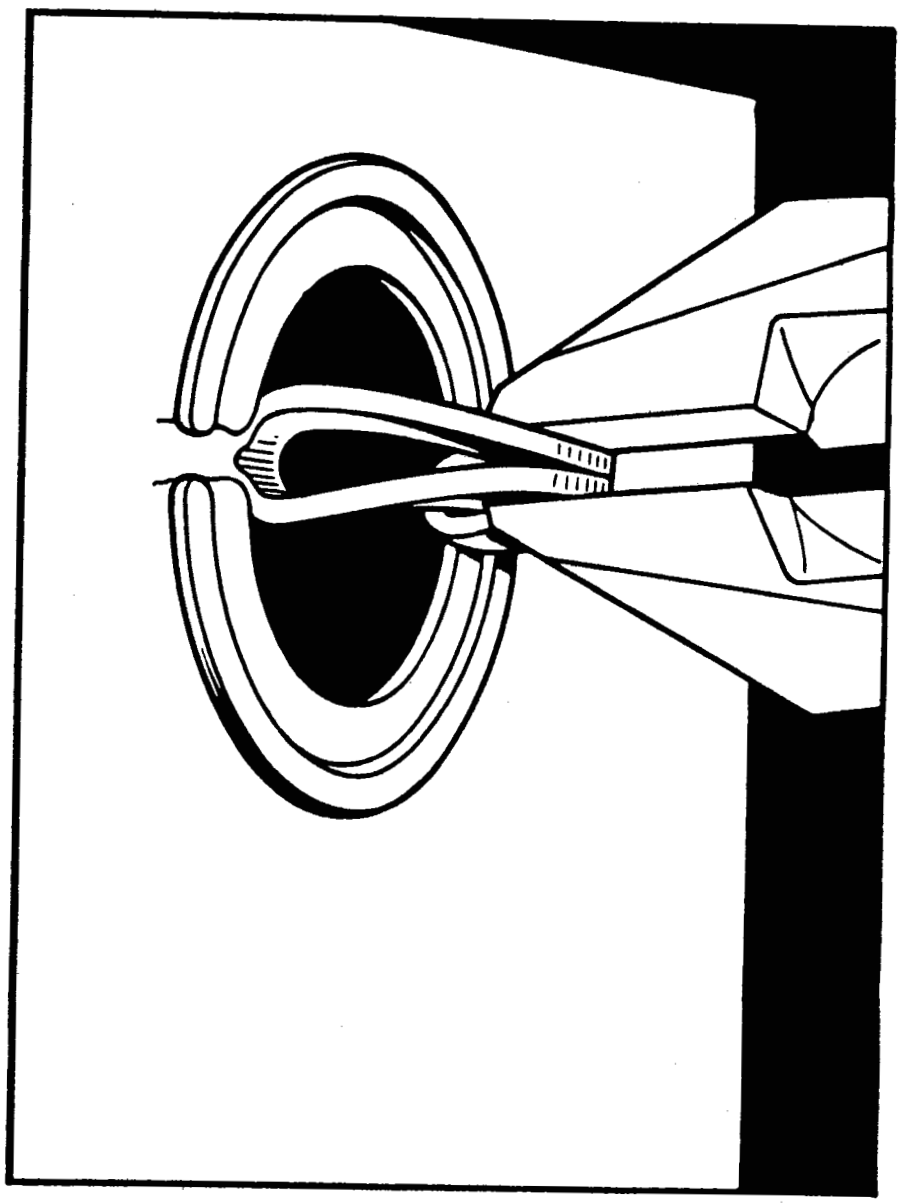


Figure 3-3
Knockout Removal - Step 3

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3.4 Keep conductor length to a minimum within the wiring gutter. Excessive conductor length will result in additional heating and may result in overheating. However, conductors should be long enough to reach the terminal location in a manner that avoids strain on the terminal.

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

SECTION 4
INSTALLATION OF PANELBOARD

4.1 *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.

4.2 *Unpacking.* Care should be exercised in unpacking the panelboard to prevent damage and loss of instruction materials and loose parts.

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

4.4 *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 damage to the plating.

CAUTION: HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE PANELBOARD COMPONENTS DURING INSTALLATION OR MAINTENANCE.

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

4.6 *Installation*

4.6.1 Adjust the alignment devices where provided.

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

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

4.7 *Connect Line and Branch Conductors.*

4.7.1 *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.

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

4.7.1.2 Care should be exercised to ensure that the terminals which have been provided are suitable for use with the types of conductors being installed in the panelboard.

4.7.1.3 Tighten all terminals. Use the manufacturer's torque values, (See 5.1.).

4.8 *Panelboard Grounding.* Ground the panelboard cabinet in accordance with 2.12. (See Section 384-20 of the National Electrical Code.)

4.8.1 *Equipment Grounding Conductors.* Prepare equipment grounding conductors in accordance with 4.7.1 above 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 250-53(b) of the National Electrical Code.

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

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

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

SECTION 5
STEPS TO BE TAKEN BEFORE ENERGIZING

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

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

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

5.4 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 with the branch circuit devices in the open position, the system may be unsafe and should be investigated. If after investigation and possible correction, low readings are still observed, the manufacturer should be contacted.

5.5 Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions. See Section 230-95 of the National Electrical Code and NEMA Standards Publication PB 2.2-1988, Application Guide for Ground Fault Protective Devices for Equipment.

5.6 Set any adjustable time current trip device settings to the proper values. Experience has indicated that damage from overcurrent can be reduced if the devices used for overload and short-circuit protection are set to operate instantaneously (that is, without intentional time delay) at 115 percent of the highest value of phase current which is likely to occur as the result of any anticipated motor starting or welding currents.

