

## MAINTENANCE OF BUILDING SWITCHGEAR

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### 1. GENERAL

1.01 This section describes the recommended procedures for the safe, economical maintenance of electrical switchgear in Pacific Company (PAC) buildings. General descriptions, terminology,

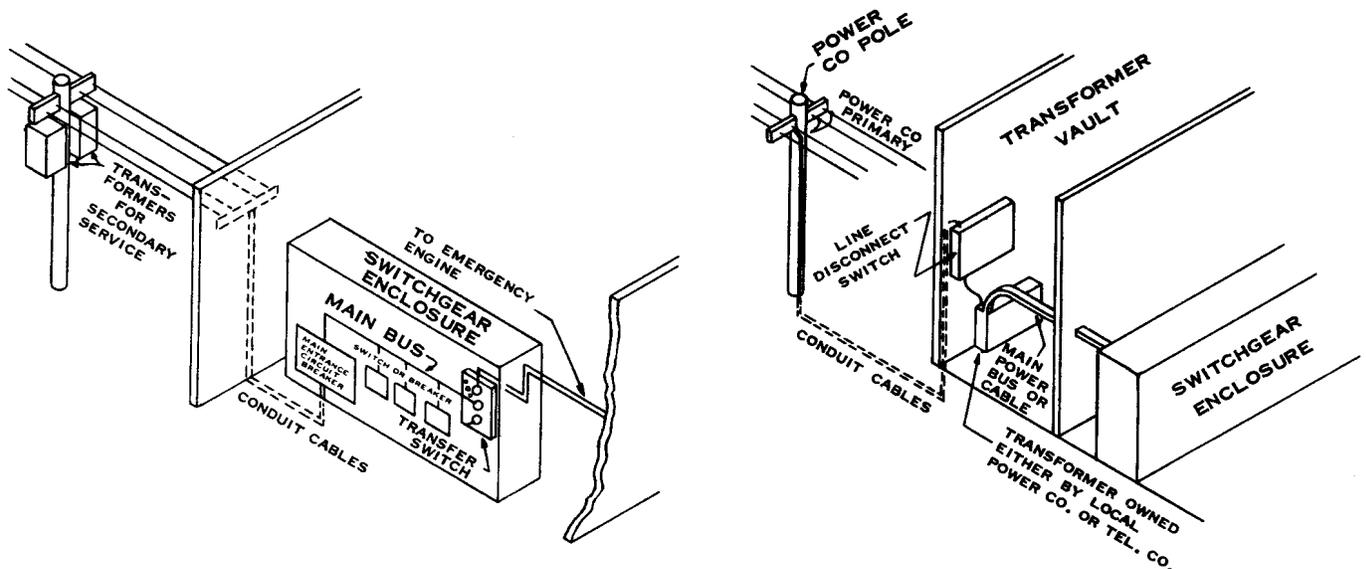
basic fundamentals of maintaining switchgear equipment are covered in Section 171-199-900PT. (See Fig. 1 for typical examples.)

1.02 The section has been revised to include details about:

- Electrical tests
- Relay inspection and tests
- Visual inspection

1.03 This section is general and is not designed to cover any particular manufacture of equipment. It is intended as a guide to procedures for a successful maintenance program for electrical distribution equipment. In all cases, this section should be used in conjunction with the manufacturers' data.

*Note:* Suggested procedures and basic background information are contained in Section 171-199-900PT and should be used in conjunction with this section.



Typical Commercial Power Installation

Fig. 1

**NOTICE**  
Not for use or disclosure outside the  
Bell System except under written agreement  
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### 2. SAFETY

**2.01** All maintenance will be done on apparatus which has been de-energized from the commercial AC service. Where temporary feed for power is required to keep vital circuits in continuous operation, provision shall be made to isolate these circuits from the equipment being routined. Prior to any work operation, the contractor or PAC employee shall test all incoming service cables to determine that all electrical power has been removed and the temporary leads are not backfeeding into the equipment being inspected.

