

# **NEMA KS 3**

**GUIDELINES FOR  
INSPECTION AND  
PREVENTIVE MAINTENANCE  
OF SWITCHES USED IN  
COMMERCIAL AND  
INDUSTRIAL APPLICATIONS**



## **NEMA Standards Publication KS 3-2010**

*Guidelines for Inspection and Preventive Maintenance  
of Switches Used in Commercial and Industrial Applications*

*Published by:*

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## CONTENTS

Foreword .....	ii
Introduction.....	iii
<b>SECTION 1 GENERAL.....</b>	<b>1</b>
1.1 Scope.....	1
1.2 Referenced Standards.....	1
<b>SECTION 2 SAFETY PROCEDURES .....</b>	<b>3</b>
2.1 Warning .....	3
2.2 Safety Procedure .....	3
2.3 Reinstallation Safety Procedure .....	3
<b>SECTION 3 GUIDELINES .....</b>	<b>5</b>
3.1 To Avoid Damaged or Otherwise Inoperable Switches Being Inadvertently Returned to Service	5
3.2 Guidance Regarding Inspection and Preventive Maintenance Procedures .....	5
3.3 For Information Regarding Switch Performance and Application .....	5
3.4 Water-Damaged Switches.....	5
3.5 Switch Inspection Once Each Year .....	5
<b>SECTION 4 INSPECTION PROCEDURES .....</b>	<b>6</b>
4.1 General.....	6
4.2 Exposed Surfaces Temperature Check .....	6
4.3 Inspection of Enclosure Interior.....	6
<b>SECTION 5 PREVENTIVE MAINTENANCE .....</b>	<b>9</b>
5.1 General .....	9
5.2 Environmental Evaluation .....	9
5.3 Fuse Provisions .....	10
5.4 Wire Connectors .....	10
5.5 Reinstallation Procedure .....	10
<b>SECTION 6 TEST PROCEDURES .....</b>	<b>11</b>
6.1 General .....	11
6.2 Mechanical Operation Test.....	11
6.3 Insulation Resistance Test .....	12
6.4 Individual Pole Resistance Test (Millivolt Drop) .....	13
<b>SECTION 7 ACCESSORY DEVICE TEST PROCEDURES.....</b>	<b>17</b>
7.1 General .....	17
7.2 Shunt Trip Release Tests .....	17
7.3 Electrical Operator Tests .....	18
7.4 Auxiliary Switch Tests.....	20
Figure 1 Pitting .....	7
Figure 2 Heat Damage .....	7
Figure 3 Typical Insulation Resistance Test Set-Up .....	12
Figure 4 Individual Pole Resistance Test Set-Up.....	14
Figure 5 Fused Switch Individual Pole Resistance Test Set-Up.....	14
Figure 6 Non-Fused Switch Individual Pole Resistance Test Set-Up.....	15
Figure 7 Sample Shunt Trip Release .....	17
Figure 8 Sample Electrical Operator / Switch Assembly.....	18
Figure 9 Sample Auxiliary Switch.....	20

## Foreword

This is the first edition of NEMA Standards Publication KS 3. To ensure that a meaningful publication was developed, draft copies were sent to a number of individuals and organizations in the public sector having an interest in or responsibility for the purchase, testing, application, use, and preventive maintenance of these products. Their resulting comments and suggestions provided a vital user and general interest input prior to final NEMA approval and resulted in a number of substantive changes to this publication. This publication will be periodically reviewed by the Switches Voting Classification of NEMA for any revisions necessary to keep it up to date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Technical Services  
National Electrical Manufacturers Association  
1300 North 17th Street  
Rosslyn, Virginia 22209

This Standards Publication was developed by the Switches Voting Classification of the National Electrical Manufacturers Association. Approval of this standard does not necessarily imply that all voting classification members voted for its approval or participated in its development. At the time it was approved, the Switches Voting Classification had the following members:

ABB Control, Inc.—Wichita Falls, TX  
Boltswitch, Inc.—Crystal Lake, IL  
Cooper Bussmann—St. Louis, MO  
Eaton Corporation—Pittsburgh, PA  
GE Industrial Solutions—Plainville, CT  
Hubbell Inc.—Bridgeport, CT  
Mersen USA—Newburyport, MA  
Siemens Industry, Inc.—Alpharetta, GA  
Schneider Electric—Palatine, IL

## Introduction

NEMA KS 3 deals with guidelines for inspection and preventive maintenance of switches used in commercial and industrial applications. These guidelines are to be used to identify switches requiring maintenance or replacement. Good practice includes periodic switch maintenance during plant shutdown or during a regular maintenance period as specified, for example, in NFPA 70B. When a switch operates automatically, good practice dictates that the source of the overcurrent should be located, and if it is suspected that the operation was at or near the interrupting rating, the switch condition should be checked prior to circuit re-energization.

When appropriately maintained, switches provide reliable protection for many years. The exact lifetime of the switch, however, is determined by the switch's operational duty and by its environment.

With respect to operational duty, for some circuits there will be occasional overload conditions or low-current fault conditions. Here the operating life will be tens of years. In other circuits, there may be high short-circuit-current faults but it should be noted that bolted faults at the switch interrupting rating are rarely encountered. Short circuit events can significantly reduce the operating life of the switch and may necessitate replacement of the switch. Switches in this Guideline are evaluated to three different UL Standards: UL 98 *Enclosed and Dead-Front Switches*, UL 977 *Fused Power-Circuit Devices*, and UL 1429 *Pullout Switches*. They are subjected to thousands of endurance test operations; overload test operations; and two interrupting tests at maximum short-circuit-current rating. Thus switches have an extensive but finite interrupting capability, and switches that experience multiple high short-circuit-current faults should receive a thorough inspection and be replaced if necessary.

