**ANSI/NEMA PB 1.1-2013**

# *General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less*

*Published by*

**National Electrical Manufacturers Association**
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

www.nema.org

Approved: September 11, 2013

© 2014 National Electrical Manufacturers Association. All rights, including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American copyright conventions.

## NOTICE AND DISCLAIMER
## (ANSI Accredited Standards Committee)

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

ANSI standards, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. As Secretary of the ANSI Accredited Standards Committee, NEMA administers the process in accordance with the procedures of the American National Standards Institute to promote fairness in the development of consensus. As a publisher of this document, NEMA does not write the document and it does not independently test, evaluate or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer's or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test or inspect products, designs or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety–related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

## TABLE OF CONTENTS

Page

Foreword ..... iv

**Section 1 SCOPE ..... 1**

**Section 2 REFERENCES ..... 2**

**Section 3 GENERAL ..... 3**

3.1 SUCCESSFUL OPERATION OF PANELBOARDS ..... 3
3.2 QUALIFIED PERSONNEL ..... 3
3.3 DEFINITION OF QUALIFIED PERSONNEL ..... 3
3.3.1 Requirements ..... 3
3.3.2 Established Safety Practices ..... 3
3.3.3 Protective Equipment ..... 3
3.3.4 First Aid ..... 3
3.4 SUITABLE RATINGS ..... 4

**Section 4 INSTALLATION OF PANELBOARD CABINETS (BOXES) ..... 5**

4.1 Installation INSTRUCTIONS ..... 5
4.2 Location in Building ..... 5
4.3 Flammable Material ..... 5
4.4 Unusual Service Conditions ..... 5
4.5 Indoor Damp Locations ..... 5
4.6 Wet Locations ..... 5
4.7 Clearance from Ceiling ..... 5
4.8 Space around the Cabinet ..... 5
4.9 Mounting of Cabinet ..... 5
4.10 Flush Mounting in Wall ..... 6
4.11 Unused Openings in Cabinet ..... 6
4.12 Grounding of Panelboard Cabinets ..... 6

**Section 5 INSTALLATION OF CONDUIT AND CONDUCTORS ..... 7**

5.1 Conduits Installation ..... 7
5.2 Knockouts Removal ..... 7
5.2.1 First Step—Remove Center Knockout ..... 7
5.2.2 Next Step—Remove Rings ..... 7
5.3 *NATIONAL ELECTRICAL CODE®*, ARTICLE 300 ..... 7
5.4 CONDUCTOR LENGTH ..... 7
5.5 EXERCISE CARE ..... 7
5.6 *NATIONAL ELECTRICAL CODE®*, SECTION 725.136 ..... 8

**Section 6 INSTALLATION OF PANELBOARD ..... 12**

6.1 PROPER STORAGE ..... 12
6.2 UNPACKING ..... 12
6.3 INSPECTION ..... 12
6.4 CARE ..... 12
6.4.1 Cleaning ..... 12
6.5 MANUFACTURER'S INSTRUCTIONS ..... 12
6.6 INSTALLATION ..... 12
6.6.1 Alignment Devices ..... 12
6.6.2 Panelboard ..... 12
6.6.3 Flange of Deadfront Shield ..... 12
6.7 LINE AND BRANCH CONDUCTORS ..... 13
6.7.1 Conductors ..... 13
6.8 PANELBOARD GROUNDING AND BONDING ..... 13
6.8.1 Equipment Grounding Conductors ..... 13
6.9 PROPER TYPE OR CLASS AND RATING ..... 13

