



# Instruction Manual for PRC® Bushings

## 1. Scope

This instruction contains general procedures to be followed during receiving, installation, storage and maintenance of all PCORE® PRC® bushings. This instruction does not cover all contingencies that may arise during installation, operation, or maintenance of such equipment. If you require additional information regarding a particular installation and the operation or maintenance of your bushing, contact PCORE. PCORE does not assume any liability or responsibility for any damage or failure that would result from improper transportation, application, installation, storage, or maintenance.

## 2. Safety

These tasks may cause safety hazards if they are not performed properly. Those who are responsible for or involved in the installation, maintenance, storage and operation of the bushings must read this instruction and understand the details before they perform the tasks. Required procedures and instructions must be followed when installing bushings on apparatus or building (hereafter, any equipment or buildings on which bushings are to be installed will be called apparatus).

All applicable safety procedures such as OSHA requirements, regional and local safety requirements, safe working practices and good judgment must also be used by personnel when installing, operating and maintaining such equipment.

Some of the hazards associated with these tasks are:

**Lethal electric shock**

**Fire or burning due to high current**

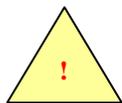
**Lifting hazards**

**Heavy equipment**

**High pressure**

**Hot oil**

Hazards will be identified by the three following categories:



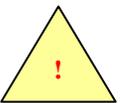
**DANGER**

*Immediate hazard, which **WILL** result in **SEVERE** personal injury, death, or property damage.*



**WARNING**

*Hazard or unsafe practice, which **MAY** result in **SEVERE** personal injury, death, or property damage.*



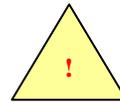
**CAUTION**

*Hazard or unsafe practice, which **MAY** result in **MINOR** personal injury or property damage.*

## 3. Bushing Components

### 3.1 Housings

The top insulating housings are made of electrical grade porcelain. The porcelain is completely vitrified and is NOT POROUS. Chips or small broken petticoats WILL NOT affect performance. BROKEN PORCELAIN DOES NOT NEED TO BE SEALED FROM MOISTURE. The bottom insulation material is electrical grade resin.



**CAUTION**

*Broken porcelain is **EXTREMELY** sharp. Gloves must be used when handling broken porcelain.*

### 3.2 Conductors

Lower current bushings have aluminum conductors and high current bushings have copper conductors.

### 3.3 Insulation Materials

Standard PRC bushings use electrical grade Crepe paper impregnated with electrical grade resin.

### 3.4 Oil Expansion Tanks

Oil expansion tanks used on PCORE PRC bushings are cylindrical sight glass.

### 3.5 Oil Level Indicators

The recommended oil level in the sight glass at 25°C with the bushing in a vertical position is half full. Small variation in levels due to ambient conditions can be expected and are not an indication of oil loss or over filling.

### 3.6 Flanges and Flange Adapter

Flanges and flange adapters are made of aluminum. For replacing older bushings or other manufacturers' bushings, PCORE offers custom-made flange adapters.

### 3.7 Terminals

Terminals are copper or brass. Some are silver or tin plated.

## 4. Cable Connections

### 4.1 Bottom Connections

PCORE PRC bushings have one of the following bottom terminals: Flat spade or threaded stud. The bushings with a flat spade can be directly connected to the apparatus. The bushings with a threaded stud MAY need adapters to connect to the apparatus.

### 4.2 Draw Lead Connections

Some bushings are designed with a hollow conductor through which a flexible cable or a rod can be pulled. The cable is a part of the apparatus on which the bushing is mounted and is not supplied with the bushing. Most draw-lead terminals have a flat spade for brazing, crimp type, or tubular brazing terminals are available.

### 4.3 Transformer and Oil Circuit Breaker Interchangeability

PCORE PRC bushings can provide maximum interchangeability between transformer and oil circuit breaker applications.

## 5. Crates

Two types of crates are used. Most bushings are shipped in wire-bound crates.

The top covers of export bushings are nailed. PRC bushings are shipped in the horizontal position in crates.

## 6. Receiving and Incoming Inspections

You should perform a visual inspection on the crate and the bushing before unloading. When unloading crates, you must take extreme care not to damage the crates or the bushings. Do not drop the bushings. The bushings should be unpacked in a flat, dry area

To open the wire bound crate, the twisted wires should be straightened with pliers. Remove any nailed covers carefully to avoid damage.

Some crates contain separate boxes containing special terminal adapters, oil reservoir tanks for horizontally mounted bushings, or other special parts. These special parts should also be checked for damage from shipment.

Examine the top porcelain and bottom resin for cracks or chips. Check all seals for oil leakage. Although surface oil is removed from the bushing after electrical testing, occasionally a gasket seal may weep an oil film when received. To check for gasket seal leakage, wipe the suspected joints clean and observe for a period of 48 hours. If oil leakage is detected, contact the factory at Le Roy. Any special parts should be checked for damage.

