

# Protective Relay Maintenance, Advanced

4.5 Days, 3.2 CEUs

Electromechanical protective relays are commonly used to protect lines and substation equipment against overloads, faults and abnormal conditions. NETA and FERC Maintenance and Testing Standards recommend testing relays at regular intervals based on equipment condition and reliability requirements. Through proper testing and maintenance, technicians can help ensure the integrity of the protection systems minimize damage to equipment and help insure service continuity.

The Protective Relay Maintenance, Advanced course is an intensive, hands-on, lab oriented course covering:

1. Impedance Relays (21)
  - a. Mho
  - b. Reactance
2. Phase Directional Overcurrent (67)
3. Ground Directional Overcurrent (67G)

The participant will learn the basics of transmission line protection combined with hands-on, realistic training on actual relays. Laboratory exercises will cover proper relay maintenance, specific test procedures including proper calculations for impedance testing, and detailed adjustment and calibration procedures utilizing state of the art relay test sets. Participants will understand applicable testing standards, what test result information should be recorded, and what hand tools are necessary for proper relay adjustment and calibration.

## Lab and Classroom Attire

AVO Training Institute is committed to the personal safety of each participant and require long pants and ANSI rated "safety-toe" work shoes for lab activities. Lecture courses may involve a tour of a work or shop area and for this reason open-toe shoes and shorts are not considered appropriate attire for the classroom.

## Learning Objectives

To receive 3.2 CEUs, participants must attend 4.5 days of class (32 contact hours) and attain a minimum average grade of 80% (overall grade will consist of 50% lab practice and 50% final exam). Upon completion of this course the participant will demonstrate that he/she is able to:

- Identify electromechanical relay components.
- Explain the application of the relays.
- Interpret AC and DC relay schemes.
- Perform as found/as left tests and calibrate the following relays (ANSI device numbers):
  - Distance (21)
  - Phase Directional Overcurrent (67)
  - Ground Directional Overcurrent (67G)
  - Targets and Indicators
- Perform direct injection testing and evaluate results.

## SCOPE

### Day 1\* (7 contact hours)

- I. Introduction (0.5 hr)
  - A. Schedule
  - B. Course Outline
- II. Relay Test Equipment (1 hr)
  - A. SMRT Quick Start
  - B. Power DB Demo (instructor led)
- III. Introduction to Directional Relaying (1 hr)
  - A. Operating Principles
  - B. Applications
  - C. Relay Operation

- D. Terminology
- E. Maximum Angle of Torque
- F. Connections
- AM Break
- IV. ABB/Westinghouse Type (CR) (3 hrs)
  - Directional Overcurrent Relays
    - A. Application
    - B. Components
    - C. Directional Unit Operating Principles
    - D. Overcurrent Unit Operating Principles
    - E. Protection Scheme

- F. Testing
- Lunch
- IV. ABB/Westinghouse Type (CR)
  - Directional Overcurrent Relays (cont'd)
  - G. Lab
    1. Directional Unit Pickup Test
    2. Directional Unit MTA Test
    3. CO Unit Pickup Test
    4. CO Unit Timing Test
    5. CO Unit Seal-In Test
    6. Adjustment Techniques

\*Class scheduling times may vary based on discussions and size of class

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## SCOPE (cont'd)

### Day 2 (7 contact hours)

- V. General Electric Directional Overcurrent Relays (JBC (4 hrs)
  - A. Application
  - B. Components
  - C. Operating Principles
  - D. Protection Scheme
  - E. Testing
- AM Break
- F. Lab
  - 1. Directional Unit Pickup Test
  - 2. Directional Unit MTA Test
  - 3. IAC Unit Pickup Test
  - 4. IAC Unit Timing Test
  - 5. IAC Unit Instrument Test
  - 6. IAC Unit Seal-In Test
  - 7. Adjustment Techniques
- VI. Introduction to Ground Directional Relays
- VII. ABB/Westinghouse Ground Directional Relay (IRD)
  - A. Application
  - B. Components
  - C. Induction Cylinder Unit Operating Principles
  - D. Overcurrent Unit Operating Principles
  - E. Protection Scheme
  - F. Testing
- Lunch
- G. Lab (3 hours)
  - 1. Voltage Polarized Directional Unit Pickup Test
  - 2. Voltage Polarized Directional Unit MTA Test
  - 3. Current Polarized Directional Unit Pickup Test
- PM Break
- 4. CO Unit Pickup Test
- 5. CO Unit Timing Test
- 6. Instrument Unit Pickup Test

- 7. CS-1 Unit Pickup Test
- 8. Seal-In Unit Pickup Test
- 9. Adjustment Techniques

### Day 3 (7 contact hours)

- VIII. General Electric Ground Directional Relay (JBCG) (1 hr)
  - A. Application
  - B. Components
  - C. Operating Principles
  - D. Protection Scheme
  - E. Testing
  - F. Lab (3 hours)
    - 1. Voltage Polarized Directional Unit Pickup Test
    - 2. Voltage Polarized Directional Unit MTA Test
    - 3. Current Polarized Directional Unit Pickup Test
    - 4. IAC Unit Pickup Test
    - 5. IAC Unit Timing Test
    - 6. Instrument Unit Pickup Test
    - 7. Seal-In Unit Pickup Test
    - 8. Adjustment Techniques
- IX. Introduction to Distance Relays (1 hr)
  - A. Power System Impedances
  - B. System Modeling
  - C. Guidelines for Testing Distance Relays
- AM Break
- X. General Electric Directional Distance Relay (GCX) (5 hrs)
  - A. Application
  - B. Components
  - C. Operating Principles
  - D. Protection Scheme
  - E. Testing
  - F. Lab
    - 1. Reach Tests
- Lunch

- 2. MTA Tests

PM Break

- 3. Characteristic Test
- 4. Adjustment Techniques

### Day 4 (7 contact hours)

- XI. General Electric Distance Relays (CEY) (4 hrs)
    - A. Application
    - B. Components
    - C. Operating Principles
    - D. Protection Scheme
    - E. Testing
  - AM Break
  - F. Lab
    - 1. Reach Tests
    - 2. MTA Tests
    - 3. Characteristic Test
    - 4. Adjustment Techniques
  - Lunch
  - XII. ABB/Westinghouse Distance Relays (KD) (3 hrs)
    - A. Application
    - B. Components
    - C. Operating Principles
    - D. Protection Scheme
    - E. Calculating and Setting KD-10
    - F. Testing
  - PM Break
  - G. Lab
    - 1. Reach Test
    - 2. MTA Tests
    - 3. Characteristic Test
    - 4. Adjustment Techniques
  - H. Special Appendix
- Day 5 (Half day) (4 contact hours)**
- XIII. Conclusion (4 hrs)
    - A. Review and Exam