

# Protective Relay Maintenance, Basic

4.5 Days, 3.6 CEUs

The Protective Relay Maintenance Distribution course is an intensive, hands-on, lab oriented presentation covering overcurrent, directional overcurrent, bus differential, and transformer differential protective relays. The participant will learn the basics of distribution protection combined with hands-on, realistic training on actual relays. Laboratory exercises will cover proper relay maintenance, specific test procedures, and detailed adjustment and calibration procedures utilizing state of the art relay test sets. Class participants will understand applicable NETA testing standards, what test result information should be recorded, and what hand tools are necessary for proper relay adjustment and calibration.

## Who Should Attend

This course is intended for electricians, technicians and engineers responsible for the testing, maintenance and calibration of relays that protect distribution feeders, transformers, buses, and loads. The participant should have basic knowledge of AC/DC electricity.

## Learning Objectives:

Upon completion of this course, the participant should be able to:

- Understand how the relay is applied in the power system
- Identify critical relay components
- Understand how to effectively use manufacturer's instruction literature to correctly interpret internal and external AC and DC relay schemes
- Understand standard tests to be performed on the relay
- Perform specified tests on, and calibrate the following relays to manufacturer's specifications (ANSI device number):
  - Instantaneous and Time Overcurrent (50/51)
  - Directional/Controlled Overcurrent (67)
  - Bus Differential (87B)
  - Transformer Percentage Differential with Harmonic Restraint (87T)
  - Targets and Indicators

## SCOPE

### Day 1\*

- I. **Introduction, Paperwork and Pre-Test**
- II. **Introduction To Basic Relays**
  - A. Purpose of Protective Relays
  - B. The Art and Science of Protective Relaying
- III. **Current and Voltage Transformers**
  - A. Elementary Connections of Instrument Transformers
  - B. Types of Current Transformers
  - C. Understanding CT Ratios
  - D. Determining CT Polarity
  - E. Measuring Current
  - F. Shorting CT Secondary Current Circuits
  - G. Operation of Current Transformers at Excessive Burden or Open Circuit Voltage
  - H. Effect on Accuracy of Open-Circuit Saturation of Iron

- I. Understanding CTs in a Schematic
- J. Voltage Transformers
- K. Coupling Capacitors Voltage Transformer Design Fundamentals
- L. Application: High-Voltage Transmission (115 kV – 500 kV)
- M. Understanding Voltage Transformers in a Schematic
- IV. **Introduction To Relaying**
  - A. Classification of Relays
  - B. Protective Zones
  - C. Fundamentals of Electro-mechanical Design
  - D. Relay Construction
  - E. Time Characteristics
  - F. Protective Relay Maintenance and Testing
  - G. Mechanical and Visual Inspections
  - H. Preventive Maintenance Testing
  - I. Acceptance Testing
  - J. Testing Techniques
  - K. General Tests

### V. Relay Test Equipment

- A. Transformer Loading
- B. Electronic Test Current Supplies
- C. Conventional Test Equipment
- D. SR-76A
- E. SR-90
- F. EPS-1000
- G. Electronic Test Equipment

### Day 2

- VI. **Westinghouse Type CO Overcurrent Relay**
  - A. Applications
  - B. Types of CO Relays
  - C. Components
  - D. Operating Principles
  - E. Protection Scheme
  - F. Types of Tests
  - G. Adjustments
  - H. Timing
  - I. Lab – CO (2.5 Hours)
    1. Pickup Test
    2. Timing Test
    3. Instantaneous Test
    4. Seal-In Test

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

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## SCOPE (Cont)

### VII. General Electric Overcurrent Relays (IAC)

- A. Applications
- B. Types of IAC Relays
- C. Components
- D. Operating Principles
- E. Protection Scheme
- F. Types of Tests
- G. Adjustments
- H. Lab – IAC (2.5 Hours)
  - 1. Pickup Test
  - 2. Timing Test
  - 3. Instantaneous Test
  - 4. Seal-In Test

### VIII. Westinghouse Voltage Relays (CV)

- A. Applications
- B. Types of CV Relays
- C. Components
- D. Operating Principles
- E. Protection Scheme
- F. Types of Tests
- G. Adjustments
- H. Lab – IAV (2 Hours)
  - 1. Pickup Test
  - 2. Timing Test
  - 3. Seal-In Test

### Day 3

### IX. General Electric Voltage Relays (IAV)

- A. Applications
- B. Types of IAV Relays
- C. Components
- D. Operating Principles
- E. Protection Scheme
- F. Types of Tests
- G. Adjustments for IAV 51A Overvoltage Relays
- H. Adjustments for IAV 51E Undervoltage Relays
- I. Lab – IAV (2 Hours)
  - 1. Pickup Test
  - 2. Timing Test
  - 3. Seal-In Test

### X. Introduction To Transformer Differential Relays

- A. Applications
- B. Operating Principles
  - 1. Basic
  - 2. Transformer Differentials
  - 3. Transformer Differentials with Harmonic Restraint

### XI. Westinghouse Differential Relays (CA)

- A. Applications
- B. Components
- C. Operating Principles
- D. Protection Scheme
- E. Types of Tests
- F. Adjustments
- G. Lab – CA Differential Relay (2.5 Hours)
  - 1. Minimum Pickup Test
  - 2. Timing Test
  - 3. Slope Test
  - 4. Seal-In Test

### XII. General Electric Differential Relays (IJD)

- A. Applications
- B. Components
- C. Operating Principles
- D. Protection Scheme
- E. Types of Tests
- F. Adjustments
- G. Lab – IJD Differential Relay (2.5 Hours)
  - 1. Minimum Pickup Test
  - 2. Timing Test
  - 3. Slope Test
  - 4. Seal-In Test

### Day 4

### XIII. Westinghouse Differential Relays (HU)

- A. Applications
- B. Components
- C. Operating Principles
- D. Protection Scheme
- E. Types of Tests

- F. Adjustments
- G. Lab – HU Differential Relay (4 Hours)
  - 1. Minimum Pickup Test
  - 2. Slope Test
  - 3. Harmonic Restraint Test
  - 4. Instantaneous Test
  - 5. Seal-In Test

### XIV. General Electric Type BDD Transformer Differential Relay with Percentage and Harmonic Restraint

- A. Applications
- B. Components
- C. Operating Principles
- D. Protection Scheme
- E. Types of Tests
- F. Adjustments
- G. Lab – BDD Differential Relay (4 Hours)
  - 1. Minimum Pickup Test
  - 2. Slope Test
  - 3. Harmonic Restraint Test
  - 4. Instantaneous Test
  - 5. Seal-In Test

### XV. General Electric Type STD Transformer Differential Relay with Percentage and Harmonic Restraint

- A. Applications
- B. Components
- C. Operating Principles
- D. Protection Scheme
- E. Types of Tests
- F. Adjustments
- G. Lab – STD Differential Relay (3 Hours)
  - 1. Minimum Pickup Test
  - 2. Slope Test
  - 3. Harmonic Restraint Test
  - 4. Instantaneous Test
  - 5. Seal-In Test

### Day 5 (1/2 Day)

### XVI. Paperwork and Post-Test