With respect to environmental effects, switches are sometimes exposed to high ambient temperatures, high humidity, and other ambient conditions that are hostile to long term performance. For example, industries may have corrosive environments or could be associated with dusty environments that could affect operating parts.

It is not intended that switches be disassembled for inspection. Rather, NEMA KS 3 should be referenced during periodic maintenance or during specific inspection following a high short-circuit-current fault. This document is intended to ensure that switches are well maintained, and provides guidelines for switch replacement.

This document is divided into separate sections as follows:

**Section 1** presents the scope and referenced standards.

**Section 2** details the safety procedures to be followed.

**Section 3** deals with general guidance.

**Section 4** deals with inspection procedures and describes thermal checks (4.2) and visual checks (4.3) of the enclosure and switch condition. Overheating of the switch would necessitate further investigation, and cracks in the insulation systems would certainly necessitate switch replacement.

**Section 5** deals with preventive maintenance and ensures that the switch's life is not compromised by external conditions. The objectives are that the switch operates in a clean environment and that the terminals are in good condition (5.2), that fuses (if required) are connected properly (5.3), and that wire connectors are in good condition and are correctly torqued (5.4).

**Section 6** deals with non-destructive test procedures that can be used to verify specific operating characteristics of switches. These include the Mechanical Operation Test (6.2), the Insulation Resistance Test (6.3), and the Individual Pole Resistance Test (millivolt drop test) (6.4). Non-compliance to one or more of these tests could necessitate switch replacement.

**Section 7** deals with the operation of accessory devices. Failure of an accessory would lead to replacement of that accessory, or switch replacement if accessories are not removable.

In summary, following an automatic overcurrent interruption at or near its interrupting rating, the condition of any protective device should be checked prior to circuit re-energization. Switches that have experienced multiple high short-circuit-current faults, as evidenced by conditions at the source of the faults, should receive a thorough inspection per the guidelines of NEMA KS 3. This document should also be used for recommended, periodic, preventive maintenance.

## Section 1 GENERAL

### 1.1 Scope

NEMA Standards Publication KS 3 sets forth, for use by qualified personnel<sup>1</sup>, a number of basic procedures that may be used for the inspection and preventive maintenance of switches used in industrial and commercial applications rated up to and including 600 V 50/60 Hz ac or ac/dc.

**NOTE**—Consult the manufacturer for other manufacturer-specific ratings.

The *National Electrical Code*<sup>®</sup> defines several switch types: General Use Switch, Isolating Switch, Motor-Circuit Switch, and Double-Throw Switch. In most cases, a switch is capable of interrupting/disconnecting its rated current at its rated voltage. An Isolating Switch does not have an interrupting rating and is actuated after the circuit has been opened by some other means. A Motor-Circuit Switch is rated in horsepower and is capable of interrupting the maximum overload current of a motor with the same horsepower rating.

The methods outlined may be used to verify specific characteristics of a switch that was originally built and tested in compliance with the requirements of NEMA Standards Publication KS 1. These methods are intended for field application and are, therefore, non-destructive in nature. Accordingly, these methods cannot be used to verify all performance capabilities of a switch since verification of some capabilities requires tests of a destructive nature.

Many tests, including those of a destructive nature, as defined in KS 1, are performed on representative samples of switches by the manufacturer, as part of a routine program of factory inspection.

The KS 3 Standards Publication is not intended, nor is it adequate, to verify proper electrical performance of a switch that has been disassembled, modified, rebuilt, refurbished, or handled in any manner not intended or authorized by the original manufacturer. Such switches should be removed from service.

### 1.2 Referenced Standards

In this publication, reference is made to the latest edition of the standards listed below. Copies are available from the indicated sources.

**National Fire Protection Association**  
1 Batterymarch Park  
Quincy, MA 02169

- NFPA 70     *National Electrical Code*<sup>®</sup>  
NFPA 70B    *Recommended Practice for Electrical Equipment Maintenance*  
NFPA 70E    *Standard for Electrical Safety in the Workplace*
- 

<sup>1</sup> For purposes of these guidelines, a qualified person is one who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training to recognize and avoid the hazards involved. In addition, the person is trained:  
—and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.  
—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.  
—in first aid.

**National Electrical Manufacturers Association**  
1300 North 17th Street  
Suite 1752  
Rosslyn, Virginia 22209

*Evaluating Water-Damaged Electrical Equipment*

- NEMA KS 1 *Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)*  
NEMA KS 2 *Distribution Equipment Switch Application and Maintenance Guide, A User's Reference*  
NEMA 250 *Enclosures for Electrical Equipment (1000 Volts Maximum)*

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

- UL 98 *Enclosed and Dead-Front Switches*  
UL 977 *Fused Power-Circuit Devices*  
UL 1429 *Pullout Switches*

## **Section 2** **SAFETY PROCEDURES**

The inspection and preventive maintenance of switches in service require the user to take all necessary precautions to avoid being injured.

### **2.1 Warning**

#### **2.1.1 Switch Testing**

**WARNING—Hazardous voltages in electrical equipment can cause death or severe personal injury. Turn off and lock out the power supplying this equipment before performing any of the following operations.**

Unless otherwise specified in this publication, inspection, preventive maintenance, and testing must always be performed on equipment that is de-energized (note that certain tests require control power to conduct the test). Verify that there is no voltage present on incoming line and load terminals (and on control power terminals, if present) and between these terminals and ground to positively ascertain that the equipment is totally de-energized. The disconnecting or isolating means on the line side of the devices being checked and/or tested must be locked in the OFF position to ensure that the equipment will remain de-energized during these procedures.

