ABB

IB 7.1.1.7-9
Issue A

INSTRUCTIONS

FIELD TESTING OF GROUND FAULT PROTECTION SYSTEMS

A. INTRODUCTION

National Electrical Code ANSI/NFPA No. 70 (Section 230-95) requires performance testing of the service ground-fault protection system when first installed and provided for solidly grounded wye services of more than 150 volts to ground but not exceeding 600 volts phase-to-phase.

The total ground-fault protection system shall be considered to consist of ground-fault sensing, relaying and disconnect means, power sources and field installed conductors, grounding connections and other electrical equipment which may affect operation of the installed ground-fault protective equipment.

B. SCOPE

These instructions contain basic information required for on-site testing of ground-fault protective equipment supplied by BBC Brown Boveri, Inc. Power system configurations and interconnections may differ from case to case and may influence performance of individual equ pments especially if the system contains several power sources or switchboards, panel-boa rds, panelboards and components supplied by different manufacturers.

Master electrical plans. therefore. must be reviewed before testing individual switchboards. If any questions regarding the power system operation ar se, the system specifier or engineer should be consulted.

These instructions supplement standard instructions normally prov ded by manufacturers with the ground-fault protective devices.

C. Genera l

Field tests should be performed by personnel or agencies knowledgeable in the equipment and qualified to perform tests. Proper equipment and test methods should be used and test Procedures followed.

CAUTION: Observe satety rules and precautions in deenergizing the equipment, installing test windings or sources and restoring service. It is suggested the ground-fault protection system be checked prior to connecting the incoming service. If the service connections have been made up, check to be sure there is no voltage on the line side of the incoming main device or tie disconnect (circuit breaker or switch).

The purpose of field testing is to verify proper performance of the ground-fault protection system and conformance with the provisions of the National Electrical Code and electrical drawings and/or manufacturer's equipment instructions.

Manufacturer's installation and instruction literature should be read and understood prior to field testing. Specifier's and manufacturer's application, rating, mounting and wiring instructions, diagrams or drawings must be followed.

Test personnel should also be familiar with basic publications referenced at the end of these instructions.

D. INSPECTION

1. inspect equipment and connections for physical damage.

2. Power system electrical drawings and manufacturer's equipment drawings should be reviewed to ascertain that the ground-fault protection can function properly. The system shall contain only compatible devices or equipments.

   Particular attention should be paid to main bonding jumpers, equipment grounding conductors, grounding electrode conductors, disconnect links, neutral conductors, and utility transformer or emergency generator ground connections.

3. Inspect equipment and interconnections to verify conformity with plans and specifications. Check for tightness of connections.

4. Check main bonding jumper, grounded service conductor and grounding electrode conductor connections.

5. Check the installation of ground links or bonding between all switchboard sections and enclosures.

6. Check to insure that no downstream grounds or equipment grounding conductors have been connected to the neutral bus except as allowed by NEC.

7. Check sensor or CT mounting and to insure that proper conductors pass through and are symmetrically aligned within the window.

   If zero-sequence (outgoing circuit) method of ground-fault current detection is used, check the phase and neutral busses or cables to insure they pass through the sensors or CT's in the same direction. In case of a ground-return method and if the grounding electrode conductor is connected to the grounded service conductor, both the main bonding jumper and the grounding electrode conductor should pass through the ground sensor or CT.

8. Inspect primary power connections of the control power transformer (if applicable) to verify continuity to the main power bus. Check control power fuses or switches if provided.

9. Incorrect wiring may result in damage to relays, sensors, or trip devices. Be sure wiring agrees with the connection diagram for the particular device before it is energized.

   Review control interlocking prior to testing of double-end, multi-source or zone-selective interlocking systems.

E. INSULATION RESISTANCE

CAUTION: Do not apply high voltage tests to solid-state relays or trip devices. If a control wiring insulation test is required, bond all terminals together and disconnect ground wire before applying test voltage.

1. If the wiring system is 4-wire, remove the neutral disconnect links in the service switchboard.

   In multiple-source or service systems with continuous neutrals, remove neutral disconnects in all interconnected services but one at a time.

   In a single-point grounded dual-fed system, and if individual neutral disconnect links are not provided, remove also the common disconnect link(s) or the main bonding jumper as well as the grounding electrode conductor if it was connected to the neutral tie point.

2. Measure insulation resistance of the neutral(s) to ground and enclosures on load side of links. There should be no grounding electrode, enclosure or structural metal frame connections to the neutral(s) downstream of the ground-fault protective devices or sensors except as allowed by NEC. The reading should be not less than 100 ohms, preferably 1 megohm or higher.

3. Measure insulation resistance of the enclosure and the ground bus to the grounding electrode conductor. The readings should be zero.

4. Return all neutral and ground connections or links to their normal intended operating condition.

5. Measure insulation resistance of the grounded service conductor to the grounding electrode conductor. The reading should be zero.

F. OPERATION TESTS

CAUTION: Care should be taken to avoid damage to ground-fault protection equipment during field tests. Signal or test current level and duration, control power voltage and frequency, and test methods should be in accordance with equipment ratings or manufacturer's recommendations. Do not apply test currents or hold test switches for more than two (2) seconds.

