NEMA PUBLICATION PB 1.1-1996

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

RETAIN FOR USE OF QUALIFIED MAINTENANCE PERSONNEL

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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 1300 N. 17TH STREET, ROSSLYN, VA 22209

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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)

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 will be reviewed periodically by the Section and updated as necessary.

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Publication No. PB 1.1-1996 revises and supersedes PB 1.1-1991.

This Standards Publication was developed by the Panelboard and Distribution Board Section. Section approval of the standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the Section was composed of the following members:

American Circuit Breaker Co.—Albemarle, NC
Circle AW Products—Portland, OR
Current Technology, Inc.—Richardson, TX
Cutler-Hammer, Inc.—Pittsburgh, PA
The Durham Company—Lebanon, MO
GE—Plainville, CT
Hubbell, Inc.—Bridgeport, CT
Lamson & Sessions—Cleveland, OH
Milbank Manufacturing Company—Kansas City, MO
Penn Panel & Box Company—Collingdale, PA
The Pringle Electrical Mfg. Co.—Fort Washington, PA
Siemens Energy & Automation, Inc.—Alpharetta, GA
Square D Company—Palatine, IL 60067

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Section 1
SCOPE

This 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 at 600 volts and less with:

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.

Section 2
REFERENCES

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269

NFPA 70 1996 — *National Electrical Code*
NFPA 70E 1994 — *Safety Related Work Practices*

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

AB 4-1996 — *Guidelines for Inspection and Preventative Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications*

PB 2.2-1994 — *Application Guide for Ground Fault Protective Devices for Equipment*

Guidelines for Handling Water Damaged Electrical Products

Section 3
GENERAL

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

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

3.3 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:

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3.3.1 Knowledgeable of the requirements of the *National Electrical Code* and of all other applicable codes, laws, and standards.

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

3.3.3 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:

3.3.4 Trained in rendering first aid.

WARNING: Hazardous voltages in electrical equipment can cause severe personal injury or death. Unless otherwise specified, inspection and 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. Follow all manufacturer's warnings and instructions.

Safety related work practices, as described in NFPA 70, 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 4
INSTALLATION OF PANELBOARD CABINETS (BOXES)

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

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

4.3 Flammable Material. Locate the cabinet well away from flammable material.

4.4 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.

4.5 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.

4.6 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.

4.7 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.

4.8 Space Around the Cabinet. When selecting a location, provide sufficient access and working space around the cabinet (See Section 110-16 of the *National Electrical Code*). The width of the working

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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 6 inches.

4.9 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*.)

4.10 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*.)

4.11 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.

4.12 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 5
INSTALLATION OF CONDUIT AND CONDUCTORS

5.1 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*.

5.2 Knockouts should be removed as follows:

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

5.2.1 FIRST: Remove center knockout INWARD.

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

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

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

5.2.2.2 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.

5.3 Refer to the *National Electrical Code*, Article 300 for proper wiring methods. See 6.7 for making proper connections.

5.4 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.