© 2014 National Electrical Manufacturers Association

6.10 DEBRIS ..... 13
6.11 STEPS IN SECTION 7 ..... 13
**Section 7 STEPS TO BE TAKEN BEFORE ENERGIZING ..... 14**
7.1 ACCESSIBLE ELECTRICAL CONNECTIONS ..... 14
7.2 BLOCKS AND PACKING MATERIALS ..... 14
7.3 SWITCHES, CIRCUIT BREAKERS, AND OTHER OPERATING MECHANISMS ..... 14
7.4 SHORT CIRCUITS AND GROUND FAULTS ..... 14
7.5 GROUND FAULT PROTECTION SYSTEM ..... 14
7.6 ADJUSTABLE TIME CURRENT TRIP DEVICE SETTINGS ..... 14
7.7 GROUNDING CONNECTIONS ..... 14
7.8 FOREIGN MATERIAL ..... 15
**Section 8 INSTALLATION OF CABINET FRONT ..... 16**
8.1 CABINET FRONT OR TRIM PACKAGE ..... 16
8.2 UNPACKING ..... 16
8.3 COVERS AND DOORS ..... 16
8.4 TOUCH-UP ..... 16
8.5 FRONT ALIGNMENT ..... 16
**Section 9 ENERGIZING EQUIPMENT ..... 17**
9.1 QUALIFIED PERSONNEL ..... 17
9.2 LOAD ON THE PANELBOARD ..... 17
9.3 ENERGIZED IN SEQUENCE ..... 17
9.4 LOADS SUCH AS LIGHTING CIRCUITS, CONTACTORS, HEATERS, AND MOTORS ..... 17
**Section 10 MAINTENANCE ..... 18**
10.1 MAINTENANCE PROGRAM ..... 18
10.2 PANELBOARD WHICH HAS BEEN CARRYING ITS REGULAR LOAD FOR AT LEAST 3 HOURS ..... 18
10.3 INSPECT PANELBOARD ONCE EACH YEAR ..... 18
10.4 ACCUMULATION OF DUST AND DIRT ..... 18
10.4.1 Visible Electrical Joints and Terminals ..... 18
10.4.2 Conductors and Connections ..... 18
10.4.3 Fuse Clip Contact Pressure and Contact Means ..... 19
10.4.4 Plug Fuses ..... 19
10.4.5 Conditions Which Caused Overheating ..... 19
10.5 PROPER AMPERE, VOLTAGE, AND INTERRUPTING RATINGS ..... 19
10.5.1 Mechanisms Free and in Proper Working Order ..... 19
10.6 OPERATION OF ALL MECHANICAL COMPONENTS ..... 19
10.6.1 Switch Operating Mechanisms ..... 19
10.6.2 Integrity of Electrical and Mechanical Interlocks ..... 19
10.6.3 Missing or Broken Parts ..... 19
10.6.4 Manufacturer's Instructions ..... 19
10.6.5 Accessible Copper Electrical Contacts, Blades, and Jaws ..... 20
10.7 DAMAGED INSULATING MATERIAL AND ASSEMBLIES ..... 20
10.8 MOISTURE OR SIGNS OF PREVIOUS WETNESS OR DRIPPING ..... 20
10.8.1 Conduits Which Have Dripped Condensate ..... 20
10.8.2 Cracks or Openings ..... 20
10.8.3 Insulating Material Which is Damp or Wet ..... 20
10.8.4 Component Devices Which Show Evidence of Moisture Damage ..... 20
10.9 BEFORE CLEANUP AND CORRECTIVE ACTION IS ATTEMPTED ..... 20
10.10 SEVERE ELECTRICAL SHORT CIRCUIT ..... 21
10.11 GROUND FAULT PROTECTION SYSTEM ..... 21
10.12 INSULATION RESISTANCE ..... 21
10.12.1 Severe Short Circuit ..... 21
10.12.2 Parts Replaced ..... 21

© 2014 National Electrical Manufacturers Association

10.12.3 Panelboard Exposed to High Humidity ..... 21
**Section 11 PERMISSIBLE LOADING OF PANELBOARDS ..... 22**
11.1 *NATIONAL ELECTRICAL CODE®* ..... 22
11.2 HARMONICS IN ELECTRICAL SYSTEM ..... 22

**Figures**

5–1 Knockout Removal—Step 1 ..... 9
5–2 Knockout Removal—Step 2 ..... 10
5–3 Knockout Removal—Step 3 ..... 11

© 2014 National Electrical Manufacturers Association

## 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.

In the preparation of this standards publication input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product section by contacting the following: These recommendations will be reviewed periodically and updated as necessary.