**2.02** PAC personnel shall point out to the contractor any known safety hazards. However, it is the responsibility of the contractor to arrange for emergency lighting, ventilation, and provision of barricades or other protection necessary for the safety of all persons and property. The contractor shall provide all safety equipment deemed necessary by his/her safety practices to adequately protect his/her personnel. There shall be sufficient fire extinguishers available to protect the telephone equipment.

### 3. INSPECTION OF SWITCHGEAR

#### Permanent Electrical Log (Exhibit 1)

**3.01** In general, switchgear requires little maintenance, the main considerations being that the equipment be kept dust free and properly lubricated. Another important consideration is that of overheating due to loose connections.

#### Annual Inspection

**3.02** After the initial inspection and cleaning, a review is made as covered in subsequent parts of this practice. The following type of annual inspection and cleaning shall be performed by experienced PAC personnel.

- (a) With extreme caution, using a vacuum cleaner with insulated attachments, clean the inside of the switchgear housing. It is not necessary to clean bus bars at this time as they will be energized and it is not intended to de-energize the board at this inspection and cleaning.
- (b) Make visual inspection for signs of overheating and loose hardware.

(c) All breakers, relays, and switches shall be visually checked to determine whether they are damaged or out of mechanical adjustment. When possible, this should include mechanically operating the equipment. Many types of safety switches should not be opened or closed under load. Where possible, exercising a switch provides a cleaning action for the contacts and thereby reduces any tendency the aging or inactivity has toward increasing the contact resistance of the switch. Fuses should be checked for over-heating.

(d) Any irregularities noted on this annual inspection should be entered on the switchgear log. A complete history of a piece of electrical equipment can assist in determining the most economical time for replacement when accelerated maintenance is needed.

(e) Where applicable, a visual inspection shall be made of the transformer vault for cleanliness, moisture, and excessive heat. Any of these conditions found should be corrected. This should be done by personnel thoroughly familiar with the dangers involved in working in a transformer vault.

*Note:* It is the intent of this annual inspection to provide a minimum of maintenance to the electrical system in an economical manner. Once every six years, perform a major maintenance program.

### 4. MAINTENANCE

#### Power Company Equipment

**4.01** As covered in Section 171-199-900PT, the ownership, responsibility, and type of power system entrance varies considerably; therefore, this section outlines the procedures that should be reviewed with your local power company and performed where a joint agreement can be reached. Each power company has a frequency schedule for maintenance on their equipment, but it is felt desirable that the items be maintained and tested at least once every six years.

**4.02** The following equipment, whether owned by the local power company or PAC, should be inspected, adjusted, and maintained on a six-year schedule.

(a) Visually inspect insulators and bushings for chipped petticoats, fractured porcelain, etc., and replace damaged parts. Clean all insulators and bushings; check gaskets for positioning, resilience, and leaks.

(1) In general, insulators can be cleaned by polishing with a soft cloth dipped in cleaner, solvent, C-12. Never use water or caustic solutions to remove oxide or dirt deposits on porcelain glaze, or resort to abrasives, steel-wool or wire brushing. When clean, polish with a soft dry cloth.

(2) Rust on bushing caps and flanges may be removed by sanding, then priming and repainting the surface. A rust inhibitor type primer and paint for application to metal surfaces should be used. Do not use aluminum or copper-based paint.

(b) Check disconnects for freedom of movement, galling, or friction in moving parts. Check for signs of heating on current-carrying parts, loose or missing hardware, and broken or missing cotter keys or retainer rings. Replace any missing or broken parts. Lubricate only as directed by manufacturers' specification, apply lubricant sparingly and wiping off surplus.

(1) Contacts should be clean and free of oxide or corrosion. Eighty per cent or better contact mating should be maintained on knife or butt type contact surfaces.

(2) The contact overtravel and positive stops must be checked. An overtravel of 1/32-inch to 1/16-inch is recommended minimum to permit wiping action when contacts close. Stops would be set to limit overtravel to a safe amount, usually 1/16-inch to 1/8-inch. High current disconnects and gang type disconnects usually have main arcing contacts which should be checked for proper operation.

