



## TECHNICAL ENGINEERING COURSES

Grounding of Distribution Systems

Power Quality Assessment

Distributed Generation

And More...

### Grounding of Distribution Systems

#### Introduction

Grounding of power systems and equipment is a subject of major impact on system performance, integrity of its equipment, safety of personnel as well as safety of the public at large. It acquires special relevance for distribution systems where grounding directly affects the reliability of supply to the customer, survivability of end-use equipment and safety of individuals.

Two distinct equipment-grounding systems are involved: power grounding and safety grounding. More often than not, the functions of these two types of grounding are confused. While the power grounding is concerned with operating the system as effectively grounded, impedance grounded or isolated neutral; safety grounding is concerned with design of equipment grounding grids to minimize risk of injury to individuals during system disturbances.

Power grounding directly affects system insulation levels, protection systems as well as system operability and outage rates. Safety grounding, as the name implies, is concerned with human safety, which is a major concern of prime importance to system operators as well as to the general population. The two functions are interlinked and are of extreme importance for individuals working with design and operation of power systems, in particular distribution systems.

#### What you will learn

- Grounding definitions as well as grounding codes and standards.
- The difference between safety grounding and power grounding.
- The importance of safety grounding procedures, of distribution networks, to the public and employees' safety.
- The importance of power grounding procedures to the sound operation of protective schemes.
- Substation Grounding.
- Measuring techniques.

#### Audience

- Utility and consulting engineers working on planning and designing electrical power transmission and distribution systems.
- Utility engineers working on planning, operating and maintenance of distribution systems.
- Engineers, and personnel involved in designing and operation of distribution systems' protection with responsibility for system security and individuals' safety.

#### Course Language:

English

#### Duration:

2 days

#### Instructor:

Dr. Magdy M.A. Salama

#### CYME Technical Engineering Courses Program Director:

Dr. Atef S. Morched

#### Further Information:

[info@cyme.com](mailto:info@cyme.com)

## Course Outline

### Day 1

- **Definitions and Code**
  - The National Electric Code ANSI / NFPA 70-1987
  - The National Electric Code, Article 110-10 ANSI / NFPA 70-1981
  - The Static Electricity ANSI / NFPA 77-1977
  - Guide for AC Substation Grounding ANSI / IEEE Std. 80-2000
  - Recommended Practice for Grounding of Industrial and Commercial Power Systems. IEEE Std. 142-1991
  - IEC-479-1
- **Basic Concepts**
  - The need for grounding
  - Grounding and earth
  - The purpose of grounding systems
  - Definition of grounding
  - Human body reaction to electricity
  - Accidental electrocution circuit parameters
  - Acceptable safety limits
- **Grounding Systems**
  - Equipment grounding
  - System grounding
  - Solidly grounded system
  - Impedance grounded system
  - Ungrounded system
  - Grounding consumer's system
  - Grounding medium voltage system
  - Grounding high voltage system
- **Soil Characteristics**
  - Resistivity of soil
  - Effect of moisture content on the soil resistivity
  - Effect of ambient temperature on the soil resistivity
  - Soil resistivity measurements
  - The two-layer soil model
- **Grounding Electrode**
  - Establishing an earth ground
  - The earth electrode
  - Electrode resistance
  - Grounding interface
  - Ground electrode resistance measurements
  - Multiplying factors for multiple rods
  - Formulas of resistance to ground
  - The factors affecting electrode resistance

### Day 2

- **Bonding Ground-system Elements**
  - Specifications of good bonding
  - Grounding conductors
  - Mechanical bonding
  - Welding connections: Exothermic bonding (Cadwelded)
  - Hydraulic press connections
- **Step Voltage and Touch Voltage**
  - Definition of step voltage
  - The approximate electric circuit for step voltage
  - Calculation of step voltage
  - Definition of touch voltage
  - The approximate electric circuit for touch voltage
  - Calculation of touch voltage
  - Calculation of ground electrodes' number
  - Calculation of ground conductors' size
- **Substation Grounding Definitions**
  - Purpose of substation grounding
  - Ground potential rise (GPR)
  - Step and touch voltages
  - Mesh voltage
  - Transferred voltage
  - Shock voltages
- **Substation Grounding Systems**
  - Ground electrode design
  - Mesh bed design
  - Substation ground mat design
- **Substation Grounding System Design**
  - Equivalent circuit for step voltage
  - Equivalent circuit for touch voltage
  - Calculation of step voltage circuit parameters
  - Step and touch voltage criteria
  - Permissible human body current
  - Calculation of grid current
  - Design procedure of substation grounding system

## Instructor



**Magdy M.A. Salama** holds a Ph.D. in Electrical Engineering since 1977. He is currently a University Research Chair Professor in the Electrical and Computer Engineering Department at the University of Waterloo. Dr. Salama's taught several courses on distribution systems engineering: design, performance and protection and has acted as an adviser, in these areas, to government agencies, electric utilities and electrical industry in Canada, USA, Europe and the Middle East. Dr. Salama is a registered professional engineer in the Province of Ontario and was awarded an IEEE Fellowship "For Contributions to the Advancement of Distribution System Performance".



### Canada & International

1485 Roberval, Suite 104  
St-Bruno, QC Canada J3V 3P8  
Tel. (450) 461-3655  
Fax (450) 461-0966

### U.S.A.

67, South Bedford St. Suite 201 East  
Burlington, Ma 01803-5177 USA  
Tel (781) 229-0269  
Fax (781) 229-2336

### U.S.A. & Canada

1-800-361-3627  
www.cyme.com  
info@cyme.com