If shipping damage is evident, you must file a claim with the transportation carrier and notify PCORE of the claim immediately.

## 7. Storage

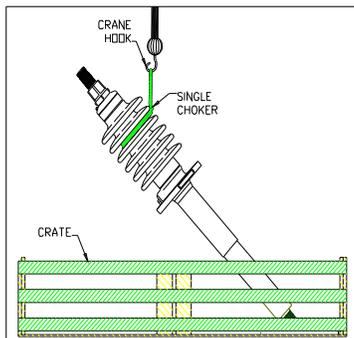
The PRC bushing can be stored either horizontally or vertically in a proper stand which cannot be tipped over. The preferred location is indoors, however bushings may be stored outdoors with bottom end covered with an opaque plastic bag. The crates are not made for extended outdoor storage; inspect the crates periodically for weather damage.

For long term outside storage, moisture or water may gather inside the protective plastic bag that covers the upper and lower end. Suitable protection, such as water-repellent grease should be provided for top and bottom terminals, and mounting hardware to protect the contact area from corrosion.

## 8. Handling and Installation

### 8.1 Removing Bushings from Crates

PCORE PRC bushings which are usually in the 25 kV through 69 kV class can be removed from the crate using a nylon choker around the upper porcelain. Position the bushing vertically, and check the oil level of the bushing before installation.



### 8.2 Cleaning

Bushings should be kept vertically in a secure stand and you must remove all dust, grease, oil or particles of packaging from the bushing with clean dry cloth. Especially the lower end and flange should be wiped clean of dust or dirt to prevent contamination of transformer oil. Before mounting bushings to the apparatus cover, inspect and clean the mounting surfaces of both the bushing and apparatus.

Check the inside wall of draw-lead tube especially when the bushing has been stored outdoors a long time. If it is dirty, remove all the dirt, dust and other foreign materials from the wall.

### 8.3 Electrical Tests

PCORE recommends that power factor and capacitance measurements be performed on all bushings before installation. The measured values should be compared with those on the nameplate. The nameplate values are of special importance in asking PCORE questions about bushings. The bushing must be kept vertically in a secure stand for the electrical tests.

The methods of measuring power factor and capacitance are in the user manual of your power factor measuring device or consult IEEE Standard C57.152 *IEEE Guide for Diagnostic Field Testing of Fluid-Filled Power Transformers, Regulators, and Reactors*. Only C<sub>1</sub> power factor and capacitance have meanings for the 25 kV through 69 kV class bushings. PCORE recommends against measuring C<sub>2</sub> power factor and capacitance of this voltage class bushings for any purpose.



### CAUTION

*Do not operate the bushing without the test tap or voltage tap cover in place.*

These measurements should agree with the nameplate values within equipment tolerances and should be kept as reference readings. When power factor and capacitance readings are in disagreement with nameplate data beyond reasonable tolerances, you should contact the factory at Le Roy.

*Never test the bushing while in the shipping crate.*

*When possible, place the bushing in a grounded test stand. It is important to isolate the flange from the grounded stand using a good insulating material. **Wood can contain significant moisture and should never be used.***



### CAUTION

*The readings may be taken with the bushing installed in the equipment provided the top terminal connections are not made or the terminal is isolated from the main bus via a PCORE Test terminal.*

After the testing has been completed, reassemble the tap cover after coating the "O-ring" lightly with silicone grease and tighten the cap.

#### 8.4 Mounting Bushings

If the bushings are stored horizontally, it is important to remove all entrapped air from the core. Place the bushing in the vertical position and shake the oil end to force any air bubbles out of the core area before installation.

##### 8.4.1 Mounting Angle

PCORE bushings with oil level sight glasses are designed for safe operation in vertical position or at angles up to 70 degrees from vertical. PCORE bushings should not be mounted horizontally unless the bushing is furnished with a supplementary oil reservoir.

##### 8.4.2 Vertical Mounting

Lift the bushings in the same way as removing bushings from the crates. If a flange adapter is required, install it before moving the bushing to the mounting hole. Put the gaskets and/or o-rings on the apparatus mounting surface per the apparatus instruction. Move the bushing to the mounting hole of apparatus. Tighten the bolts to the torque specified from the apparatus manufacturer.

##### 8.4.3 Draw-Lead Connection

Bushings designed for draw-lead applications have the draw lead terminal, nut and pin in place. Before installation, you must remove the top terminal, the draw lead nut, the retaining pin and the draw lead terminal. Braze the apparatus cable to the draw lead terminal. Pass a wire or pull cord through the bushing center conductor from the top and attach it to the hole in the top end of the draw lead terminal on the flexible cable. While lowering the bushing into the opening in the cover, simultaneously pull the cable up through the center conductor. Secure the draw lead terminal into the top of the bushing by replacing the retaining pin through the conductor and then replace the draw lead nut. A light coating of silicone should be applied to the O-ring of the top terminal before replacing. Refer to the section Bolting and Terminal Torque Settings for terminal tightness.