(c) Check fuses for proper size and connections for tightness in ferrules.

(d) Lightning arresters are generally sealed components, free of maintenance except for an occasional cleaning and mechanical inspection. Clean the arrester thoroughly when inspecting the transformer. Tighten all bolted connections to ground. Megger test value should

read infinity unless internal resistors are used in the manufacture of the lightning arrester. Replace low reading or grounded arresters.

#### Routine Maintenance and Cleaning

**4.03 This work should be done on de-energized equipment only.** The inside of the house service switchboards and other enclosures housing electrical switchgear shall be cleaned with a vacuum cleaner and insulated attachments, then hand cleaned. The outside of the switchgear can be cleaned with cloths dampened with mild soap and water. Keep free from dust, lint, dirt, and abrasive material. Wipe clean all buses, supports, etc. Inspect buses and connections for signs of overheating and weakening of insulation. Inspect buses for adequate support, spacing, and bracing in accordance with the National Electrical Manufacturers' Association (NEMA) standards for bus bar bracing. Check to see that all structure supports and anchor bolts are tight. All control equipment connections, screws, lugs, bolts, solderless connectors, etc., shall be checked for tightness to ensure good electrical continuity and mechanical condition. The contractor shall inspect the ground for a solid, continuous and proper size ground. The connections shall be cleaned and tightened. Inspect all raceway systems entering the switchboard to determine that it is properly bonded with locknuts, etc. Check to see that the service entrance equipment is grounded in accordance with current National Electrical Code (NEC) requirements.

**4.04 Lubrication:** The finest grease and oils tend to oxidize with time. Evidence of oxidation is hardening and darkening. Hence, lubricants should be renewed periodically to prevent sluggishness and allow smooth operation. Lubricants should be renewed periodically in accordance with manufacturers' recommendations. A complete list of lubricants is contained in Sections 065-330-102 and 065-330-110 and can be used if manufacturers' recommendations are not available. These lubricants shall be supplied by the contractor.

**4.05 Cleaning Agents:** Section 065-330-120 lists the approved cleaning fluids, their use and purpose. The contractor shall use the approved cleaning fluids for removal of old oxidized grease. **NO CARBON TETRACHLORIDE SHALL BE USED.** When using solvents in any quantity, the work area should be well ventilated. Only lint-free cloths shall be used.

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### Circuit Breakers – Low Voltage Power

**4.06 Typical Visual Inspection Procedures (Exhibit 2):** When working on low voltage circuit breakers, the power circuit must be de-energized. The following steps should be taken in servicing these breakers:

(a) **Circuit Breakers:** Do not attempt to remove breaker from switchboard mounting, but open front or rear panels to gain access to interior of breaker.

- Inspect primary fingers (if applicable) in back of breakers. Check to see that no springs are missing or broken, or the fingers excessively worn. Clean out dust or dirt.
- Remove arc chutes and inspect for cracked, broken, or burned parts. Replace the defective parts and clean.
- Inspect and clean main and arcing contacts in accordance with manufacturers' instructions.
- **Danger:** With the arc chutes removed, the moving parts of the breakers are exposed; mechanically close breakers to inspect contact action and alignment. Use extreme care to keep all parts of the human body in the clear. These exposed breaker parts are actuated by stored energy devices and serious injury will result if any parts of a human body are caught by the breaker contacts or moving mechanism.
- Open and close breakers several times to determine that operation is smooth, with no binding.
- Lubricate the racking-in device (if applicable) and inspect. Make sure there is no evidence of binding.
- Lubricate mechanical joints and mechanism used to close and open in accordance with 4.04. Clean dash pots and change oil.
- Tighten all screwed or bolted connections.
- Blow dust and dirt from breaker and arc chutes. Use low pressure dry air.

- Determine that proper movement of the trip bar will trip breaker.
- Determine that trip arms on the various trip devices properly engage the trip bar.
- Determine that breaker position indicator is showing proper position of breaker.
- If any adjustments are necessary, consult the manufacturers' instruction bulletin for proper adjustment.