Safety related work practices described in NFPA 70E must be followed at all times.

#### **2.1.2 Test Equipment**

**WARNING—High voltages involved with some test equipment can cause death or serious injury. Do not touch or permit anyone else to touch the switch or the test leads when voltage is applied. Strict adherence to the safety procedures recommended by the manufacturers of the test equipment is required.**

### **2.2 Safety Procedure**

In all the following clauses, where removal of the enclosure cover is necessary, the following safety steps must be taken in the sequence shown.

- 2.2.1** Operate the switch to the OFF position. Turn OFF all power supplying the switch to electrically isolate it from all other circuits.
- 2.2.2** Open the enclosure and verify that there is no voltage on the incoming and load conductors (including control power conductors, if present) and between these conductors and ground to positively ascertain that the equipment is de-energized.
- 2.2.3** If disconnection of power and accessory leads, cables, or bus bars is required, be sure to properly identify all connections to ensure safe and accurate reconnection.
- 2.2.4** Before any functional tests are performed, be sure to connect the test switch with properly rated cable torqued to the recommended values marked on the rating label of the switch.

### **2.3 Reinstallation Safety Procedure**

- 2.3.1** Do not re-energize equipment until all connections (power and control) are thoroughly checked for accuracy and tightness (torqued to value listed on the rating label), internal areas of enclosure are cleaned of any conductive loose parts or debris, all switches are turned off, and all enclosure covers are reinstalled.

- 2.3.2** If it is necessary to replace the switch, make sure the new switch is properly rated for the application.

## Section 3 GUIDELINES

### 3.1 To Avoid Damaged or Otherwise Inoperable Switches Being Inadvertently Returned to Service

To avoid damaged or otherwise inoperable switches being inadvertently returned to service, it is suggested that such switches be destroyed.

### 3.2 Guidance Regarding Inspection and Preventive Maintenance Procedures

Industrial users have requested guidance regarding inspection and preventive maintenance procedures that could be carried out on a regularly scheduled basis. Sections 4 through 7 of this publication set forth guidelines for inspection, preventive maintenance, and testing. These clauses may be applied independently or in combination to establish such a program. For additional assistance, consult the manufacturer's published instructions or NFPA 70B.

### 3.3 For Information Regarding Switch Performance and Application

For information regarding switch performance and application refer to NEMA Standards Publications KS 1 and KS 2, respectively.

### 3.4 Water-Damaged Switches

Switches that are known to have been subjected to water damage should be replaced. For additional information, refer to the NEMA document *Evaluating Water-Damaged Electrical Equipment*.

### 3.5 Switch Inspection Once Each Year

It is recommended to inspect switches once each year or after any short circuit event.

## **Section 4** **INSPECTION PROCEDURES**

### **4.1 General**

The following inspection practices are recommended.

### **4.2 Exposed Surfaces Temperature Check**

#### **4.2.1 Purpose**

To determine if there is excessive temperature on the external cover of a switch.

**CAUTION**—Severe burns can result from high temperatures. Do not hold hand or fingers in contact with surfaces if excessive heat is felt.

#### **4.2.2 Procedure**

A switch that has been carrying its regular load for at least 3 hours just prior to inspection should be tested by feeling the external deadfront surfaces with the palm of the hand.

### **4.2.3 Results**

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. Further investigation may be necessary. Proceed to 4.3.

### **4.3 Inspection of Enclosure Interior**

#### **4.3.1 Purpose**

To evaluate the operating environment, the apparent condition of the switch, that proper conductors have been used, and if there is any visual indication that overheating has occurred.

#### **4.3.2 Procedure**

**WARNING**—Follow all safety procedures described in Section 2.

**4.3.2.1** After being properly isolated, verify that the switch has been properly applied within its marked ratings. If the switch has not been applied within its ratings, it should be replaced with a switch suitable for the application.

**4.3.2.2** Examine the switch surfaces for the presence of dust, dirt, soot, grease, or moisture. If such contamination is found, the surfaces should be cleaned. Refer to 5.2.2.1 for cleaning and precautionary instructions.

**4.3.2.3** Examine the switch bases for cracks. The integrity of the base is important in withstanding the stresses imposed during operation. Switches should be replaced if cracks are found.

**4.3.2.4** Verify that the conductors are of the correct size and type for the application. Visually check all electrical connections to the switch to be certain that such connections are clean and secure. Loose or contaminated connections increase electrical resistance, which can damage insulation and conductors and interfere with proper switch operation. Increased electrical resistance causes overheating of a connection. Such overheating is indicated by discoloration or cracks of the switch bases, discoloration or flaking of external metal parts, or melting or blistering of adjacent wire insulation. Pitting or melting of connection surfaces is a sign of arcing due to a loose or otherwise poor connection. (See Figures 1 and 2.)

- a. If there is no evidence of looseness, e.g., overheating, do not disturb or tighten the connections.
- b. If there is evidence of overheating (as noted in 4.2) or arcing, an investigation of the cause should be made and corrective steps taken. (See Section 5.)

