

# Substation Maintenance II

4.5 Days, 3.2 CEUs

This course is the next step after Substation I, which will help enhance the skills needed to perform all substation tasks. It offers training on the components of power and distribution type transformers, including common insulating and cooling mediums, and explains common transformer configurations.

This course is designed to provide an in-depth study to aid skilled qualified substation maintenance technicians in the safe performance of substation component preventive maintenance. This hands-on course is intended for apprentices, technicians and engineers 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 participants will demonstrate that they are able to:

- Obtain required information from a transformer nameplate.
- Perform needed inspections per NETA/MTS 2019.
- Demonstrate and interpret results of required tests performed on transformers.
- Calculate temperature corrections.
- Summarize ASTM requirements for testing and sampling gas and oil in transformers.
- Outline storage battery maintenance.

## SCOPE

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

- I. Introduction (0.5 hr)
- II. Introduction to Safety (2.5 hr)
  - A. Lab Safety Rules
  - B. On-the-Job Safety
  - C. General Safety Precautions

- III. Nameplate Data (4 hrs)
  - A. Transformer Nameplate

#### Labs (3 hrs)

- A. Nameplate Data Exercises

### Day 2 (7 contact hours)

- IV. Transformer DC Testing (3 hrs)
  - A. DC Testing
  - B. Insulation Resistance
  - C. Winding Resistance Testing

### Labs (4hrs)

- A. Transformer Insulation Resistance
- B. Transformer Winding Resistance Testing (single coil)
- C. Dual Coil Winding Resistance Test (optional)
- D. Core Ground Testing (optional)

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

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## SCOPE (cont'd)

### Day 3 (7 contact hours)

- V. Transformer AC Testing (3 hrs)
  - A. AC Testing
  - B. Power Factor Testing
  - C. Transformer Bushing Test
  - D. Core Excitation Current Testing

#### E. Turns Ratio Testing

#### **Labs (4 hrs)**

- A. Transformer Turns Ratio Testing
- B. Transformer Power Factor Testing
- C. Transformer Core Excitation Testing
- D. Bushing Testing
- E. Single Phase Turn Ratio Testing (optional)
- F. CT Multi-Tap Testing

### Day 4 (7 contact hours)

- VI. Transformer Oil Testing (2 hrs)
  - A. Insulating Liquids
  - B. Liquid Sampling
  - C. Sampling for Gas-In-Oil Analysis
  - D. Silicone Insulating Fluid
  - E. Dielectric Breakdown Voltage Test
  - F. Color Testing

- G. Visual Examination
- H. Neutralization Number Test
- I. Interfacial Tension Test
- J. Moisture Content Test
- K. Liquid Insulating Power Factor Testing

#### **Labs (optional)**

- A. Liquid Insulating Power Factor Testing (optional)
- B. Oil Dielectric Testing (optional)

### VII. Transformer Gas Testing (2 hrs)

- A. Gas Detection
- B. Oxygen Testing
- C. Combustible Gas Testing
- D. Gas Analysis Interpretation

### VIII. Storage Battery Maintenance (3 hrs)

- A. Systems and Components
- B. Applications
- C. Battery Types
- D. Battery In-Service Operation
- E. Effects of Temperature and Duty Cycle on Battery Life
- F. Battery Safety
- G. Battery Inspections

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

- IX. Conclusion
  - A. Review
  - B. Final Test

# EQUIPMENT LIST

## SUBSTATION MAINTENANCE II

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REVISED: March 2021 BY: I. Baraybar  
COURSE #231, Rev 5  
4.5 days

### TEXT

1 / STUDENT Course book - SUBSTATION MAINTENANCE II, Course 231, Rev 5,  
March 2021

(\*Client must provide when course is offered onsite)

### EQUIPMENT

1 / CLASS 10 kV INSULATION RESISTANCE TESTER  
1 / CLASS POWER FACTOR TEST SET (DELTA 4000)  
1 / CLASS TRANSFORMER TURNS RATIO TESTER (TTR)  
1 / CLASS SINGLE PHASE TRANSFORMER TURNS RATIO TESTER (TTR)  
1 / CLASS TRANSFORMER OHMMETER  
1 / CLASS VOLTAGE DETECTOR (MEDIUM VOLTAGE)  
1 / CLASS STATIC DISCHARGE STICK (60/80 kV)  
1 / 2 STUDENTS 670511 OIL TEST CELL  
1 / 2 STUDENTS RUBBER BLANKET  
1 / CLASS MEGGER MRCT TESTER

### PERSONAL PROTECTIVE EQUIPMENT

\*2 / CLASS TESTED CLASS 2, GLOVES (SIZE 9, 10 & 11)  
\*1 / STUDENT SAFETY GLASSES

### FIXED EQUIPMENT

\*1 / CLASS THREE PHASE 500 kVA (MINIMUM) LIQUID FILLED  
TRANSFORMER (PREFER TAPPED PRIMARY AND  
SECONDARY) AND INSTRUCTION MANUAL  
\*2 / CLASS CONDENSER BUSHINGS

### TOOLS

2 / CLASS TOOL BOX WITH HAND TOOLS  
1 / STUDENT SCIENTIFIC CALCULATOR

### SUPPLIES

1 / CLASS PACKAGE OF LINT FREE TOWELS  
1 / CLASS PACKAGE OF RED SCOTCH BRITE