

# Substation Maintenance I

4.5 Days, 3.2 CEUs

Substation Maintenance is a major part of any utility or plant maintenance program. Equipment failures usually result in significant downtime because of long delays in equipment replacement. However, most of these failures can be detected and prevented. This course provides an overview of substation equipment and equipment operations. Labs and instructions provided are designed to help the technician locate weak or faulty components in the substation systems; it focuses on medium voltage circuit breakers (air and vacuum) and switchgear. The course is designed to aid skilled qualified substation maintenance technicians responsible for the maintenance and testing of industrial and utility substations.

## 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 and lab practice, the participant will demonstrate that he/she is able to:

- Explain the configuration and function of common equipment found in a substation.
- Identify components of air, oil, and vacuum circuit breakers, and metal-clad switchgear (including switchyard equipment).
- Use medium-voltage circuit breaker and switchgear manufacturer's instruction manuals and NETA specifications to:
  - Perform all required tests
  - Verify measurements
  - Make adjustments as required

## SCOPE

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

- I. Introduction (0.5 hr)
- II. Safety for Technicians (1.5 hr)
  - A. Lab Safety Rules
  - B. On-the-Job Safety
- AM Break
- III. Substation Overview (2 hrs)
  - A. Components of a Power System
  - B. Substation Breaker Configurations
  - C. Substation Components

- D. Metering in Substations
- E. Relaying in Substations
- Lunch
- IV. Disconnect Switches Maintenance & Testing (1.5 hrs)
  - A. Components
  - B. Interlocking
  - C. Motor-Operated Mechanism
  - D. Vacuum Interrupters
  - E. Maintenance Requirements
  - F. Electrical Testing

### PM Break

- V. Switchgear Maintenance & Testing (1.5 hrs)
  - A. Arrangement of Components
  - B. Maintenance Intervals
  - C. Enclosure Maintenance
  - D. Maintaining the Insulation System
  - E. Maintaining Auxiliary Components
  - F. Electrical Testing of Switchgear

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

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## SCOPE (cont'd)

### Day 2 (7 contact hours)

#### VI. Circuit Breaker Fundamentals (4 hrs)

- A. Circuit Breaker Functions
- B. Ratings
- C. Principles of Arc Interruption
- D. Breaker Insulation Media
- E. Contacts

#### AM Break

- F. Insulation Requirements
- G. Circuit Breaker Controls
- H. Methods of Operation

#### Lunch

#### VII. Circuit Breaker Maintenance and Testing (3 hrs)

- A. Overall Maintenance
- B. ITE/ABB 5 HK Circuit Breaker

#### PM Break

- C. Square D Vacuum Circuit Breaker
- D. Electrical Testing

### Day 3 (7 contact hours)

#### VIII. Labs (7 hrs)

- A. MV Switch / MV Bus

#### AM Break

- A. MV Switch / MV Bus (cont'd)

#### Lunch

- B. MV Air Breaker Maintenance

#### PM Break

- B. MV Air Breaker Maintenance (cont'd)

### Day 4 (7 contact hours)

#### IX. Labs (7 hrs)

- A. MV Vacuum Breaker Maintenance

#### AM Break

- A. MV Vacuum Breaker Maintenance (cont'd)

#### Lunch

- B. Power Factor Testing Circuit Breakers

#### PM Break

- B. Power Factor Testing Circuit Breakers (cont'd)

### Day 5 (Half Day) (4 contact hours)

#### X. Conclusion (4 hrs)

- A. Review

#### AM Break

- B. Final exam

# STANDARD EQUIPMENT LIST

## Substation Maintenance I

## Certification Course

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REVISED Aug., 2018 (JJ)  
SME: Ray Pitts/Ralph Parrett  
COURSE 230, Rev 7, Aug., 2018  
4.5 DAYS

### **TEXT**

1 / STUDENT            *SUBSTATION MAINTENANCE I*  
                                 COURSE #230, Rev 7, Aug., 2018

**(\*CLIENT MUST PROVIDE WHEN COURSE IS OFFERED ONSITE)**

### **TEST EQUIPMENT**

1 / CLASS            VOLTAGE DETECTOR (MEDIUM VOLTAGE)  
2 / CLASS            MICRO-OHMMETER 100A MINIMUM (DLRO)  
1 / CLASS            MOM-2  
1 / CLASS            10 kV INSULATION RESISTANCE TESTER  
1 / CLASS            POWER FACTOR TEST SET (SUCH AS DELTA 2000)  
1 / CLASS            60/80 kV OVERPOTENTIAL TESTER AC OR DC (DC  
                                 PREFERRED)  
1 / CLASS            STATIC DISCHARGE STICK (60/80 kV TO MATCH  
                                 OVERPOTENTIAL TESTER)

### **PERSONAL PROTECTIVE EQUIPMENT**

\*1 / CLASS            SET OF GROUNDING CABLES (BALL TYPE DALLAS ONLY)  
\*2 / CLASS            TESTED, CLASS 4, GLOVES (SIZE 9, 10 & 11)  
\*1 / CLASS            INSULATED QUICK RELEASE GRIPALL STICK  
\*1 / STUDENT           SAFETY GLASSES

### **FIXED EQUIPMENT**

***ALL EQUIPMENT MUST BE DE-ENERGIZED FOR LAB EXERCISES***

\*1 / CLASS            5-15 kV VACUUM CIRCUIT BREAKER W/INSTRUCTION  
                                 MANUALS AND CONTROL PRINTS  
  
\*1 / CLASS            5-15 kV AIR CIRCUIT BREAKER W/INSTRUCTION MANUALS  
                                 AND CONTROL PRINTS

*ALL SPECIAL TOOLS ASSOCIATED WITH THE CIRCUIT BREAKERS: (LIFTING DEVICES, SPREADER BARS, CHARGING HANDLES, SLOW CLOSE OR SPRING CHOKING TOOLS, TRUCKING TOOLS AND RACKING TOOLS OR DEVICES)*

# STANDARD EQUIPMENT LIST

Substation Maintenance I

Certification Course

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## **OPTIONAL FIXED EQUIPMENT**

- \*1 / CLASS 5 - 15 kV OIL CIRCUIT BREAKER W/INSTRUCTION MANUALS
- \*1 / CLASS VACUUM BOTTLES (1 BROKEN, 1 GOOD)
- \*1 / CLASS LINE UP OF SWITCHGEAR (5 or 15 kV). IT SHOULD HAVE AT LEAST 3 CUBICLES WITH CIRCUIT BREAKERS AND SOURCE DISCONNECT SWITCH, PREFERABLY WITH CURRENT LIMITING FUSES.

## **TOOLS**

- 1 / STUDENT CALCULATOR
- 2 / CLASS TOOL BOX (SEE ATTACHED LIST)
- \*1 / CLASS DIAL CALIPER
- \*1 / CLASS 3/8 INCH DRIVE TORQUE WRENCH (20 OR 30 TO 200 in.lb.)
- \*1 / CLASS 1/2 INCH DRIVE TORQUE WRENCH (0-140 ft.lb.)

## **SUPPLIES**

- 1 / CLASS
- 2 / CLASS 1 BOX SCOTCHBRITE (GREEN GENERAL PURPOSE)
- \*1 / CLASS BOX OR PACKAGE LINT FREE SHOP TOWELS
- \*1 / CLASS 1 PT. DENATURED ALCOHOL
- \*1 / CLASS TUBE/CAN CONDUCTIVE LUBE (NO-OX-ID SPECIAL GRADE A)
- \*1 / CLASS TUBE/CAN NON-CONDUCTIVE LUBE (MOBIL 28 OR EQUIVALENT)