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

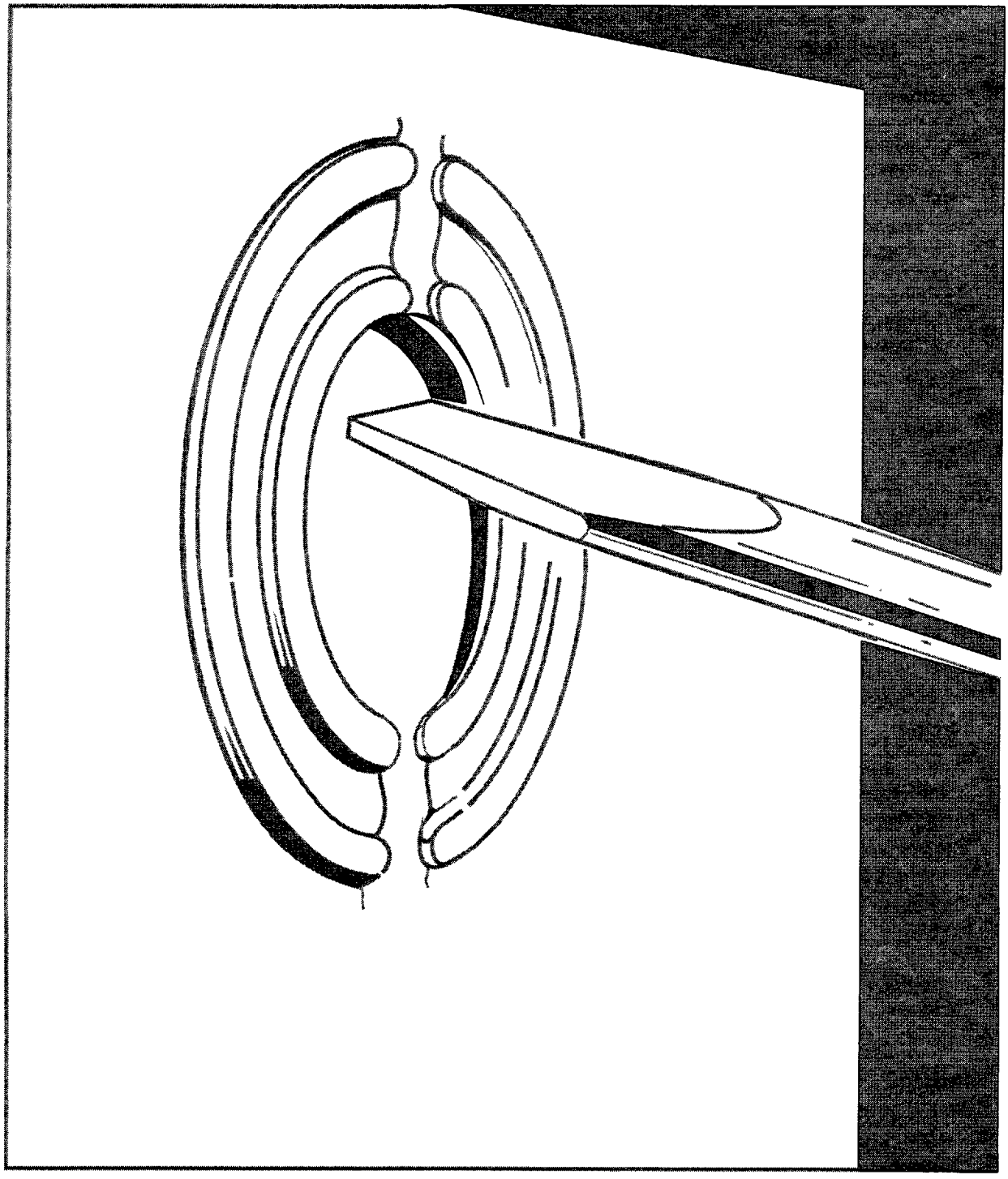


Figure 1
Knockout Removal – Step 1

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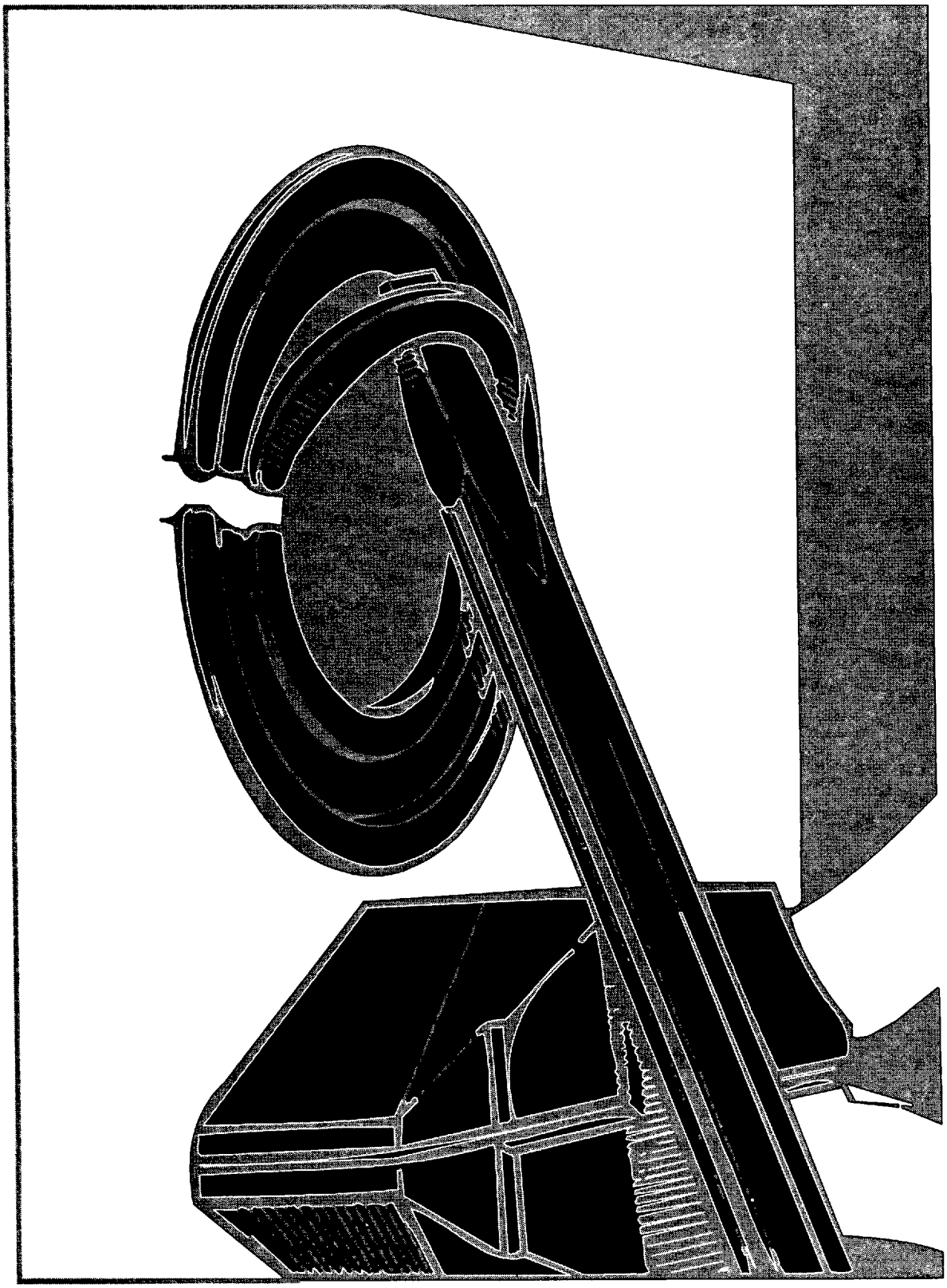