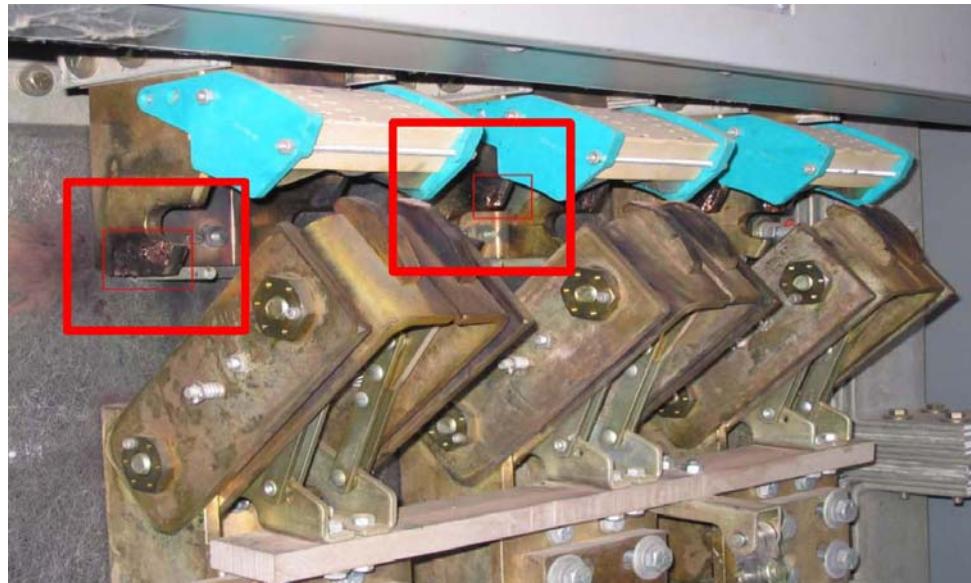


Figure 1  
Pitting

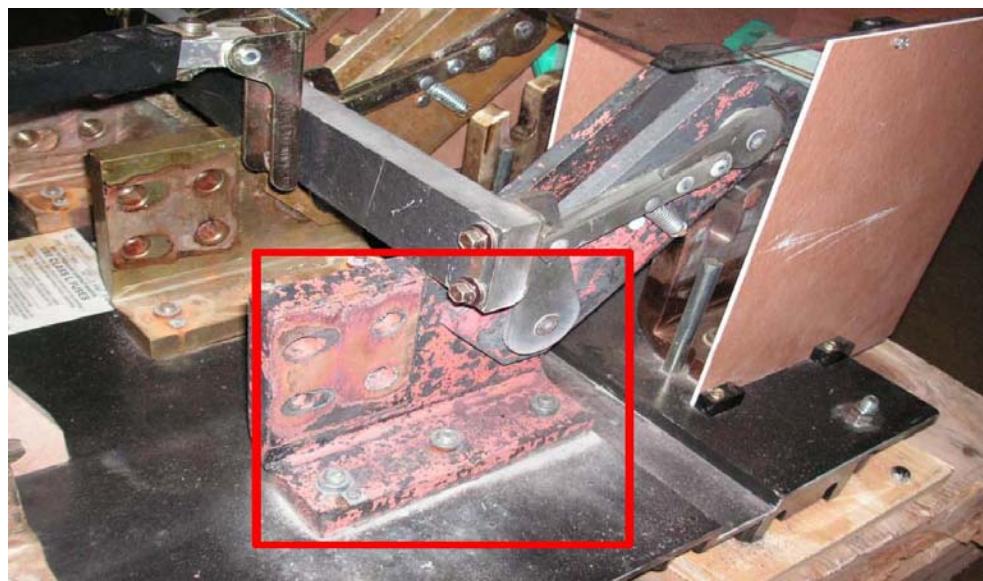


Figure 2  
Heat Damage

- 4.3.2.5** Examine the switch for evidence of a high short circuit closing operation. Any of the following observations will warrant performing the Section 6 Test Procedures or the replacement of the switch. In some cases, switch interior renewal parts can be obtained from the manufacturer to bring the assembly back to a serviceable condition.

Evidence of excessive high current switch closing operation includes:

- Bright metal or metallic deposits on insulating surfaces or the enclosure interior
- An excessive number of small, bright metal balls resting on the enclosure bottom end wall
- Excessive black film on insulating surfaces or the enclosure interior adjacent to the contact air gap or arc chute exhaust
- Enclosure shape distortion caused by excessive internal pressure
- Contacts not fully engaging or closing
- Rough mechanism operation

#### **4.3.2.6 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the installation safety procedures given in 2.3 in conjunction with any installation instructions provided by the manufacturer.

## Section 5 PREVENTIVE MAINTENANCE

### **5.1 General**

Under normal conditions, properly applied switches require maintenance only for verification of environmental conditions and that the correct enclosure type for those conditions is being used. However, when inspections determine an abnormal condition and indicate the possibility of damage, it may be necessary to perform certain maintenance steps. This clause is intended to assist the user in performing these steps.

These steps cover the only maintenance that should be performed on switches unless specifically authorized by the switch manufacturer.

### **5.2 Environmental Evaluation**

#### **5.2.1 Purpose**

To examine the operating environment and the switch's physical condition. Preventive maintenance and corrective actions are included as appropriate.

#### **5.2.2 Procedure**

**WARNING—Follow all safety procedures described in Section 2.**

The switch enclosure must be opened to perform the following steps and, in some cases, it will be necessary to remove the switch from the enclosure.

- 5.2.2.1** After being properly isolated, examine the switch surfaces for dust, dirt, soot, or moisture. If evidence of contaminants or moisture is found, or more than a thin film of dust, dirt, or soot is seen, the switch should be cleaned as suggested below.

The insulating surfaces of the switch should be cleaned using a lint free dry cloth, brush, or vacuum cleaner. Avoid blowing material into the switch or into surrounding equipment.

**CAUTION**—Commercial cleaners and lubricants may attack and damage the plastic insulating materials of the switch. Therefore, such cleaners should not be used. Only the methods described in 5.2.2.1 should be used. Follow manufacturer's recommendations for the use of grease.

Steps should be taken to eliminate the source of the contamination or to provide an appropriate enclosure that will protect against the future entry of contaminants. With respect to the prevention of moisture, the switch should be housed in an enclosure appropriate for the environment.