Senior Technical Director, Operations
National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

Publication PB 1.1- 2013 revises and supersedes PB 1.1-2007.

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

Eaton Corporation.—Pittsburgh, PA
GE Industrial Solutions—Plainville, CT
Hubbell, Inc.—Orange, CT
Milbank Manufacturing Company—Kansas City, MO
Penn Panel & Box Company—Collingdale, PA
Reliance Controls Corporation—Racine, WI
Siemens Industry, Inc.—Norcross, GA
Schneider Electric —Palatine, IL

© 2014 National Electrical Manufacturers Association

# 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.

© 2014 National Electrical Manufacturers Association

## Section 2
## REFERENCES

**National Fire Protection Association (NFPA)**
Batterymarch Park
Quincy, MA 02269

| | |
|---|---|
| NFPA 70 | *National Electrical Code®* |
| NFPA 70E | *Standard for Electrical Safety in the Workplace* |

**National Electrical Manufacturers Association (NEMA)**
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

| | |
|---|---|
| AB 4 | *Guidelines for Inspection and Preventative Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications* |
| PB 2.2 | *Application Guide for Ground Fault Protective Devices for Equipment* |
| | *Guidelines for Handling Water Damaged Electrical Products* |

© 2014 National Electrical Manufacturers Association

# Section 3
# GENERAL

**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 70E, should be followed at all times.
All requirements of the *National Electrical Code*® NFPA 70 should be followed.

**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.**

## 3.1 SUCCESSFUL OPERATION OF PANELBOARDS

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 QUALIFIED PERSONNEL

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

## 3.3 DEFINITION OF 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:

### 3.3.1 Requirements

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

### 3.3.2 Established Safety Practices

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

### 3.3.3 Protective Equipment

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.

### 3.3.4 First Aid

Trained in rendering first aid.

© 2014 National Electrical Manufacturers Association

### 3.4 SUITABLE RATINGS

Verify that all equipment being installed has ratings suitable for the installation.

© 2014 National Electrical Manufacturers Association

# Section 4
# INSTALLATION OF PANELBOARD CABINETS (BOXES)

## 4.1 INSTALLATION INSTRUCTIONS

Installation of 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 110.26 of the *National Electrical Code*®). The width of the working space in front of the panelboard should be at least 30 inches, or the width of the cabinet, whichever is greater, 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*®.)

© 2014 National Electrical Manufacturers Association

### 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 312.3 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.

© 2014 National Electrical Manufacturers Association

# Section 5
# INSTALLATION OF CONDUIT AND CONDUCTORS

## 5.1 CONDUITS INSTALLATION

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 312 of the *National Electrical Code®*.

## 5.2 KNOCKOUTS REMOVAL

Knockouts should be removed as follows:

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

### 5.2.1 First Step—Remove Center Knockout

Remove center knockout INWARD.

#### 5.2.1.1 Screwdriver Blade

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

### 5.2.2 Next Step—Remove Rings

Remove rings ONE AT A TIME without straining remaining rings.

#### 5.2.2.1 Pry First Ring

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 5-3).

#### 5.2.2.2 Second Ring

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 *NATIONAL ELECTRICAL CODE®*, ARTICLE 300

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

## 5.4 CONDUCTOR LENGTH

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.

## 5.5 EXERCISE CARE

Exercise care to maintain the largest practical bending radius of conductors; otherwise the insulation may be damaged and terminal connections may become loosened. Deflection of conductors shall comply with *NEC®* Section 312.6.