Figure 2
Knockout Removal – Step 2

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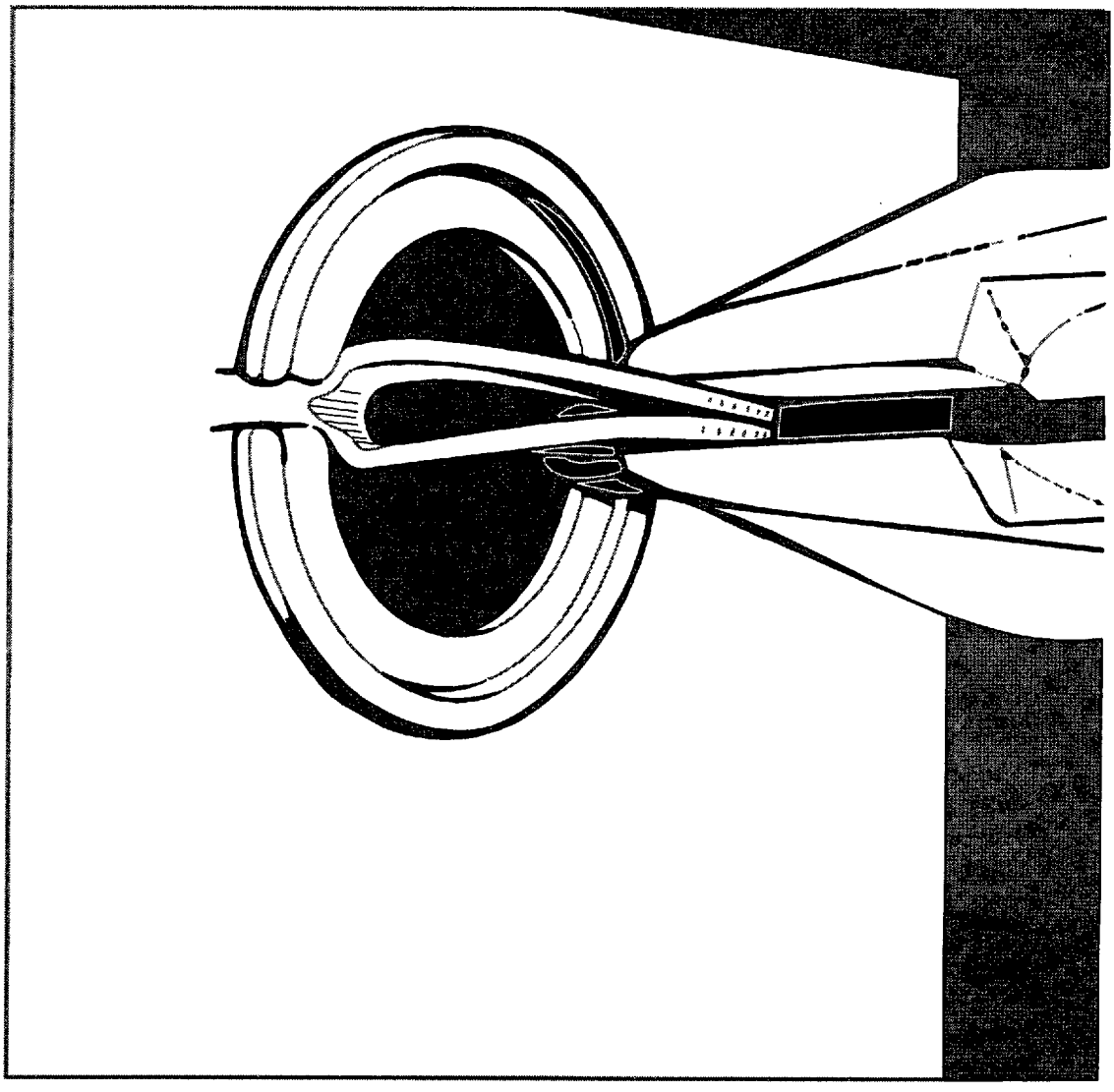