- 5.2.2.2** Examine the switch and terminations for signs of overheating as described in 4.3.2.4. If such evidence is found, the following maintenance steps should be performed.

**5.2.2.2.1** Copper switch terminals and connecting straps (wire connectors and bus bars) can normally be cleaned. They should be carefully disassembled, cleaned, and dressed, following the manufacturer's instructions. All metal and abrasive particles should be removed before reassembling. Care should be taken to ensure that the switch terminals and connecting straps are properly torqued during re-installation.

**CAUTION**—When performing this procedure, extreme care should be exercised to prevent any damage to plated connections or mechanical disturbance to the switch and to prevent any particles from entering the switch mechanism, contacts, or arc suppression areas.

If the damage is extensive, or cannot be corrected by dressing the surfaces, the damaged parts should be replaced if they are intended by the manufacturer to be replaceable. If the damaged parts are not intended to be replaceable, the complete switch and/or bus connections should be replaced.

**5.2.2.2.2** Aluminum wire connectors and bus bars cannot be cleaned or repaired; therefore, they must be replaced.

**5.2.2.2.3** If wire conductors are damaged, the damaged lengths of the conductors should be cut off before reinstalling the conductors. (See 5.4.)

### **5.3      Fuse Provisions**

**5.3.1** If the switch has fuses and a fuse base, visually check the fuse connections to the switch for evidence of looseness, overheating, or arcing on the fuse clips or mounting arrangements for the fuse. (See 4.3.2.4.)

**5.3.2** If the connecting surfaces show evidence of overheating, the switch and fuses should be replaced.

**5.3.3** If there is no evidence of overheating or looseness, do not disturb or tighten the connections.

### **5.4      Wire Connectors**

**5.4.1** If conductors are removed from the wiring connectors, the following steps should be performed.

**5.4.1.1** Examine wire connectors. If the wire connectors appear to be in good condition, they may be reused. If the connectors, screws, or their plating appear worn or damaged, or there is evidence of cross threading or binding, the connector assembly should be replaced.

**5.4.1.2** If the wire conductors are damaged, the damaged wires should be repaired or replaced.

**5.4.1.3** When required, an oxide inhibiting compound should be applied.

**5.4.1.4** All wire connectors should be torqued in accordance with the nameplate marking or the switch manufacturer's instructions.

### **5.5      Reinstallation Procedure**

If the switch needs to be reinstalled or replaced, follow the safety installation procedures given in 2.3.

## **Section 6** **TEST PROCEDURES**

### **6.1 General**

The KS 3 Standards Publication is not intended, nor is it adequate, to verify proper electrical performance of a switch that has been disassembled, modified, rebuilt, refurbished, or handled in any manner not intended or authorized by the original switch manufacturer. The following non-destructive tests may be used to verify specific operational characteristics of switches: mechanical operation test, insulation resistance test, and individual pole resistance test (millivolt drop test).

### **6.2 Mechanical Operation Test**

#### **6.2.1 Purpose**

To verify that the switch mechanism is operating freely.

#### **6.2.2 Equipment**

Appropriately rated continuity indicating device.

#### **6.2.3 Procedure**

**WARNING—Follow all safety procedures described in Section 2.**

- 6.2.3.1** After disconnecting and locking out all power, operate the switch ON and OFF 2 or 3 times. The switch handle should operate smoothly without binding.
- 6.2.3.2** Using an ohmmeter or other indicating device, verify that all switch contacts are open when the handle is in the OFF position and closed when the handle is in the ON position.
- 6.2.3.3** For switches that are provided with mechanical trip provisions (generally indicated by a test button), operate the tripping means according to the manufacturer's instructions. With the switch in the tripped position, verify that the contacts are open using an ohmmeter (or other indicating device). Reset the switch according to the manufacturer's instructions and operate the switch to the ON and OFF positions. Use an ohmmeter (or other indicating device) to verify that all the contacts are closing and opening respectively.

#### **6.2.4 Results**

The switch must be repaired or replaced if:

- a. The contacts are not open with the switch in the OFF position
- b. The contacts are not closed with the switch in the ON position
- c. The switch does not reset
- d. The mechanical trip provisions (if provided) do not trip the switch

#### **6.2.5 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

### 6.3 Insulation Resistance Test

**CAUTION**—If applied incorrectly, the voltages utilized in the insulation resistance tests may damage electronic or other accessory components. Refer to the manufacturer's instructions for guidelines.

**NOTE**—Where the switch can be safely isolated as installed, the test may be performed with the switch in its equipment.

See Figure 3 for typical test set-up.

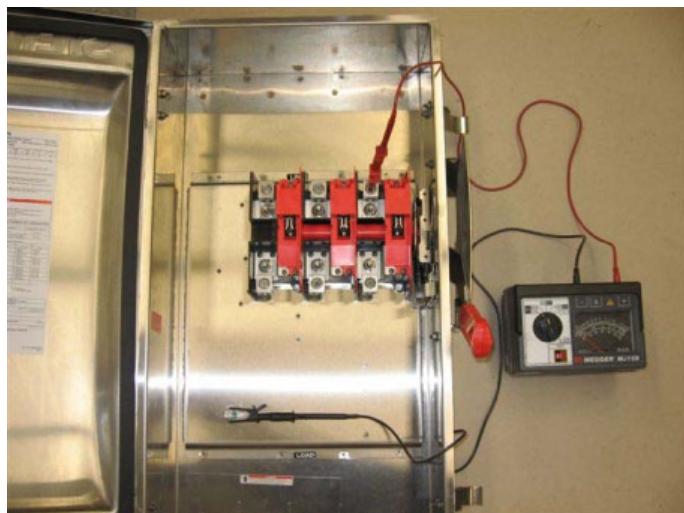
#### 6.3.1 Purpose

To determine the adequacy of the insulation between line and load terminals, between poles, and between each pole and ground.