1. If the ground fault relays are AC control powered, disconnect control power leads from the transformer and connect them to a rated voltage, single phase external power source (overcurrent protected). If relays are DC control powered, apply DC voltage of proper magnitude and polarity. If self-powered trip devices require external control power for the tests, apply control circuit voltage of proper magnitude and polarity.

2. Set ground-fault protective device at a representative pickup value (if adjustable). Time dials of ground-fault relays or trip devices shall be set at maximum during tests (if adjustable). Use a timer or a cycle counter for time interval measurements.

3. One of the following methods can be used to apply test currents to ground-fault protective devices:

   (a) External Test Winding

   Loop a test coil of wire having sufficient current carrying capacity through the sensor or CT window or use a multiturn test cable with required number of loops. Wire the test winding to the current signal source through a test switch. By means of a switch, apply sufficient test current so that the ampere turns of the test winding numerically equal 2.5 times the relay current setting (e.g. 25 turns, 10 amperes, 250 ampere turns, 100A primary trip setting).

   (b) Built-in Test Winding

   If sensors contain a test winding and ground-fault relays have wired provisions for sensor testing, operate the relay test switch for (2) seconds or less. The test current magnitude is normally higher than required for pickup at the maximum relay setting, hence there will be no need to readjust the relay dials.

   (c) Test Set

   Some circuit breakers with integral ground-fault protection can be tested with a compatible test set which applies a simulated ground-fault signal of specified values and checks integrity of built-in sensors. Follow test set instructions.

   (d) Primary Current

   Connect the test current supply to main power conductors (bus, cable terminal). For example, in a 4-wire system, the supply can be connected to the neutral (grounded circuit) and the ground bus (equipment grounding) conductors. Close test supply or test set circuit breaker to apply sufficient bus test current so that the current equals 2.5 times the relay or circuit breaker ground trip pickup setting (e.g. 100A setting, 250A test current).

4. If presetting of the test current is desired, keep the application time as short as possible to prevent overload of the relay and trip device circuits or possible damage.

5. Operating time of ground-fault protective devices shall not exceed one second at test current levels of 2.5 times relay or trip device pick-up current settings. If the time measurement is less than one second at a given test current level, it will result in equal or shorter time at higher test current levels.

6. Following each test and with the test current no longer flowing, an attempt should be made to close the main disconnect under test without operating any reset button. If the disconnect will stay closed, the test current should be reapplied and the ground-fault protection should again function.

7. Operate test buttons of ground fault relays or monitors, if provided, to check the functions, disconnect tripping, and target or lamp indicator resetting. If the relays are of a seal-in or latching type, operate the reset push button after each test.

8. Following tests, the power system and equipment shall be restored to the operating condition. Turn off and disconnect all external power and equipment. Reinstall disconnected links or conductors. Remove all temporary jumpers. Set ground-fault protective devices in accordance with specifications.

   CAUTION: Reconnect control power leads to the transformer.

G. RECORDS

A record of the tests shall be prepared, dated and be available for inspection. The sample test sheet attached to these instructions can be used as a check list and formal record. If check charts or labels are furnished with the equipment, appropriate entries shall be made to record acceptance or periodic tests.

H. REFERENCE PUBLICATIONS

1. NFPA 70-1984 - National Electric Code 1984.

2. PB2.1-1979 - NEMA Instructions for Safe Handling, Installation, Operation and Maintenance of Switchboards.

3. PB1.1-1979 - NEMA Instructions for Safe Installation, Operation, and Maintenance of Panelboards.

4. PB 2.2-1983 - NEMA Application Guide for Ground Fault Protective Devices for Equipment.

TEST REPORT

GROUND-FAULT PROTECTION

Job: _____

Location: _____ Date of Test: _____

Circuit: _____

Switchboard: _____ Single/Double End

Disconnect Device: _____

GF Protective Device: _____

GF Sensor: _____

Test Equipment: (Describe on back or attach a page.)
Test Setup and Method: (Describe on back or attach a page.)

A. INSPECTION

1. Wiring and conductors ---------- ☐
2. Connections and wire clamping ---------- ☐
3. Bonding, splice bussing and grounding ---------- ☐
4. Sensor mounting and wiring ---------- ☐
5. Control circuit overcurrent protection ---------- ☐
6. Other: _____

B. INSULATION RESISTANCE

1. Neutral-to-ground ---------- ☐
2. Neutral-to-enclosure ---------- ☐
3. Enclosure and grd. bus-to-ground ---------- ☐
4. Grounded service conductor-to-ground ---------- ☐
5. Other: _____

C. OPERATION TEST

1. GF protective device setting: _____A, _____sec. Time curve: _____
2. Control power _____
3. Test current: (a) _____A, x _____ turns = _____ AT
   or (b) Test set signal _____
   or (c) Primary current _____A
4. Trip operation ---------- ☐
5. Time delay: one second or less ---------- ☐
6. Test button, lamp, indicator operation ---------- ☐
7. Other: _____

D. LABEL AFFIXED ☐

E. EQUIPMENT RESTORED TO OPERATIONAL CONDITION ☐

GFP settings (as left) _____

Tested by: _____

Make the report available to the authority having jurisdiction.