(b) **Molded Case Circuit Breakers:** When working on molded case circuit breakers, the power circuit must be de-energized. The following steps should be taken when servicing and testing these breakers:

- Do not attempt to remove breaker from switchboard mounting, but open front or rear panels to gain access to breaker.
- Open and close breaker several times to determine that operation is smooth, with no binding.
- Tighten all screwed or bolted connections.
- Determine that breaker position indicator is showing proper position of breaker.

### Switches

**4.07 Safety, disconnect, transfer, and pressure contact switches** have a tendency to build up high resistance across the contacts if they are not operated frequently. Several manufacturers' of this equipment have designed this apparatus in such a manner as to make it difficult to actually see the contacts and moving parts. Where possible, the main contacts of the switch should be cleaned, adjusted, and a thin film of lubricant placed on them. The fuse clips, connections to the bus or cable, mounting in switchboard, and handles should be checked for tightness and proper alignment. When applicable, the tension on the contacts may be checked when signs of discoloration, caused by heating, are noted.

**4.08 Bus Duct and Cables:** Examine all joints. Tighten, as required, with a torque wrench to the tension recommended in manufacturers'

service specification or by ASA. Loose or overheated joints shall be dismantled. Measure insulation resistance to ground with megger and record the results; include the ambient temperature and name-plate date of instrument used. Compare results with ASA standards for the type and size of cable tested. Label each phase conductor with insulating tape to identify each for initial and subsequent measurements.

#### 4.09 Acceptance Testing and Proof Tests of

**Power Cables:** Newly installed cables in conduit or trenches should be given a die-electric test at higher than normal use values. This test should be a nondestructive test, using direct current high voltage test equipment. Main power cables should be tested based on experience, age, usage, and the importance placed on the actual service. DC high potential nondestructive test is recommended using the manufacturers' data, NEMA standards, or Insulated Power Cable Engineers Association (IPCEA) Specification Bulletin S-19-81 available from the American Standards Association, to determine the adequacy of the insulation. By keeping good records of these results over a period of time, the maximum life can be gained from the cable and replacement made prior to a breakdown of the insulation. Testing procedures are as follows:

- (a) Use high voltage DC equipment capable of DC output suitable for the test requirements.
- (b) Provide a separate reliable AC input supply voltage, preferably from a constant voltage type transformer, to the test set. Avoid fluctuating input voltages.
- (c) Cables should be tested in groups or pairs.
- (d) Disconnect both ends of cable(s) to be tested. New or old cable which fails repeatedly at other than repaired locations should be replaced. Cable with dry, brittle outer covering, or cracked and obviously poor inner insulation, should be replaced and the expense of the testing eliminated.
- (e) Inspect and clean potheads. Observe for cracks, chips, and loose connections that may cause arcing faults.

#### Motor Protective Equipment

4.10 For descriptive information covering this equipment, refer to Section 171-199-900PT. Since there is a wide variation in the use and design of this equipment, no specific frequency is stated. In the case of testing and inspecting equipment of this nature, the experience and judgment of local management will determine the extent of the work to be done.

#### Electrical Tests

4.11 **Circuit Breakers — Low Voltage Power:**  
This is equipment owned by the telephone company and shall be tested every six (6) years. This includes molded case breakers.

4.12 Electrical tests shall be made every six (6) years on all circuit breakers, by subjecting them to actual operating current, to ensure they will operate within the same limits after service as when new, and to check coordination with the rest of the electrical system insofar as practicable. No adjustments should ever be attempted by anyone other than trained personnel having the necessary tools and test equipment. The breakers must be meggered. A 1000-volt hand-cranked megger should be used. On a breaker with a 240-volt control, the minimum megger reading should be one meg-ohm. The megger readings must be taken with the breaker closed and latched. Megger readings must be taken from each pole to the breaker frame and from each pole to each of the other poles. The key-type interlocking mechanism should be inspected and tested to ascertain that it is functioning as designed.

4.13 Most of these breakers are equipped with one series overcurrent trip device per phase. The operation of any one of these devices will trip the breaker.