© 2014 National Electrical Manufacturers Association

### 5.6 *NATIONAL ELECTRICAL CODE®*, SECTION 725.136

Refer to the *National Electrical Code®*, Section 725.136 for the separation requirements for conductors of Class 2 and Class 3 remote-control, signaling and power-limited circuits.

© 2014 National Electrical Manufacturers Association

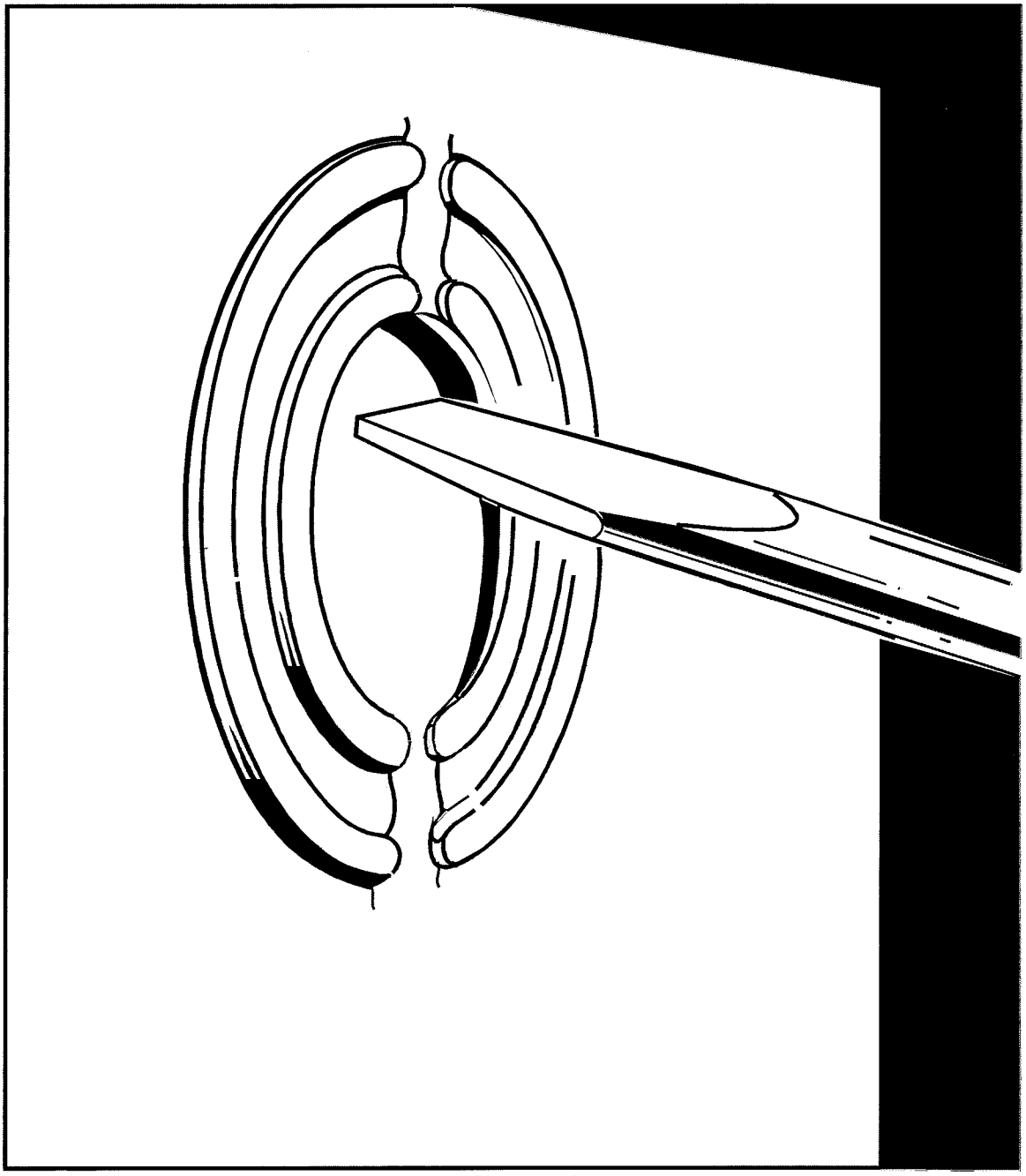

**Figure 5–1**
**KNOCKOUT REMOVAL—STEP 1**

© 2014 National Electrical Manufacturers Association

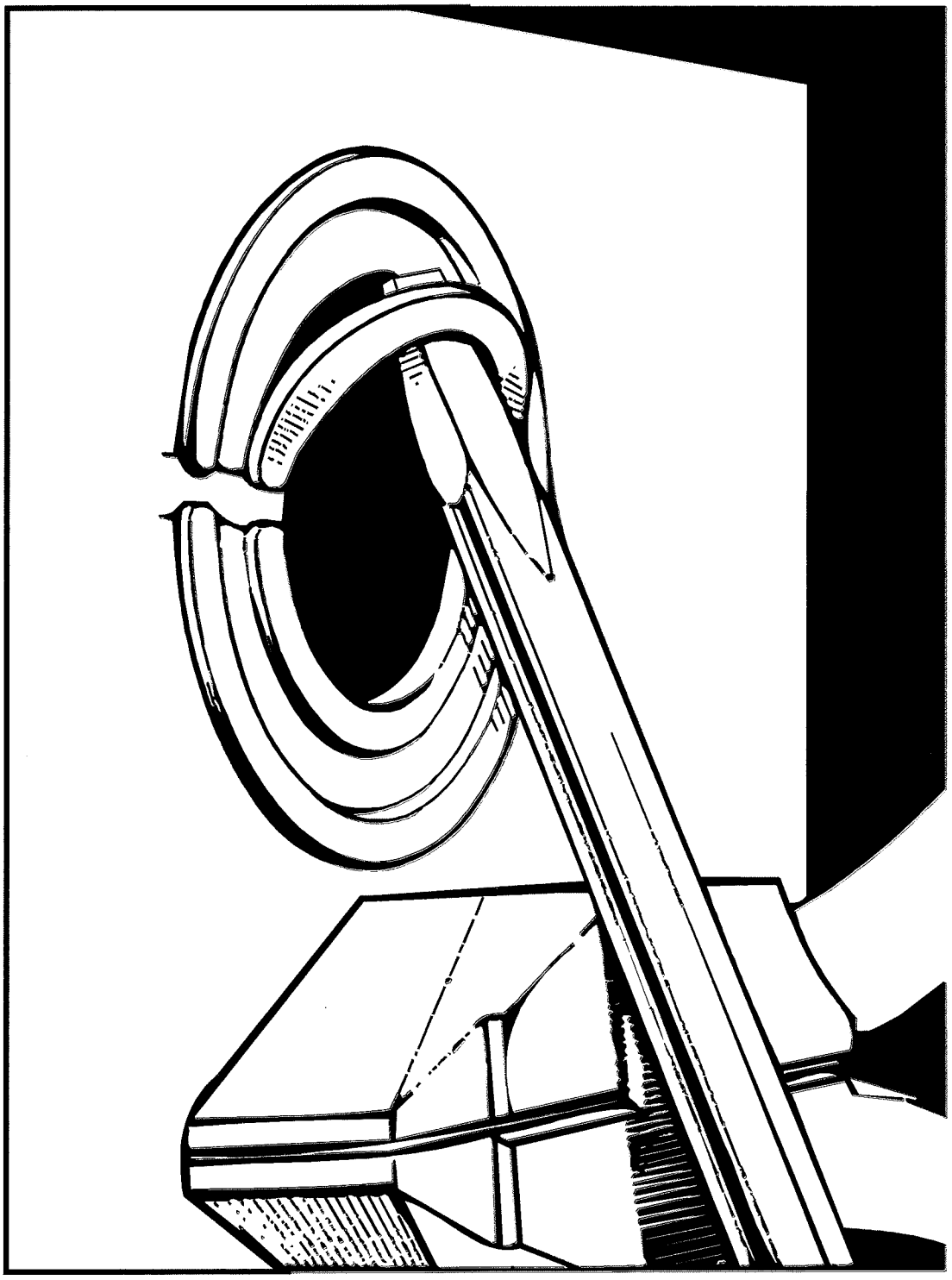

**Figure 5–2**
**KNOCKOUT REMOVAL—STEP 2**

© 2014 National Electrical Manufacturers Association

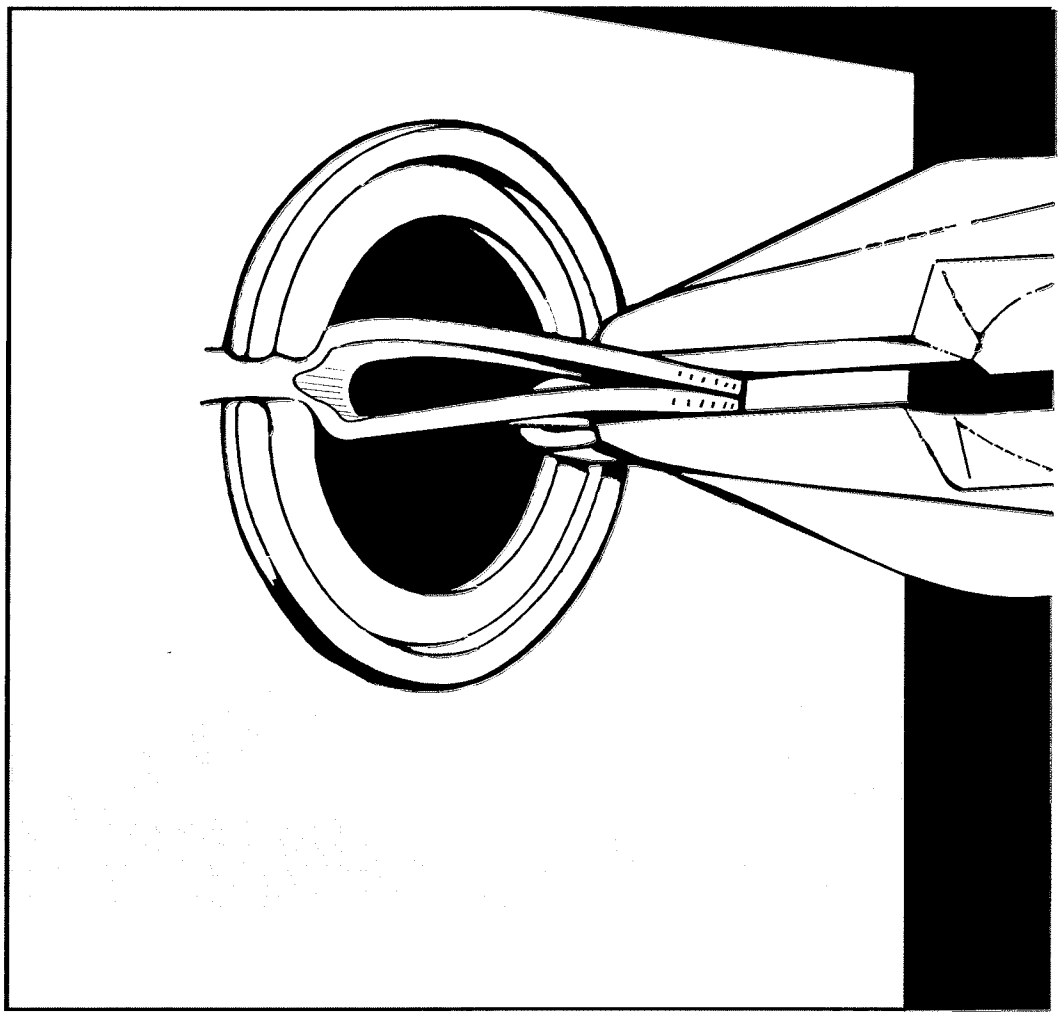

**Figure 5–3**
**KNOCKOUT REMOVAL—STEP 3**

© 2014 National Electrical Manufacturers Association

# 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.

## 6.4 CARE

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 Alignment Devices

Adjust the alignment devices where provided.

### 6.6.2 Panelboard

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

### 6.6.3 Flange of Deadfront Shield

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.

© 2014 National Electrical Manufacturers Association