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

5.8 Remove all foreign material 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

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

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

6.3 Install covers, close doors, and make certain that no conductors are pinched and that all enclosure parts are properly aligned and tightened.

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

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

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SECTION 7
ENERGIZING EQUIPMENT

WARNING: HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. ENERGIZING A PANELBOARD FOR THE FIRST TIME AFTER INITIAL INSTALLATION OR MAINTENANCE IS POTENTIALLY DANGEROUS.

7.1 Qualified personnel should be present when the equipment is energized for the first time. If short circuit conditions caused by damage or poor installation practices have not been detected in the procedures specified in Section 5, serious personal injury and damage can occur when the power is turned on.

7.2 There should be no load on the panelboard when it is energized. Turn off all of the downstream loads.

7.3 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.

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

SECTION 8
MAINTENANCE

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

8.2 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. (See NEMA Standards Publication AB 4, clause 8.3.4).

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SAFETY RELATED WORK PRACTICES, AS DESCRIBED IN NFPA 70E, PART II SHOULD BE FOLLOWED AT ALL TIMES.

CAUTION: HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE PANELBOARD COMPONENTS DURING INSTALLATION OR MAINTENANCE.

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

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

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

8.3.1.2 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.

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

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8.3.1.4 Inspect all component devices. Replace any component device which shows evidence of moisture damage or has been subjected to water damage or flooding.

8.3.1.5 Look for and replace deteriorated insulating material and assemblies where sealing compounds have melted.

8.3.2 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.

8.3.3 Carefully inspect all visible electrical joints and terminals in the bus and wiring system.

8.3.3.1 Visually check connections to be certain that they are clean and secure. Loose and/or contaminated connections increase electrical resistance which can cause overheating. Such overheating is indicated by discoloration or flaking of insulation and/or metal parts. Pitting or melting of connecting surfaces is a sign of arcing due to a loose, or otherwise poor connection. Parts which show evidence of overheating or looseness should be cleaned and re-torqued or replaced if damaged. Tighten bolts and nuts at bus joints to manufacturers torque specifications.

CAUTION: DO NOT REMOVE PLATING FROM ALUMINUM PARTS IN JOINTS OR TERMINATIONS. REMOVAL OF PLATING CAN RESULT IN OVERHEATING. REPLACE DAMAGED ALUMINUM PARTS.

8.3.3.2 Examine all conductor connections for overheating and other damage as described in 8.2 above. If evidence of overheating or looseness is present, clean, or if necessary replace, damaged parts and/or conductor sections. Tighten connections as necessary. (See 5.1).

8.3.3.3 Examine fuse clip contact pressure and contact means. If there is any sign of overheating or looseness (see 8.2), check the spring pressure and tightness of fastening means. Replace the fuse clips if damaged or if the spring pressure compares unfavorably with that of other identical fuse clips within the panelboard.

8.3.3.4 Re-tighten plug fuses.

8.3.3.5 BE SURE THAT ALL CONDITIONS WHICH CAUSED THE OVERHEATING HAVE BEEN CORRECTED.

8.3.4 Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions. See Section 230-95 of the National Electrical Code and NEMA Standards Publication PB 2.2-1988, Application Guide for Ground Fault Protective Devices for Equipment.

8.3.5 Check the operation of all mechanical components. Replace as required.

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

8.3.5.2 Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms.

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

8.3.5.4 Adjust, clean, and lubricate or replace parts according to the manufacturers instructions.

8.3.6 After a severe short circuit, examine all devices and bus supports for cracks or breakage and replace components as required. Refer to NEMA Standards Publication AB 4 for inspection procedures for circuit breaker devices.

8.4 Clean and dress readily accessible copper electrical contacts, blades, and jaws according to the manufacturer's instructions when inspection indicates the need.

8.5 Lubricate switches and operating mechanisms according to the manufacturer's instructions, which are usually printed on diagrams or labels.

8.5.1 Use *clean* nonmetallic light grease or oil as instructed. (See NEMA Standards Publication AB 4).

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

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

8.5.4 Wipe off excess lubrication to avoid contamination.

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

8.5.6 Check circuit breakers and fuses to ensure they have the proper ampere, voltage and interrupting ratings. Ensure that non-current-limiting devices are not 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.

8.5.7 Check insulation resistance (See 5.4) as follows:

8.5.7.1 If a severe short circuit has occurred. (See 8.6);

8.5.7.2 If it has been necessary to replace parts or clean insulating surfaces;

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

8.6 If a severe electrical short circuit has occurred, the excessive currents may have resulted in structural component and/or bus and conductor damage due to mechanical distortion, thermal damage, metal deposits, or smoke. The manufacturer should be consulted before clean up and correction is attempted.

8.7 In the event of water damage, i.e., flooding or sprinkler discharge, the manufacturer should be consulted before clean up and corrective action is attempted.

SECTION 9
PERMISSIBLE LOADING OF PANELBOARDS

9.1 The ratio of load current to the ampere rating of the overcurrent protective device determines it operating temperature. In compliance with Section 384-16 of the National Electrical Code, the 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.

9.2 Some types of electrical equipment cause harmonics in the electrical system which may result in overheating. This condition should be considered when determining panelboard loading, as possible de-rating of equipment may be necessary.

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced 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 their particular needs. 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.

(Standardization Policies and Procedures, p. 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.

(Standardization Policies and Procedures, p. 2)

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.

(Standardization Policies and Procedures, p. 8)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes:

1. NEMA Standard, which relates to a product, process or procedure 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.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp 7 & 16)

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, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.

(Standardization Policies and Procedures, pp. 7 & 16)

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, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon. *(Standardization Policies and Procedures, pp 7 & 16)*

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.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

July 17, 1990

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