

# Circuit Breaker Maintenance, SF<sub>6</sub>

4 Days, 2.8 CEUs

This course covers all elements of routine SF<sub>6</sub> circuit breaker maintenance and inspections. A balance of lecture and hands-on activities are utilized to emphasize operating characteristics and maintenance and testing requirements. Instruction includes the hazards involved in working with SF<sub>6</sub> gas as well as the important differences between SF<sub>6</sub> circuit breakers compared to conventional insulating mediums.

This hands-on course is intended for new or experienced electricians and technicians that install, maintain, repair or troubleshoot SF<sub>6</sub> circuit breakers rated at 1.2 kV and higher. Participants should have basic knowledge of AC/DC electricity and circuit breaker fundamentals.

## Lab and Classroom Attire

AVO is committed to the personal safety of each participant and requires safety glasses, 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 2.8 CEUs, participants must attend 4 days of class (28 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 and lab practice, the participant will demonstrate that he/she is able to:

- Describe the safety hazards involved in working with SF<sub>6</sub> gas.
- Explain the procedure for adding gas to an SF<sub>6</sub> circuit breaker.
- Summarize the electrical and mechanical operating principles of an SF<sub>6</sub> puffer circuit breaker.
- Interpret an electrical schematic for an SF<sub>6</sub> puffer circuit breaker.
- Carry-out a circuit breaker inspection per manufacturers' technical manual.
- Perform and evaluate electrical and mechanical tests that are required by the manufacturer.

## SCOPE

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

- I. Introduction
  - II. Safety for Technicians
    - A. Lab Safety Rules
    - B. On-the-Job Safety
  - III. Introduction To SF<sub>6</sub> Circuit Breakers
    - A. Circuit Breaker Arc Interruption Mediums
- AM Break
- B. Sulfur Hexafluoride (SF<sub>6</sub>) Circuit Breakers
  - C. Characteristics of SF<sub>6</sub> Gas
  - D. SF<sub>6</sub> and the Environment
- Lunch
- IV. Safe Handling of SF<sub>6</sub> Gas
    - A. Asphyxiation
    - B. Toxicity

- C. Arcing By-Products of SF<sub>6</sub> Gas
- PM Break
- D. S<sub>2</sub>F<sub>10</sub>, Is It a Concern?
  - E. Additional Safety Concerns
  - F. Removal of Hazardous Solid by Products
  - G. Transportation of SF<sub>6</sub>
  - H. Storing SF<sub>6</sub> Gas Cylinders

### Day 2 (7 contact hours)

- V. SF<sub>6</sub> Circuit Breaker Types
    - A. Live Tank SF<sub>6</sub> Circuit Breakers
    - B. Dead Tank SF<sub>6</sub> Circuit Breakers
- AM Break
- C. Dual Pressure SF<sub>6</sub> Circuit Breakers

- D. Puffer SF<sub>6</sub> Circuit Breakers
  - E. Puffer Interrupter Operation
  - F. Self-Blast SF<sub>6</sub> Circuit Breakers
- Lunch
- VI. Evacuating, Reclaiming and Filling SF<sub>6</sub>
    - A. SF<sub>6</sub> Gas Filling Physics
    - B. Filling Precharged SF<sub>6</sub> Circuit Breakers
    - C. Filling a New Circuit Breaker After Site Assembly
- PM Break
- D. Reclaiming and Filling a Circuit Breaker Opened for Service Work
  - E. Filling an SF<sub>6</sub> Circuit Breaker – (From a Gas Cart)
  - F. Adding Gas (In-Service)

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

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## SCOPE (continued)

### Day 3 (7 contact hours)

#### VII. SF<sub>6</sub> Circuit Breaker Components

- A. SF<sub>6</sub> Gas Density Monitor
- B. Other Pressure Monitoring Components
- C. Rupture Discs
- D. Entrance Bushings
- E. Grading Rings
- F. Pre-Insertion Resistors

#### AM Break

- G. Capacitors
- H. Heaters
- I. Operating Mechanisms
- J. Auxiliary Switches
- K. Lab (2 Hours)
  - 1. Contact Resistance

#### Lunch

#### VIII. SF<sub>6</sub> Breaker Maintenance and Testing

- A. Qualified Person
- B. Inspections
- C. Leak Rates and the Need for Testing
- D. Field Leak Detection Methods
- E. Leak Testing
- F. Testing SF<sub>6</sub> Gas
- G. Measuring Contact Resistance

#### PM Break

- H. Time Travel Analysis
- I. Control Circuitry
- J. Other Tests
- K. Test Results Interpretation

### Day 4 (7 contact hours)

#### L. Labs (6 Hours)

- 1. Periodic Maintenance

#### AM Break

- 2. Time/Travel Analysis

#### Lunch

- 2. Time/Travel Analysis (cont'd)

#### PM Break

#### IX. Conclusion (1 hr)

- A. Review
- B. Final Exam