## 6.7 LINE AND BRANCH CONDUCTORS

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 an antioxide compound.

#### 6.7.1.1 Wiring Gutters

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

#### 6.7.1.2 Types and Temperature Ratings

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 AND BONDING

Ground the panelboard cabinet in accordance with 4.12. (See Section 408.40 of the *National Electrical Code*®.)

### 6.8.1 Equipment Grounding Conductors

Where separate equipment grounding conductors are used, prepare equipment grounding conductors in accordance with 6.7.1 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 250.28 of the *National Electrical Code*®) or at separately derived systems (as permitted in Section 250.30 of the *National Electrical Code*®).

NOTE—An equipment grounding terminal bar is not always required. For example, when a properly installed metallic raceway is used as the equipment grounding path or when the grounded conductor terminals (neutral bar) complies with the conditions of the last sentence of Section 408.40 of the *National Electrical Code*®.

## 6.9 PROPER TYPE OR CLASS AND RATING

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

## 6.10 DEBRIS

Clean the cabinet of all debris, which has accumulated during the panelboard installation Ensure that all foreign materials, including cement, plaster and paint (overspray) are cleaned and removed. Remove all such materials with great care to avoid damage to conductors, plating, etc. (see 6.4.1).

## 6.11 STEPS IN SECTION 7

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

© 2014 National Electrical Manufacturers Association

# Section 7
# STEPS TO BE TAKEN BEFORE ENERGIZING

## 7.1 ACCESSIBLE ELECTRICAL CONNECTIONS

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 BLOCKS AND PACKING MATERIALS

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

## 7.3 SWITCHES, CIRCUIT BREAKERS, AND OTHER OPERATING MECHANISMS

Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain they operate freely. If devices with self-test function are installed, perform test and verify proper operation per the manufacturer's instructions.

Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms. For key interlocked systems, assure that only the required number of keys are accessible to the operator.

## 7.4 SHORT CIRCUITS AND GROUND FAULTS

To make sure that the system is free from short circuits and ground faults, 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. Some electronic equipment (metering, SPD, etc.) may be damaged by this testing. Refer to the manufacturers equipment markings for guidelines.

## 7.5 GROUND FAULT PROTECTION SYSTEM

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 PB 2.2, *Application Guide for Ground Fault Protective Devices for Equipment.*

## 7.6 ADJUSTABLE TIME CURRENT TRIP DEVICE SETTINGS

Set any adjustable time current trip device settings to the proper values.

NOTE—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 GROUNDING CONNECTIONS

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.

© 2014 National Electrical Manufacturers Association

## 7.8 FOREIGN MATERIAL

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.

© 2014 National Electrical Manufacturers Association

# Section 8
# INSTALLATION OF CABINET FRONT

## 8.1 CABINET FRONT OR TRIM PACKAGE

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 COVERS AND DOORS

Install covers, close doors, and make certain that no conductors are pinched and that all enclosure parts are properly aligned and tightened. Hinged covers or doors must open a minimum of 90 degrees when installed.