4.14 In testing a low voltage power circuit breaker equipped with series overcurrent trip devices, several points must be remembered:

- The values of current are high and the voltage low. Therefore, it is advisable to use the shortest and largest possible connection between the test unit and breaker.
- The connection to the primary fingers of the breaker must be tight.

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- The breaker is tested one phase at a time.
- Trip devices must be allowed to fully reset between tests.

4.15 The recommended tests for a low voltage power circuit breaker are:

- Timing (long and short time delay elements)
- Instantaneous

4.16 With the circuit breaker connected to the multi-amp test set, start below the expected pickup current value on the long delay trip unit, slowly raising the current through the breaker until the point is determined at which the plunger or trip bar starts to move in the direction to cause eventual tripping of the breaker. Record this current value. Apply a current of 300% of this pickup value and determine the necessary time to trip the breaker. Record this time. Allow roughly 10% ± tolerance. Determine the setting of instantaneous pickup from "coordinating curve" if available, from "as found" if not. Apply 100 to 110% of pickup current; the breaker should trip. Record the result. Compare results with applicable manufacturer's curve. Variations will show adjustments required. If necessary, the contractor shall adjust breaker and retest. Should a breaker require replacement of major parts, the contractor shall notify the switchgear coordinator before proceeding, except in an emergency. Additional procedures will be found in the manufacturer's instruction and maintenance book, and also in Multi-Amp Corp. Operating Instructions.

4.17 Molded case circuit breakers need to be tested for calibrated accuracy and reliability of tripping below an overload condition. Before electrically testing these units, mechanically open and close the breaker several times to remove any contact film or oxide. Since molded case breakers have thermal trip units, it is necessary to set the test current to approximate test values before attaching leads of the test set to the pole of the breaker. This can be done by shorting test leads, adjusting power-stat and noting current on ammeter. Then connect leads to the breaker pole and proceed with the test.

4.18 All breaker tests shall be performed in accordance with Multi-Amp Electronic Corporation's operating instructions for model CB-225 test set. No change in trip settings from "as found"

shall be made by the contractor without express approval of the switchgear coordinator. It will be the responsibility of this coordinator to notify the Engineering Dept. of any changes.

4.19 Refer to Section 770-280-600 for the various types of relays and definitions of their uses.

4.20 Relays should be checked with current and an accurate timing device when they are placed in service and every six (6) years thereafter, unless experience indicates a different interval. This will help to ensure that the relay was not damaged during shipping or installation and will operate in the desired time shown by the coordination study curves. If a relay does not give the desired operating time for a given current, the desired time can usually be obtained by cleaning and adjustment. Only qualified personnel, properly equipped with test equipment and manufacturer's data, should work on this equipment.

4.21 The relay should be inspected for loosened terminals, lock screws and other parts, filings or other foreign material in magnet gaps, burned or dirty contacts, sticky contact backstops, dirty, worn or broken bearings or other cause for sluggish operation, damaged coils, resistors or wiring, and damaged or maladjusted indicator targets or holding devices. Performance tests of the relays will vary somewhat with the type of relay. The following is a typical visual and electrical test procedure. For a step-by-step procedure, the tester should refer to the Multi-Amp Corporation's operating instructions.

(a) Visual Inspection (see Exhibit 4):

(1) Remove cover:

- Inspect cover gasket.
- Check glass for tightness in the frame, cracks, etc.
- Clean glass inside and out.

(2) Open trip circuit:

- This is done by opening the red-handled switch in the relay or removing the connection block in the relay. Open the latches that hold the relay in the case, and carefully remove relay from case.

Remember that the switch blades attached to the case in the relay, or the bars in the bottom of the case, are still "hot." If extreme care is not exercised, the breaker will be tripped. With capacitor trip, high voltages are present and may be several hundred volts.