Figure 3
Knockout Removal – Step 3

Section 6
INSTALLATION OF PANELBOARD

6.1 *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.

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

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

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6.4 Care should be taken to protect the panelboard internal parts from contamination during the installation process

6.4.1 *Cleaning.* Clean the cabinet of all foreign materials. 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.

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

6.6 *Installation*

6.6.1 Adjust the alignment devices where provided.

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

6.6.3 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.

6.7 Connect Line and Branch Conductors

6.7.1 *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.

6.7.1.1 Distribute and arrange conductors neatly in the wiring gutters. (See Section 5 .)

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

6.7.1.3 Tighten all terminals Use the manufacturer's torque values, (See 7.1).

6.8 Panelboard Grounding. Ground the panelboard cabinet in accordance with 4.12 . (See Section 384-20 of the *National Electrical Code*.)

6.8.1 Equipment Grounding Conductors. Prepare equipment grounding conductors in accordance with 6.7.1 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*.

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

6.10 Clean the cabinet of all debris which has accumulated during the panelboard installation (see 6.4.1).

6.11 If the job is complete, perform the steps in Section 7 and then install the cabinet front (see Section 8).

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Section 7
STEPS TO BE TAKEN BEFORE ENERGIZING

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

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

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

7.4 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.

7.5 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, Application Guide for Ground Fault Protective Devices for Equipment.

7.6 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.

7.7 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.

7.8 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 8 .

Section 8
INSTALLATION OF CABINET FRONT

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

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

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

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

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8.5 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.

Section 9
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.

9.1 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 7, serious personal injury and damage can occur when the power is turned on.

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

9.3 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.

9.4 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 10
MAINTENANCE

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

10.2 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.

WARNING: Hazardous voltages in electrical equipment can cause severe personal injury or death. Unless otherwise specified, inspection and maintenance should only be performed on panelboards to which power has been turned-off, disconnected and electrically isolated so that no accidental contact can be made with energized parts. Follow all manufacturer's warnings and instructions.

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.

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

10.4 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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10.4.1 Carefully inspect all visible electrical joints and terminals in the bus and wiring system.

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10.4.2 Visually check all conductors and 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. Damage to plating can result in overheating. Replace damaged aluminum parts.

10.4.3 Examine fuse clip contact pressure and contact means. If there is any sign of overheating or looseness follow the manufacturer's maintenance instructions or replace the fuse clips. Loose fuse clips can result in overheating.

10.4.4 Re-tighten plug fuses.

10.4.5 Be sure that all conditions which caused the overheating have been corrected.

10.5 Check circuit breakers, switches, 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.

10.5.1 Operate each switch or circuit breaker several times to ensure that all mechanisms are free and in proper working order. Replace as required. See NEMA AB-4 for maintenance of molded case circuit breakers.

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

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

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

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

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

10.6.4.1 Use *clean* nonmetallic light grease or oil as instructed.

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

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

10.6.4.4 Wipe off excess lubrication to avoid contamination.

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.

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

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

10.8 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.

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

10.8.2 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.

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

10.8.4 Inspect all component devices. Replace any component device which shows evidence of moisture damage or has been subjected to water damage or flooding. Additional information may be found in the NEMA document "Guidelines for Handling Water Damaged Electrical Products."

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

10.10 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. Examine all devices and bus supports for cracks or breakage. The manufacturer should be consulted before clean up and correction is attempted.

10.11 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, Application Guide for Ground Fault Protective Devices for Equipment.

10.12 Check insulation resistance (See 7.4) under any of the following conditions:

10.12.1 If a severe short circuit has occurred. (See 10.10);

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

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

Section 11
PERMISSIBLE LOADING OF PANELBOARDS

11.1 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.

11.2 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.

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