

Circuit Breaker Maintenance, Medium Voltage

3.5 Days, 2.5 CEUs

Unlike a low-voltage breakers, medium voltage breakers rated at 1 kV or higher, rely on external controls to operate effectively. That means technicians have more components to test and maintain to ensure a 3 to 5 cycle operating time. Failure of one of these breakers can cause catastrophic damage to other equipment and is extremely hazardous to nearby personnel. With safe and proper maintenance, technicians can ensure that tripping operations execute as required for equipment protection. In addition to improving electrical system reliability, well maintained circuit breakers also minimize the arc flash hazard energy levels that technicians can be exposed to during a fault.

This hands-on course is intended for new or experienced electricians and technicians that install, maintain, repair or troubleshoot air, vacuum, oil, and SF₆ metal-clad circuit breakers and switchgear, rated at 1 kV and higher. The student should have basic knowledge of AC/DC electricity.

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 2.5 CEUs, the participant must attend 3.5 days of class (25 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, the participants will demonstrate that they are able to:

- Identify components and insulation mediums for all circuit breakers (vacuum, air magnetic, oil, and SF₆).
- Evaluate breaker ratings for various applications.
- Interpret control schematics.
- Outline removal and restoration procedures.
- Practice circuit breaker maintenance service per manufacturers' and NETA MTS specifications.
- Perform and evaluate the results of all required tests during labs.
- Utilize appropriate personal protective equipment and safe work procedures including lockout/tagout.

SCOPE

Day 1* (7 contact hours)

- I. Introduction (0.5 hr)
 - A. Schedule
 - B. Course Outline
- II. Safety for Technicians (0.5 hr)
 - A. Lab Safety Rules
 - B. On-the-Job Safety

- III. Circuit Breaker Fundamentals (1 hr)
 - A. Circuit Breaker Standards
 - B. Circuit Breaker Ratings
 - C. The Interrupting Rating
 - D. MVA versus KA
 - E. Principles of Arc Interruption
 - F. Contacts
 - G. Insulation Requirements
 - H. Circuit Breaker Controls
 - I. Methods of Operation
 - J. Auxiliary Switches

AM BREAK

- IV. Maintenance and Testing Air-Magnetic Circuit Breakers (4 hours)
 - A. Maintenance and Testing Standards

LUNCH

- B. Specialty Tools
- C. General Maintenance
- D. Electrical Testing

PM BREAK

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

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SCOPE

- E. Labs
 - i. Visual and Mechanical Inspection
 - ii. Insulation Resistance
 - iii. Contact Resistance
 - iv. Dielectric Withstand

Day 2 (7 contact hours)

- V. Maintenance and Testing Vacuum Circuit Breakers (7 hours)
 - A. Maintenance and Testing Standards
 - B. Principles of Operation

AM BREAK

- C. General Maintenance
- D. Electrical Testing

LUNCH

- E. Lab
 - i. Visual and Mechanical Inspection
 - ii. Contact Erosion Test
 - iii. Contact Wipe
 - iv. Contact Resistance
 - v. Insulation Resistance

PM BREAK

- E. Lab
 - vi. Overpotential (Hipot) Test
 - vii. Vacuum Bottle Integrity Test

Day 3 (7 contact hours)

- VI. Oil Circuit Breaker Maintenance and Testing (7 hours)
 - A. Maintenance/Testing Standards
 - B. Inspections/Test Procedures

AM BREAK

- C. Oil Circuit Breaker Types
- D. Oil Circuit Breaker Construction
- E. Bushings
- F. Current Transformers

LUNCH

- G. Oil Circuit Breaker Maintenance
- H. Power Factor Testing of Oil Circuit Breakers

PM BREAK

- I. Lab
 - i. Tank Loss Index

Day 4 (Half Day) (4 contact hours)

- VII. Circuit Breaker Cell Maintenance and Control Circuitry (3 hours)
 - A. Switchgear Cell Configurations
 - B. Switchgear Maintenance

AM BREAK

- C. Maintenance Intervals
- D. Switchgear Cell Maintenance
- E. Circuit Breaker Control Circuitry

VIII. Conclusion (1 hour)

- A. Review
- B. Final Exam



STANDARD EQUIPMENT LIST
Circuit Breaker Maintenance, Medium Voltage
Course Number: 300 Rev 5

REVISED: October 2023

BY: Cory Marchant

DAYS: 3.5 DAYS

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

TEXT (PER 1 STUDENT)	
QUANTITY	ITEM
1	CIRCUIT BREAKER MAINTENANCE, MEDIUM VOLTAGE, REV 5, OCTOBER 2023

EQUIPMENT (PER STUDENT)	
QUANTITY	ITEM
1	SCIENTIFIC CALCULATOR

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 CLASS)	
QUANTITY	ITEM
1	VOLTAGE DETECTOR (MEDIUM VOLTAGE)
1	MICRO-OHMMETER 100A MINIMUM (DLRO) OR MOM-2
1	10kV INSULATION RESISTANCE TESTER
1	MEGGER EGIL "BREAKER ANALYZER" (WITHOUT TRANSDUCER)
1	POWER FACTOR TEST SET (SUCH AS DELTA 4000)
1	60/80 kV OVERPOTENTIAL TESTER AC OR DC
1	STATIC DISCHARGE STICK (60/80 kV MATCH OVERPOTENTIAL TESTER)

PERSONAL PROTECTIVE EQUIPMENT (PER CLASS)	
QUANTITY	ITEM
*1	SET OF GROUNDING CABLES (BALL TYPE DALLAS ONLY)
*2	TESTED, CLASS 4, GLOVES (SIZE 9 & 11)
*1	INSULATED QUICK RELEASE GRIPALL STICK

PERSONAL PROTECTIVE EQUIPMENT (PER STUDENT)	
QUANTITY	ITEM
*1	SAFETY GLASSES

FIXED EQUIPMENT (PER CLASS)	
QUANTITY	ITEM
*1	5-15 kV VACUUM CIRCUIT BREAKER W/INSTRUCTION MANUALS AND CONTROL PRINTS
*1	5-15 kV AIR CIRCUIT BREAKER W/INSTRUCTION MANUALS AND CONTROL PRINTS
*1	5-15kV SWITCHGEAR LINEUP

*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)

TOOLS (PER CLASS)	
QUANTITY	ITEM
1	STANDARD SAE TOOL BOX
1	MANUFACTURER'S ASSOCIATED TOOLS
1	PRINTS AND INSTRUCTION MANUAL FOR BREAKERS

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