#### 6.3.2 Equipment

Perform dielectric tests in accordance with the manufacturer's instructions.

This test requires an insulation resistance tester capable of applying a voltage of at least 500 volts. It should also be noted that more in-depth information can be obtained when 1000 volt testers are used since they are more likely to detect deteriorated insulation systems. (See Figure 3.)



**Figure 3**  
**Typical Insulation Resistance Test Set-Up**

#### 6.3.3 Procedure

**WARNING**—Follow all safety procedures described in Section 2.

**CAUTION**—If applied incorrectly, the voltages utilized in the insulation resistance test may damage electronic or other accessory components. To avoid such damage, the following procedure should be adhered to closely. Do not apply test voltages to accessory terminals.

**6.3.3.1** After disconnecting and locking out all power supplying the device to be tested, remove the switch from the electrical system. In cases where the switch can be safely isolated/disconnected from line and load connections as installed, the test may be performed with the switch in its equipment.

#### **6.3.4 Test**

- 6.3.4.1** All exposed metal parts except line, load, and accessory terminals should be electrically connected together.
- 6.3.4.2** Using an insulation resistance tester, apply a voltage of at least 500 volts to determine the resistance. Voltage is to be applied as follows.

**WARNING—High Voltage—Do not touch switch or leads.** See 2.1.2 for proper safety procedure.

**6.3.4.2.1** Between line and load terminals of each individual pole with the switch in the OFF position and tripped position if possible.

**6.3.4.2.2** Between terminals of adjacent poles with the switch in the ON position.

**6.3.4.2.3** From line terminals to the metal enclosure with the switch in the ON position.

#### **6.3.5 Results**

All resistance readings should be one megohm or greater for each measurement. If any reading is less than one megohm, the switch should be replaced or the manufacturer should be consulted before restoring the switch to service. Any reading less than one megohm may indicate contaminated, unsound, or cracked insulating material.

#### **6.3.6 Reinstall Switch**

If applicable, reinstall the switch following the manufacturer's instructions. Also refer to 5.4 for information on reinstalling wire connectors and/or conductors.

#### **6.3.7 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

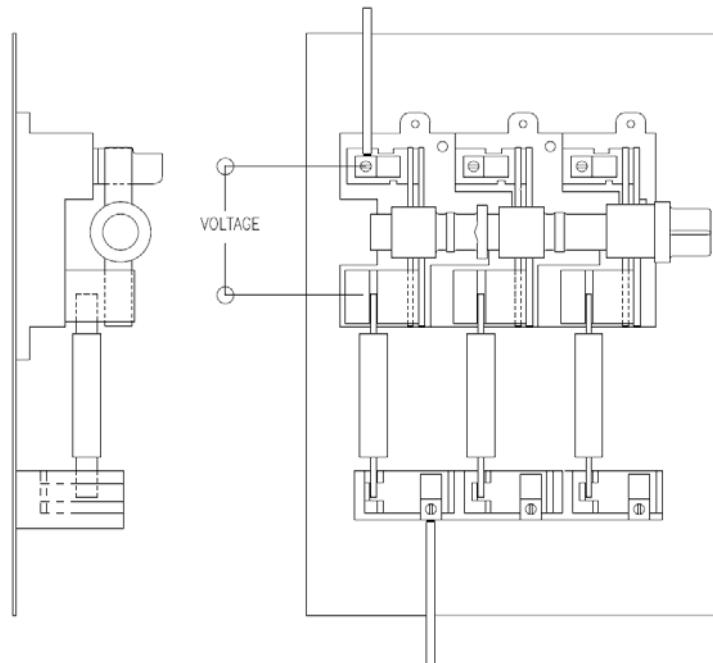
### **6.4 Individual Pole Resistance Test (Millivolt Drop)**

See Figure 4, Figure 5, and Figure 6 for typical test set up.

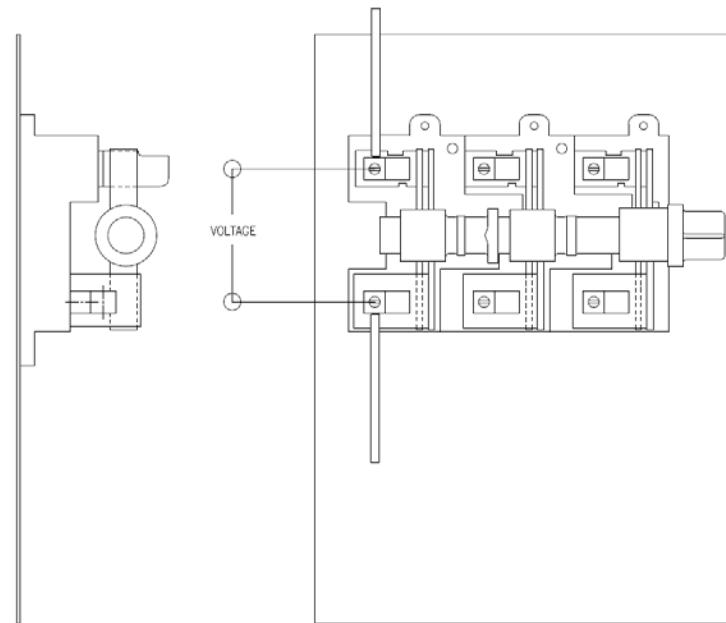
**NOTE**—The switch should be removed from the equipment for this test. In cases where the switch can be safely isolated as installed, the test may be performed with the switch in its equipment.



