

Circuit Breaker Maintenance, SF₆

4 Days, 2.8 CEUs

This course covers all elements of routine SF₆ 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 SF₆ gas as well as the important differences between SF₆ 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 SF₆ 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 SF₆ gas.
- Explain the procedure for adding gas to an SF₆ circuit breaker.
- Summarize the electrical and mechanical operating principles of an SF₆ puffer circuit breaker.
- Interpret an electrical schematic for an SF₆ 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 SF₆ Circuit Breakers
 - A. Circuit Breaker Arc Interruption Mediums
- AM Break
- B. Sulfur Hexafluoride (SF₆) Circuit Breakers
 - C. Characteristics of SF₆ Gas
 - D. SF₆ and the Environment
- Lunch
- IV. Safe Handling of SF₆ Gas
 - A. Asphyxiation
 - B. Toxicity

- C. Arcing By-Products of SF₆ Gas
- PM Break
- D. S₂F₁₀, Is It a Concern?
 - E. Additional Safety Concerns
 - F. Removal of Hazardous Solid by Products
 - G. Transportation of SF₆
 - H. Storing SF₆ Gas Cylinders

Day 2 (7 contact hours)

- V. SF₆ Circuit Breaker Types
 - A. Live Tank SF₆ Circuit Breakers
 - B. Dead Tank SF₆ Circuit Breakers
- AM Break
- C. Dual Pressure SF₆ Circuit Breakers

- D. Puffer SF₆ Circuit Breakers
 - E. Puffer Interrupter Operation
 - F. Self-Blast SF₆ Circuit Breakers
- Lunch
- VI. Evacuating, Reclaiming and Filling SF₆
 - A. SF₆ Gas Filling Physics
 - B. Filling Precharged SF₆ 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 SF₆ Circuit Breaker – (From a Gas Cart)
 - F. Adding Gas (In-Service)

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

Circuit Breaker Maintenance, SF₆

4 Days, 2.8 CEUs

SCOPE (continued)

Day 3 (7 contact hours)

VII. SF₆ Circuit Breaker Components

- A. SF₆ 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. SF₆ 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 SF₆ 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



STANDARD EQUIPMENT LIST

Circuit Breaker Maintenance, SF₆

COURSE NUMBER 332 REV3

REVISED: 03/07/2016

BY: JIM CLOSSON/DB/MC/JJ

DAYS: 4 DAYS

*ASSOCIATED FITTINGS FOR A RECLAIMER (RENTAL)

**TOOL BOX (BOX 2 OF 2) WITH TRANSDUCER, BRACKET, RODS, C-CLAMP VISE GRIPS.

TEXT (PER 1 STUDENT)	
QUANTITY	ITEM
1	CIRCUIT BREAKER MAINTENANCE, SF ₆ COURSE 332, REV 3, MARCH 2017

MATERIALS NEEDED (PER CLASSROOM)	
QUANTITY	ITEM
*1	PROJECTOR OR TV WITH PROJECTION CAPABILITIES
*1	DRY ERASE BOARD WITH MARKERS AND ERASERS
*10	STUDENT TABLES
*10	STUDENT CHAIRS

EQUIPMENT (PER STUDENT)	
QUANTITY	ITEM
1	CALCULATOR

EQUIPMENT (PER CLASS)	
QUANTITY	ITEM
1	MEGGER DLRO 100 AMP OR SIMILAR
1	DIGITAL GAS LEAK DETECTOR (RENTAL)
1	*SF ₆ RECLAIMER UNIT FROM DILO W/ HOSE & POWERCORD (RENTAL)
1	ALL IN ONE SF ₆ ANALYZER (RENTAL)
1	BOX 1 OF 2 - MEGGER EGIL BREAKER ANALYZER WITH **BOX 2 OF 2 - LINEAR TRANSDUCER
1	DIGITAL MULTIMETER
2	8 FOOT FIBERGLASS STEPLADDER
1	VERIFY SUFFICIENT SF ₆ GAS FOR CLASS TO GO FORWARD

TOOLS (PER CLASS)	
QUANTITY	ITEM
1	STANDARD SAE TOOL BOX (EXAMPLE ATTACHED)
**1	MANUFACTURER ASSOCIATED TOOLS
**1	PRINTS AND INSTRUCTION MANUAL FOR BREAKER
**1	OUTSIDE UTILITY THERMOMETER

(RENTAL) FOR DALLAS OPEN ENROLLMENT ONLY: INFORMATION IN EQUIPMENT PROVIDER FOLDER. FOR LOCATIONS (OTHER THAN DALLAS) THIS EQUIPMENT MUST BE PROCURED BY CLIENT.

NOTE: REFER TO FAQ FORM FOR ADDITIONAL INFORMATION FOR CLIENT COURSES.

FOR VIRTUAL CLASSES:
CONTENT MATERIAL WILL BE PROVIDED IN DIGITAL FORMAT