

# 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. Designed to supplement and support traditional course lecture, labs and hands-on instruction allow the technician to locate and troubleshoot components in substation systems, with additional focus 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 the course and labs, participants will demonstrate that they are 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).
- Utilize medium voltage circuit breaker and switchgear manufacturer 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. On-the-Job Safety
  - B. Electrical Hazards
  - C. Non-Electrical Hazards
  - D. Special Training
- AM Break
- III. Substation Overview (2 hrs)
  - A. Components of a Power System
  - B. Substation Switching 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. 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. Torque Requirements for Switchgear Assemblies
  - 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. Electrical Testing
  - B. Visual Inspections

#### PM Break

- C. Operation and Timing Tests
- D. Circuit Breaker Maintenance

### 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 (4 contact hours)

#### X. Conclusion (4 hrs)

- A. Review

#### AM Break

- B. Final exam



## STANDARD EQUIPMENT LIST

### Substation Maintenance I, Course 230 Rev 7

REVISED: 12/14/22

BY: IDA BARAYBAR

DAYS: 4.5 DAYS

NOTE: All items indicated with an asterisk (\*) must be supplied by the client on On-Site courses

#### TEXT ( PER 1 STUDENT)

| Issued ea | ITEM  |
|-----------|---|
| 1         | Substation Maintenance I course book, Course 230, Rev 7, Dec 2022 |

#### MATERIALS NEEDED (PER CLASSROOM)

| Issued ea | ITEM   |
|-----------|--|
| *1        | PROJECTOR OR TV WITH PROJECTION CAPABILITIES |
| *1        | DRY ERASE BOARD WITH MARKERS AND ERASER      |
| *10       | STUDENT TABLES                               |
| *10       | STUDENT CHAIRS                               |

#### CLASSROOM MATERIAL (PER STUDENT)

| Issued ea | ITEM                    |
|-----------|-------------------------|
| 1         | No. 2 MECHANICAL PENCIL |
| 1         | 12" CLEAR RULER         |
| 1         | CALCULATOR              |

#### TESTING EQUIPMENT (PER CLASS)

| Per class | ITEM   |
|-----------|--|
| 1         | Voltage detector (medium voltage)                            |
| 1         | Microohmmeter 100A minimum (DLRO)                            |
| 1         | MOM 2  |
| 1         | 10 kV insulation resistance tester                           |
| 1         | Power factor test set (such as Delta 2000)                   |
| 1         | 60/80 kv overpotential tester ac or dc (dc preferred)        |
| 1         | Static discharge stick (60/80 to match overpotential tester) |

**PERSONAL PROTECTIVE EQUIPMENT (PER STUDENT)**

| Issued ea  | ITEM  |
|------------|---|
| *2/CLASS   | TESTED, CLASS 4, GLOVES (SIZE 9, 10, and 11)    |
| *1/STUDENT | SAFETY GLASSES                                  |
| *1/CLASS   | SET OF GROUNDING CABLES (BALL TYPE DALLAS ONLY) |
| *1/CLASS   | INSULATED QUICK RELEASE GRIPALL STICK           |

**FIXED EQUIPMENT (PER CLASS)**

| Per class   | ITEM   |
|---|--|
| ALL EQUIPMENT MUST BE DEENERGIZED FOR LAB EXERCISES |  |
| *1  | 5-15 kV VACUUM CIRCUIT BREAKER W/INSTRUCTION MANUALS, CONTROL PRINTS |
| *1  | 5-15 kV AIR CIRCUIT BREAKER W/INSTRUCTION MANUALS, CONTROL PRINTS    |

All special tools associated with the circuit breakers, such as: lifting devices, spreader bards, charging handles, slow close or spring choking tools, trucking tools and racking tools

**OPTIONAL FIXED EQUIPMENT (PER CLASS)**

| Per class | ITEM  |
|-----------|---|
| *1        | 5-15 kV oil circuit breaker with instruction manual   |
| *1        | Vacuum bottles (1 broken, 1 good)   |
| *1        | Line up of switchgear (5 or 15 kv). Should have at least 3 cbicles with circuit breakers and source disconnect switch, preferably with current limiting fuses |

**TOOLS**

|           |  |
|-----------|--|
| *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)           |
| 1/STUDENT | Calculator   |
| 2/CLASS   | Tool box (see attached list)                         |