- (3) Check that removal of the connection block or opening of current circuit shorts the current transformer secondary. In one type of relay, the current-carrying switch is equipped with a tip that shorts the current transformer before opening the relay coil circuit. On the drawout relay, this shorting device is inside the case and closes as the relay connection plug is withdrawn.
  - (4) Foreign material in the relay, such as dust, filings, etc., should be removed using dry compressed air 25psi or lower.
  - (5) Remove any rust or filings from disc or magnet poles with a magnet cleaner or brush.
  - (6) Hold relay up to the light to make sure the disc has good clearance between magnet poles and does not rub.
  - (7) Inspect relay for the presence of moisture.
  - (8) Pitted or burned contacts should be cleaned.
- (b) Overcurrent Relay Test (see Exhibit 5):  
For types of tests, see the Multi-Amp test booklet for detailed test procedures for:

- (1) Zero set
  - (2) Pickup
  - (3) Time current characteristics
  - (4) Target and seal-in operation
- (c) Overcurrent Instantaneous Relays: Consult the manufacturer's instruction leaflet to identify current terminals and contact terminals.
- (d) Over or Undervoltage Relays: Consult the manufacturer's instruction leaflet to identify potential terminals and contact terminals. Types of tests include:

- (1) Zero set
- (2) Pickup
- (3) Timing

(e) Directional Overcurrent Relays: Test the overcurrent unit for pickup and timing as for an overcurrent relay, except that for directional controlled relays, the directional unit contacts must be blocked closed for this test or the overcurrent unit will not operate.

(f) Percentage Differential Relays: Consult the manufacturer's instruction leaflet for proper connections and information on characteristics. Set up controls on the test unit in accordance with instructions in the Multi-Amp instruction book.

4.22 It is most important that all test results be recorded and filed for future reference (see Exhibit 3).

4.23 After the relays have been inspected, overhauled and tested, it is now necessary to return the relay to service. The same precautions should be exercised in returning the relay to service as in taking it out of service.

4.24 After completion of the electrical tests of relays removed from the switchgear, the relays shall be replaced in their drawout compartments, and a check of wiring continuity shall be made by mechanically operating the relay to ensure it will trip the protective device ahead. **MAKE CERTAIN** the circuit works properly to avoid the serious consequences of misoperation or failure to operate.

## 5. REPORTS

5.01 The electrical maintenance contractor or the telephone company employee performing the inspection and test shall complete the applicable "form" reports (Exhibits 1 through 5) in as many copies as required by the switchgear coordinator. The original of each report shall be placed in the switchgear logbook at the building. One copy shall be retained by the contractor. In addition to the forms, the contractor (when employed) shall make written recommendations indicating any major defects or deviations in the electrical system detected during the test and inspection, and any violations of national or local codes that may affect the safety of personnel or continuity of service.



MAINTENANCE OF BUILDING SWITCHGEAR  
SWITCHGEAR LOG

CITY OR DISTRICT Oakdale, Calif BUILDING 2800 Orange Ave. YEAR 1966

DATE	REPORTS OF TESTS, INSPECTIONS, REPAIRS, CLEANING AND OTHER WORK
2/6/65	Initial inspection conducted in accordance with BSP Section 171-199-901PT
	by <i>J. Smith, Engr.</i>
2/10/66	Conducted annual inspection per BSP Section 171-199-901PT by Brown
	Electric Co. <i>J. J. Brown</i>
5/12/66	Experienced nuisance trip on circuit breaker TP-1. No trouble
	found (CYW)
7/11/66	Fuses blown on switch FP-3, Bø due to overload on motor. (CYW)

Exhibit 1

**LOW VOLTAGE POWER CIRCUIT BREAKER (INCLUDES MOLDED CASE)  
VISUAL INSPECTION**

CITY \_\_\_\_\_  
 BUILDING \_\_\_\_\_  
 BREAKER MFG. \_\_\_\_\_  
 BREAKER TYPE \_\_\_\_\_

DATE					
CIRCUIT DEENERGIZED					
CIRCUIT PROPERLY TAGGED					
BREAKER REMOVED (IF APPLICABLE)					
PRIMARY FINGERS (IF APPLICABLE)					
ARC CHUTES					
CONTACTS					
CLEAN					
ALIGNED					
PRESSURE					
MECHANICAL OPERATION					
PROPER LUBRICATION					
RACKING DEVICE (IF APPLICABLE)					
ROLLERS (IF APPLICABLE)					
TRIP MECHANISM					
TIGHTEN BOLTED AND SCREWED CONNECTIONS					
TRIP BAR					
TRIP ARM					
INSPECTOR					