##### 8.4.4 Horizontal Mounting

The bushings are shipped with the oil reservoir-mounting hole plugged and with oil at the standard level for vertical mounting. The oil volume in all bushings fluctuates significantly with temperature. PCORE PRC bushings are designed to operate with air ambient from -50°C to +40°C. An oil reservoir tank mounted on the flange of a horizontally mounted bushing accommodates the oil volume change.

It is important to fill and install the bushing properly to guarantee long life expectancy. Two things are extremely important. First, all air must be out of the bushing, and secondly, the oil level must be adjusted properly according to the bushing oil temperature. Failure to follow these instructions can cause bushing failure.

Before installing the bushing into the equipment (or wall), perform the following steps while the bushing is held horizontally

- A. Remove the oil filler plug in the stainless steel cover at the top of the bushing.
- B. Add oil through the fill hole in the top cover until the bushing is completely full. Tip the bushing slightly so the air bubble is at the fill hole in the top cover. Fill with oil until some oil comes out of the fill hole in the top cover. Use the extra oil supplied with the bushing, or any NON-PCB type I or type II transformer oil. The oil must meet the minimum requirements for new transformer oil per IEEE C57.106 (latest revision).
- C. Replace the fill plug in the top cover and tighten slightly by hand. Rock the bushing back and forth to release all entrapped air inside the bushing into the sight glass area. Watch the sight glass for air bubbles. Continue rocking until no the air is being released into the sight glass. More oil may have to be added to the bushing.
- D. Loosen the oil filler plug in the top bushing cover to bleed off the entrapped air (air bubble).

- E. Add oil to the bushing until oil comes out of the fill hole in the top cover. Be sure the fill hole in the top cover is slightly higher than the bottom of the bushing.
- F. Repeat steps B through E as necessary until the air bubble that remains inside the sight glass is less than 1/4 inch in diameter. **DO NOT STORE THE BUSHING COMPLETELY FILLED.** Any oil expansion could cause the bushing to leak.

Install the bushing in the apparatus and perform the following steps immediately. It is important to keep the bushing in a horizontal position during installation.

- G. Remove the oil reservoir plug from the flange and install the oil reservoir. Be sure the O-ring is properly installed on the reservoir.
- H. Remove the oil filler plug from the oil reservoir top. **IT IS IMPORTANT TO DETERMINE THE TEMPERATURE OF THE OIL IN THE BUSHING BEFORE ADJUSTING THE LEVEL. THIS MAY BE DIFFERENT THAN THE AMBIENT AIR.** The best method is to use a dial thermometer or a thermocouple inserted as far into the reservoir as possible. Try to get into the flange thorough the neck of the reservoir. **DO NOT USE A GLASS THERMOMETER.** Wait a few minutes for the reading to stabilize.
- I. Add oil to the reservoir until the oil level in the reservoir is at the proper level. **FOR PROPER OIL LEVEL INDICATION, THE OIL THAT YOU ADD TO THE RESERVOIR SHOULD BE THE SAME TEMPERATURE AS THE OIL IN THE BUSHING.** Use the dip stick to measure the oil level. The top mark is for 55°C, the second is 40°C, the middle for 25°C, the fourth for 10°C, and the bottom for -5°C oil temperature. Interpolation between marks is not critical. If in doubt, use slightly less oil.
- J. Tighten the oil fill plug in the bushing cover and install the oil fill plug in the oil reservoir top. Make sure the O-rings are properly installed and seated on the plugs.

*Do not operate a bushing with the bushing oil level not visible in the sight glass under normal ambient conditions. This could result in serious damage to the bushing and/or apparatus on which the bushing is being mounted.*

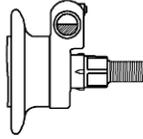


*Under these conditions, operation may result in severe personal injury, death or property damage. It is normal for the oil level to drop below the sight glass in some bushings in extremely cold conditions. Contact PCORE Electric Company if you have any questions.*

#### 8.4.5 Horizontal Mounting with Integrated Tank

PCORE Electric Company horizontal bushings with the integrated tank design can be used in either the vertical or horizontal position. There is no need to adjust the oil level during installation for this type of bushing. To install this type of bushing in the horizontal position it is important to remember the following:

- A. Place bushing into the vertical position prior to installation.
- B. Carefully shake the oil end of the bushing to help move any air bubbles formed during shipment to the air gap at the top of the bushing.
- C. Keep the air end of the bushing elevated above the oil end at all times during the installation until into the horizontal position, to prevent air bubbles from forming along the bushing core.
- D. Care should be taken to avoid tipping or rotating the integrated tank sight glass forward or backward during installation – as this may cause a properly filled bushing's oil level to appear high or low in the sight glass.