**Figure 4**  
**Individual Pole Resistance Test Set-Up**



**Figure 5**  
**Fused Switch Individual Pole Resistance Test Set-Up**



**Figure 6**  
**Non-Fused Switch Individual Pole Resistance Test Set-Up**

#### **6.4.1 Purpose**

To assess the electrical integrity of internal connections and contacts in a switch. This can be done by conducting a millivolt drop test across the line and load terminals of each pole with the switch contacts closed.

The millivolt drop (resistance) of a switch pole can vary significantly because of inherent variability in the extremely low resistance of the electrical contacts and connectors. Such variations do not necessarily predict unacceptable performance and should not be used as the sole criteria for determination of acceptability.

#### **6.4.2 Equipment**

- 6.4.2.1** This test should be conducted using a 24 volt, or less, direct current power supply capable of supplying the rated current of the switch. For switch rated higher than 500 amperes, the power supply should be capable of delivering no less than 500 amperes.
- 6.4.2.2** If the above equipment is not available for field tests, a Digital Low Resistance Ohmmeter (DLRO), or 4-point tester, capable of 10 to 100 amperes (dc) may be used.

**NOTE**—Use of a multimeter or low current ohmmeter in place of the power supply will not provide an accurate or reliable measurement of millivolt drop and should not be used.

**CAUTION**—Do not exceed the current rating of the fuse where the fuse cannot be isolated from the test circuit.

#### **6.4.3 Procedure**

**WARNING**—Follow all safety procedures described in Section 2.

- 6.4.3.1** After being properly isolated, remove the switch from the enclosure. In cases where the switch can be safely isolated/disconnected as installed, the test may be performed with the switch in its equipment.

#### **6.4.4 Test**

**NOTE**—If the switch is equipped with an under-voltage trip release, energize the trip release to allow proper operation of the switch.

##### **6.4.4.1 The test is performed as follows.**

**6.4.4.1.1** Apply test current across a pole equal to the switch rating (or 500 Amperes minimum for switch rated in excess of 500 Amperes). Record the millivolt drop and the test current. Do not maintain current for more than 1 minute. If this equipment is not available, use the following test.

**6.4.4.1.2** Apply test current across a pole of 10 Amperes, or the Ampere rating of the switch, for switch rated less than 100 Amperes. For switch rated more than 100 Amperes, apply a test current across a pole of 100 Amperes. Record the millivolt drop and the test current, or resistance. Do not maintain current for more than 1 minute.

**6.4.4.1.3** De-energize the test circuit. Manually operate the switch to the OFF and then ON positions.

**6.4.4.1.4** Repeat steps 6.4.4.1.1 and 6.4.4.1.2 for a total of three readings on the pole being tested.

**6.4.4.1.5** Repeat steps 6.4.4.1.1 through 6.4.4.1.3 for each of the remaining poles of the switch.

#### **6.4.5 Results**

Test results will vary according to the switch ampere rating and manufacturer. The manufacturer should be consulted to determine the maximum allowable voltage drop. If the average test values of any pole of the switch exceed the maximum allowable drop, the switch may have reached the end of life and additional tests may have to be conducted.

**NOTE**—Inconsistent readings could be the result of oxide films or foreign material on the contact surfaces, depending on the service history of the switch. If high millivolt or high resistance readings are detected, refer to the manufacturer's recommendations, and if necessary, clean and/or lubricate the contact surfaces, then repeat tests in this section. If results are still out of acceptable range, the switch should not be returned to service.

#### **6.4.6 Reinstall Switch**

If applicable, reinstall the switch following manufacturer's instructions. Also refer to 5.4 for information on reinstalling wire connectors and/or conductors.

#### **6.4.7 Reinstallation Procedure**

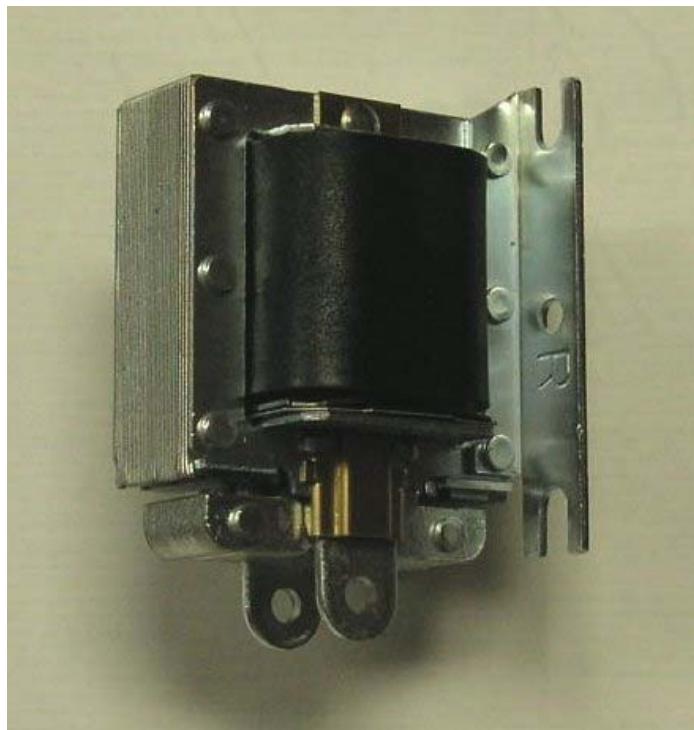
For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

## Section 7 ACCESSORY DEVICE TEST PROCEDURES

### 7.1 General

If testing instructions for the specific accessory being tested are available from the manufacturer, those instructions should be followed to verify the operation of the accessory. If the manufacturer's instructions are not available, the tests described below may be used to verify the basic operation of the accessory.