Exhibit 2

**ELECTRICAL TEST  
MAINTENANCE OF BUILDING SWITCHGEAR  
CIRCUIT BREAKER TEST REPORT**

CITY \_\_\_\_\_ FEEDER NAME \_\_\_\_\_  
 BUILDING \_\_\_\_\_ TRIP COIL RATING\* \_\_\_\_\_  
 BUILDING NO. \_\_\_\_\_ TIME DELAY RANGE\* \_\_\_\_\_  
 TYPE OF BREAKER \_\_\_\_\_ INSTANTANEOUS\* \_\_\_\_\_  
 AVAILABLE FAULT CURRENT\* \_\_\_\_\_ INTERRUPTING CAPACITY\* \_\_\_\_\_

\* THIS INFORMATION TO BE COMPLETED BY COORDINATOR PRIOR TO TEST.

**OVERCURRENT TRIP UNITS – "AS FOUND"**

TYPE \_\_\_\_\_  
 SHORT DELAY \_\_\_\_\_

**TEST OF TRIP UNITS**

	<u>TEST CURRENT</u>	<u>CURVE SEC.</u>	<u>PHASE A</u>	<u>PHASE B</u>	<u>PHASE C</u>
BREAKER SETTING (AMPS.)	_____	_____	_____	_____	_____
TIME DELAY (SECS.) AT 300%	_____	_____	_____	_____	_____
INSTANTANEOUS PICK-UP (AMPS.)	_____	_____	_____	_____	_____

ADJUST SETTING, IF NECESSARY, RETEST, RECORD "AS LEFT" VALUES BELOW:

	<u>TEST CURRENT</u>	<u>CURVE SEC.</u>	<u>PHASE A</u>	<u>PHASE B</u>	<u>PHASE C</u>
BREAKER SETTING (AMPS.)	_____	_____	_____	_____	_____
TIME DELAY (SECS.) AT 300%	_____	_____	_____	_____	_____
INSTANTANEOUS PICK-UP (AMPS.)	_____	_____	_____	_____	_____

TESTED BY \_\_\_\_\_ DATE \_\_\_\_\_

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**PROTECTIVE RELAY VISUAL INSPECTION**

BUILDING LOCATION \_\_\_\_\_ CIRCUIT DESIGNATION \_\_\_\_\_  
 RELAY \_\_\_\_\_ PHASE OR LOCATION IN PANEL \_\_\_\_\_  
 MFG. \_\_\_\_\_ STYLE NO. \_\_\_\_\_ FUNCTION \_\_\_\_\_  
 C.T. RATIO \_\_\_\_\_ P.T. RATIO \_\_\_\_\_  
 TAP RANGE \_\_\_\_\_ INSTANTANEOUS RANGE \_\_\_\_\_  
 TIME OPERATIONS INDICATOR \_\_\_\_\_ AMPS. INSTAN. OPERATIONS INDICATOR \_\_\_\_\_ AMPS.

<b>RELAY INSPECTION</b>					
<b>DATE</b>					
<b>COVER</b>					
GLASS TIGHT					
GLASS CLEAN					
GASKET TIGHT					
<b>RELAY CONDITION</b>					
DUST					
RUST					
IRON FILINGS					
<b>BEARINGS STICKY</b>					
<b>SHORTING BARS IN PLACE</b>					
<b>CONNECTIONS TIGHT</b>					
<b>CONTACTS</b>					
DIRTY					
PITTED					
<b>OPERATIONS INDICATOR</b>					
ARMATURE FREE					
TARGET FREE					
<b>INSTANTANEOUS ATTACHMENT</b>					
ARMATURE FREE					
TARGET FREE					
<b>DISC RUBBING</b>					
<b>INSPECTOR</b>					

Exhibit 4