## 8.4 TOUCH-UP

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

## 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.

© 2014 National Electrical Manufacturers Association

# 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

Only qualified personnel should energize equipment 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 LOAD ON THE PANELBOARD

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

## 9.3 ENERGIZED IN SEQUENCE

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 LOADS SUCH AS LIGHTING CIRCUITS, CONTACTORS, HEATERS, AND MOTORS

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

© 2014 National Electrical Manufacturers Association

# Section 10
# MAINTENANCE

## 10.1 MAINTENANCE PROGRAM

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

## 10.2 PANELBOARD WHICH HAS BEEN CARRYING ITS REGULAR LOAD FOR AT LEAST 3 HOURS

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. Thermographic (infrared) scanning has become a useful method of investigating thermal performance.

**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, 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 PANELBOARD ONCE EACH YEAR

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

## 10.4 ACCUMULATION OF DUST AND DIRT

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.

### 10.4.1 Visible Electrical Joints and Terminals

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

### 10.4.2 Conductors and Connections

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 manufacturer's torque specifications.

© 2014 National Electrical Manufacturers Association

**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 Fuse Clip Contact Pressure and Contact Means

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 Plug Fuses

Re-tighten plug fuses.

### 10.4.5 Conditions Which Caused Overheating

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

## 10.5 PROPER AMPERE, VOLTAGE, AND INTERRUPTING RATINGS

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 Mechanisms Free and in Proper Working Order

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 OPERATION OF ALL MECHANICAL COMPONENTS

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

### 10.6.1 Switch Operating Mechanisms

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 Integrity of Electrical and Mechanical Interlocks

Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms. For key interlocked systems, assure that only the required number of keys are accessible to the operator.

### 10.6.3 Missing or Broken Parts

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

### 10.6.4 Manufacturer's Instructions

Adjust, clean, and lubricate or replace parts according to the manufacturer's instructions.

#### 10.6.4.1 Clean Nonmetallic Light Grease or Oil

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

#### 10.6.4.2 Molded Case Circuit Breakers

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

© 2014 National Electrical Manufacturers Association

#### 10.6.4.3 Clean, Light Grease

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 Excess Lubrication

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.**

### 10.6.5 Accessible Copper Electrical Contacts, Blades, and Jaws

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

## 10.7 DAMAGED INSULATING MATERIAL AND ASSEMBLIES

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

## 10.8 MOISTURE OR SIGNS OF PREVIOUS WETNESS OR DRIPPING

Look for any moisture or signs of previous wetness or dripping inside the cabinet.

NOTE—Condensation in conduits or dripping from outside sources is one known cause of panelboard malfunction.

### 10.8.1 Conduits Which Have Dripped Condensate

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

### 10.8.2 Cracks or Openings

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 Insulating Material Which is Damp or Wet

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 Component Devices Which Show Evidence of Moisture Damage

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 BEFORE CLEANUP AND CORRECTIVE ACTION IS ATTEMPTED

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.

© 2014 National Electrical Manufacturers Association

## 10.10 SEVERE ELECTRICAL SHORT CIRCUIT

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 cleanup and correction is attempted.

## 10.11 GROUND FAULT PROTECTION SYSTEM

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 PB 2.2 *Application Guide for Ground Fault Protective Devices for Equipment.*

## 10.12 INSULATION RESISTANCE

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

### 10.12.1 Severe Short Circuit

If a severe short circuit has occurred (see 10.10);

### 10.12.2 Parts Replaced

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

### 10.12.3 Panelboard Exposed to High Humidity

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

© 2014 National Electrical Manufacturers Association

# Section 11
# PERMISSIBLE LOADING OF PANELBOARDS

## 11.1 *NATIONAL ELECTRICAL CODE®*

In compliance with the *National Electrical Code®*, the normal continuous loads (3 hours or more) 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 HARMONICS IN ELECTRICAL SYSTEM

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.

§

© 2014 National Electrical Manufacturers Association

<This page is intentionally left blank.>

© 2014 National Electrical Manufacturers Association