

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

Substation Maintenance I

4.5 Days, 3.2 CEUs

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 1**

REVISED 11/12/2022 BY: CORY MARCHANT COURSE NUMBER 230, REV 8, 4.5 DAYS

This list is based on a maximum class size of 10

TEXT (FOR 1 STUDENT)

SUBSTATION MAINTENANCE I COURSE #230, Rev 8, Dec 2022

MATERIALS NEEDED (PER CLASSROOM)

1	PROJECTOR OR TV WITH PROJECTION CAPABILITIES
1	DRY ERASE BOARD WITH MARKERS AND ERASERS
5	STUDENT TABLES
10	STUDENT CHAIRS

EQUIPMENT NEEDED FOR TRAINING (PER CLASS)

1	5-15kV AIR CIRCUIT BREAKER, WITH MANUAL
1	5-15kV VACUUM CIRCUIT BREAKER, WITH MANUAL
1	5-15kV OIL CIRCUIT BREAKER, WITH MANUAL
1	5-15kV METAL CLAD INTERRUPTER SWITCH, WITH MANUAL
25'	5-15kV MEDIUM VOLTAGE BUS GEAR, WITH MANUAL
1	5-15kV SWITCHGEAR LINEUP. MINIMUM OF 3 CUBICLES WITH CIRCUIT BREAKERS & DISCONNECT SWITCH. PREFERABLY WITH CURRENT LIMITING FUSES.

ALL ELECTRICAL EQUIPMENT USED FOR THE HANDS-ON MUST BE DE-ENERGIZED, ISOLATED AND GROUNDED FROM ASSOCIATED GEAR

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

TESTING EQUIPMENT (PER CLASS)

Issued ea ITEM

1	70/120kV DC HI-POTENTIAL TEST SET, MEGGER (WITH LEADS AND MANUAL)
1	5/10kV MEGOHM METER INSULATION RESISTANCE TESTER, MEGGER (WITH LEADS AND MANUAL)
1	10A DLRO (DIGITAL LOW RESISTANCE OHM METER), MEGGER (WITH LEADS AND MANUAL)
1	200A MOM2 (MICRO OHM METER 200), MEGGER (WITH LEADS AND MANUAL)
1	DELTA 4k SERIES POWER FACTOR TEST SET, MEGGER (WITH LEADS AND MANUAL)

PPE AND MATERIALS LIST (PER CLASS)

Issued ea ITEM

1	VOLTAGE DETECTOR (MEDIUM VOLTAGE)
1	70kV DISCHARGE STICK
1 SET	GROUNDING CABLES (<i>BALL TYPE, DALLAS ONLY</i>)
1 PAIR	CLASS 2 RUBBER INSULATED GLOVES WITH GAUNTLETS SIZE 10/11
1	INSULATED QUICK RELEASE GRIP ALL STICK (<i>DALLAS ONLY</i>)
1 PAIR	SAFETY GLASSES
1	VACUUM BOTTLES (1 BROKEN, 1 GOOD)
1	CALCULATOR
1	TOOL BOX
1	DIAL CALIPER
1	3/8" DRIVE TORQUE WRENCH (20 OR 30 TO 200 "LB)
1	1/2" DRIVE TORQUE WRENCH (0-140 FT LB)
1 BOX	SCOTCHBRITE (RED GENERAL PURPOSE)
1 BOX	LINT FREE SHOP TOWELS
1 PINT	DENATURED ALCOHOL
1 CAN	CONDUCTIVE LUBRICANT (NO-OX-ID SPECIAL GRADE-A)
1 TUBE	NON CONDUCTIVE LUBRICANT (MOBIL 28 OR EQUIVELANT)

TOOL BOX LIST (PER CLASS)

1	TOOL BAG/BOX
2	KLEIN MULTI TOOL SCREW DRIVER
1	8" CRESSENT WRENCH
1	8" ADJUSTABLE WRENCH
1 SET	STANDARD OPEN WRENCH
1 SET	METRIC OPEN WRENCH
1	25' TAPE MEASURE
1	6" PRECISION RULER
5	12" STRANDED ALUMINUM JUMPERS
1	RECHARGEABLE FLASHLIGHT