### 7.2 Shunt Trip Release Tests



**Figure 7**  
**Sample Shunt Trip Release**

#### 7.2.1 Purpose

To verify that the shunt trip release device (Figure 7) will trip the switch when energized.

#### 7.2.2 Equipment

This test requires a power supply capable of maintaining the rated voltage.

#### 7.2.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**CAUTION—**Switches and accessory devices can be damaged if power is applied to the wrong terminals. The specific lead wires or terminals for each accessory must be properly identified before conducting any of the following tests.

- 7.2.3.1** After disconnecting and locking out all power, isolate the shunt trip solenoid leads from the control circuit for testing.

**7.2.3.2** Connect a test power supply to the terminals (or leads) of the shunt trip release device.

**WARNING—High Voltage. Do not touch switch or test leads while voltage is applied.**

**7.2.3.3** Operate the switch to the ON position.

**7.2.3.4** Set the power supply voltage to 75% of the rated voltage of the shunt trip and energize. The switch should open. If the switch with shunt trip release is used in a ground fault relay system, use 55% of the rated voltage instead of 75% of the rated voltage.

**CAUTION**—If the switch does not open within 1 to 2 seconds, turn off the test power supply to prevent possible damage to the shunt trip release coil.

**7.2.3.5** When the test is completed, turn off the test power supply, disconnect it from the shunt trip release device terminals (or leads), and reconnect the control circuit wires to the shunt trip release device terminals (or leads). If an under-voltage trip release device was connected during the test, turn off the test power supply, disconnect the test power supply wires, and reconnect the control circuit wires to the under-voltage release device.

#### **7.2.4 Results**

The switch should open when the power supply to the shunt trip release is turned on. If the switch does not open, check the connections and repeat the test. If the switch still does not open, replace the shunt trip release, if replaceable. If it is not possible to replace the shunt trip release, the switch should be replaced.

#### **7.2.5 Reinstallation Procedure**

If the switch needs to be reinstalled or replaced, follow the safety installation procedures given in 2.3 and the manufacturer's instructions.

### **7.3 Electrical Operator Tests**



**Figure 8**  
**Sample Electrical Operator / Switch Assembly**

### 7.3.1 Purpose

To verify that the electrical operator (Figure 8) will operate the switch to the ON and OFF positions.

### 7.3.2 Equipment

This test requires a power supply capable of maintaining the rated voltage.

### 7.3.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**CAUTION—**Switches and accessory devices can be damaged if power is applied to the wrong terminals. The specific lead wires or terminals for each accessory must be properly identified before conducting any of the following tests.

- 7.3.3.1 After disconnecting and locking out all power, remove the control circuit wires from the terminals of the electrical operator.
- 7.3.3.2 Set test power supply to the rated voltage of the electrical operator and connect to the terminals of the electrical operator marked “common” and “close” or “on.”
- 7.3.3.3 With the switch in the OFF position, turn on the test power supply. The switch contacts should close.

**WARNING—High Voltage. Do not touch switch or test leads while voltage is applied.**

- 7.3.3.4 Turn the test power supply off. Disconnect its leads to the electrical operator.
- 7.3.3.5 Connect the test power supply leads to the terminals of the electrical operator marked “common” and “open” or “off.”
- 7.3.3.6 With the switch in the ON position, turn on the test power supply. The switch contacts should open.
- 7.3.3.7 When the test is completed, turn off the test power supply, disconnect it from the electrical operator terminals, and reconnect the control circuit wires to the electrical operator terminals.

**NOTE—**It may also be possible to test the operation of the electrical operator by leaving the control circuit wiring in place and energized and pushing the “open” and “close” buttons on the operator. Follow step 7.3.3 to ensure that the main power to the switch is disconnected, but the power to the control circuits would be left in place.

### 7.3.4 Results

The switch should operate to the ON and OFF positions when the above steps are followed. If the switch does not operate properly, check the connections and ensure that there is no obvious obstruction of the operating mechanism and repeat the test. If the electrical operator still does not operate properly, it should be replaced.

### 7.3.5 Reinstallation Procedure

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

## 7.4 Auxiliary Switch Tests



**Figure 9**  
**Sample Auxiliary Switch**

### 7.4.1 Purpose

To verify that the contacts of the auxiliary switch(es) (see Figure 9) change status when the main switch contacts are opened and closed.

### 7.4.2 Equipment

This test requires an ohmmeter or low voltage continuity tester.

### 7.4.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

- 7.4.3.1** Remove the control circuit wires from the terminals (or leads) of the auxiliary switch(es).
- 7.4.3.2** Starting with the main switch in the OFF position, use an ohmmeter or continuity tester connected to the terminals (or leads) of each auxiliary switch, to verify that its contact position (open or closed) is in agreement with the wiring diagram provided by the manufacturer.
- 7.4.3.3** Connect the ohmmeter or low voltage continuity tester to the terminals (or leads) of one auxiliary switch to monitor the contact.
- 7.4.3.4** Operate the main switch to the ON position. The auxiliary switch contact should change position.
- 7.4.3.5** Repeat steps 7.4.3.2 through 7.4.3.4 for each auxiliary switch.

- 7.4.3.6** When the test is completed, reconnect the control circuit wires to the terminals (or leads) of the auxiliary switch(es). If an under-voltage trip release device was connected, refer to 7.2.3.5 for instructions.

#### **7.4.4 Results**

Each auxiliary contact should change position (move from open to closed or vice versa) as the main switch is operated from the OFF to ON or ON to OFF positions. If the auxiliary switches do not perform correctly, check the connections and repeat the test. If performance is still incorrect, the auxiliary switches should be replaced; or if the auxiliary switch is not replaceable, replace the complete switch.

#### **7.4.5 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

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