#### 8.4.6 Torque Specifications for Bolts

Before mounting bushings to the apparatus cover, inspect and clean the mounting surfaces of both the bushing and apparatus. Install the gasket or O-ring supplied by the apparatus manufacturer. Secure the bushing on the apparatus cover by tightening all the bolts uniformly in several steps. Do not attempt to pull the bolts down to the final setting on the first tightening. It is good practice to allow time between the several tightening steps for the gasket to set. Care in tightening avoids possible damage or distortion of the mounting flange. Normally, the torque values as listed will provide adequate compression for sealing.

**Use the torque recommendations and mounting specification of the apparatus manufacturer.** Reduce torque if gasketed per manufacturing recommendations for material being used. Adjust torque for other metals for bolts in flange. Values below are for SAE Grade 1 or 2.

| BUSHING FLANGE       |                |
|----------------------|----------------|
| Bolt Diameter (inch) | Torque (ft-lb) |
| 3/4                  | 105            |
| 1                    | 200            |
| 1 1/8                | 250            |

| DRAW LEADS       |                    |                |
|------------------|--------------------|----------------|
| Current (ampere) | Thread Size (inch) | Torque (ft-lb) |
| 400              | 3/4                | 20             |

| REMOVABLE TOP TERMINALS |  |
|-------------------------|--|
| Torque (ft-lb)          |  |
| 50                      |  |

#### 8.4.6 Bottom Terminal

If a bottom terminal and shield are to be installed, pass the cable through the hole in the shield and mount the bottom terminal. Mount the terminal. Then push the shield to the bushing and mount the shield on the bushing.

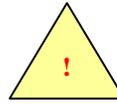
#### 8.4.7 Top Terminals

After power factor and capacitance tests are completed for the apparatus, connect the top terminal for energization.

### 9. Partial Discharge Tests

PCORE does NOT add a pressurized gas blanket over the

top of the oil in the bushings. It is possible to encounter some partial discharges in the sight glass during overvoltage tests. The partial discharges are a result of a partial vacuum formed in the gas space above the oil. The condition occurs most often after transformer heat-run tests. It can be eliminated by venting the gas space to atmospheric pressure.



*When the bushing is hot, do NOT remove oil fill plug.*

### CAUTION

### 10. Energization

During initial energization, you should monitor oil level changes. If oil level changes excessively, contact the factory in Le Roy.

### 11. Maintenance

Little maintenance is required other than periodically checking the oil level as indicated in the sight glass. Unless a bushing is damaged, the oil level should remain within the sight glass fluctuating slightly with thermal and ambient conditions.

Although we discourage the breaking of the seal of the oil-fill plug in the bushing reservoir; if the oil level over an observed period of time remains low and ambient conditions are normal, oil may be added. However, contact the factory in LeRoy first.

Removal of oil filler plug should be done only in a dry atmosphere. Provide oil that meets the IEEE C57. 106 standard for new transformer oil. If there is mechanical damage to the bushing which results in loss of oil, or the oil level in the bushing is still indicating low after the addition of oil the bushing should be taken out of service.

Bushings exposed to salt spray, cements dust, and other abnormal contamination deposits are subject to a special hazard and must be cleaned regularly to prevent flashover and corrosion of metal parts. The sight glass should also be cleaned regularly. We endorse and recommend the measurement of power factor and capacitance at the time of installation and repeating the measurement regularly. These values should be used as a base to compare the TRENDS of future measurements. Field measurements of power factor and capacitance may differ from measurements made under the controlled conditions in the factory. Contact the factory if you encounter any of the following:

- A. Measurement of power factor increases to 1.5 times the original installation value.
- B. Measurement of capacitance increases by 10 percent over the original installation value.

### 12. Re-shipping or Returning Bushings

To ship the bushing to another site, you may re-use the original crate. **Inspect the crate for damage and repair before using.**

**Bushings with damaged porcelain or sight glasses pose some danger. Wrap broken porcelain or glasses with duct tape and blankets (Burlap works well).**

It is recommended that bushings be returned to the factory for all significant repairs. Inquiries concerning repairs should be addressed to the factory at Le Roy. You MUST obtain a Return Authorization (RO) number before shipping bushings or bushing attachments to PCORE. The handling of all requests will be expedited if the factory is furnished the

Catalog number and the serial number which are on the nameplate. The catalog number identifies the bushing rating. The first two digits of the serial number are the last two digits of the manufacturing year.

*Do not attempt field repairs.*

*A bushing experiencing a core problem may have a high pressure and/or hot oil inside. Do not remove oil fill plug.*



*Bushings are assembled using heavy clamping pressures. A bushing with a shattered oil sight glass must be wrapped with burlap and duct tape before the bushing is removed from installation.*