



Content  
Community  
Connection

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## **5-Day (30 Hours) Electrical Grounding Training - Industrial Power Systems, HV Applications, Grounding and Bonding for Telecommunications Networks**

Course details: <https://www.electricityforum.com/electrical-training/5-day-electrical-grounding-training>

This 5-Day Live online instructor-led Electrical Grounding suite of courses encompasses three of our leading grounding and bonding courses:

[Grounding and Bonding Training](#) - \$399

[High Voltage Electrical Grounding](#) - \$399

[Tower Grounding Training For Telecom Applications](#) - \$249

Package Price: All 3 courses in one week: \$899 (with \$100 discount coupon)

Our 2-Day basic Industrial Grounding and Bonding course is founded on the Electrical Code and is designed to give students the correct information they need to design, install and maintain effective electrical grounding systems in industrial, commercial and institutional

power systems.

Our 1-Day High Voltage Grounding course will provide the basic principles of grounding a power supply network to ensure safety of personnel and equipment. Understanding these principles will provide the correct tools to design a grounding system applicable to utility networks and industrial plant distribution. This course covers the basic procedures in working safely on medium and high voltage systems.

Our 2-Day Telecommunications Grounding course will define and completely explain grounding and bonding for telecommunications systems. It will provide information for the installation of a grounding and bonding system for communications infrastructure. This live online instructor-led course will provide the participants with a good understanding of the principles of lightning protection and grounding of telecommunications facilities, such as self-supporting radio towers, guyed masts, monopoles and rooftop antenna mounting frames and structures and how techniques are applied in the field to protect these structures and the associated equipment, staff and the general public.

### **INCREASE YOUR GROUNDING KNOWLEDGE**

- Focus on specific electrical grounding and bonding problems and consequences relating to fires, safety of personnel, and damage to equipment
- Participate in a discussion of electrical grounding and bonding problems and how to overcome or avoid them
- Gain a firm foundation of knowledge for your next project involving electrical grounding and bonding
- Develop your knowledge of theory and practice

### **LEARN ABOUT**

- Specific grounding problems, installations and CEC requirements
- Testing procedures for industrial, commercial and institutional electric power grounding systems
- Practical solutions to grounding problems

## YOU WILL LEARN

- Work more safely and efficiently
- Have a better understanding of electrical grounding requirements under the CEC.
- Make fewer installation mistakes and pass inspections more easily
- Be more aware of the benefits of good grounding and bonding systems
- Be better prepared to design your next grounding and bonding system

## WHO SHOULD ATTEND

- Utility And Industrial Electrical Engineers And Engineering Technicians
- Project Engineers
- Design Engineers
- Field Technicians
- Electrical Technicians
- Electricians
- Plant Operators
- Plant Engineers
- Electrical Supervisors

## STUDENTS RECEIVE

- 100-Page Digital Electrical Grounding Handbook - Value \$20 (details below)
- 1.4 Continuing Education Unit (CEU) Credits
- A **FREE** Magazine Subscription (Value \$25)
- **\$100** Coupon toward any future Electricity Forum event (restrictions apply)
- Course Presentations in Paper Format

## **COURSE OUTLINE**

### **5-Day (30 Hours) Electrical Grounding Week Program Outline**

#### **Course Instructor:**

*Pablo Diaz, Electricity Forum Lightning Protection and Electrical Grounding Consultant*

## **DAY ONE**

### **Course #1: Industrial Electrical Grounding and Bonding Training Program**

#### **Session 1: Electrical Grounding Overview**

- Scope / Introduction
- Grounding Definitions
- Why Electrical Grounding
- Grounding Concepts
- Major Cause Of Trouble In An Electrical Distribution System
- Faults In The Electrical System
- Codes/Handbooks & Industry Standards
- CEC & NEC Object, Scope And Definitions
- IEEE Grounding Standards, Guidelines & Recommendations
- Grounding Subsystems

#### **Session 2: Grounding Electrode System**

- Earth Grounding Subsystems
- Soil Resistance, Resistance-To-Ground And Soil Resistivity
- Grounding Concept Frequency Limitations

- Grounding Electrodes- CEC 10-700
- Manufactured Grounding Electrodes
- In-Situ Grounding Electrodes
- Pipe Grounds, Metallic Water Lines & Steel Piling
- Primary & Secondary Facility's Grounding Systems
- Grounding Electrode Connections
- Empirical, Practical Formulas Of Grounding Electrodes
- Ground Rods, Accessories And Applications
- Other Electrodes: Conductor Encased In Concrete, Conductive Cement
- Resistance-To-Ground Components
- Voltage & Current Distribution In The Soil
- Grounding Connections & Connectors (Mechanical, Compression, Exothermic)
- Grounding Conductor's Material, Size
- Ground Resistance/Resistivity Testers – 3 & 4 Pole Earth Ground Measurements

### **Session 3: System and Circuit Grounding**

- Electrical Grounding Methods
- Grounding Of Alternating Current Systems
- Single-Phase, 3 Wire Solidly Grounded System
- 3-Phase, 4 Wire Solidly Grounded System (Mid-Point Grounded)
- 3-Phase, 4 Wire, Solidly Grounded System, WYE Configuration
- 3-Phase, 4 Wire, Solidly Grounded System With No-Neutral Load
- Grounding Connections For Equipment In Ungrounded Systems
- Ground Faults / Ground Faults Main Consequences
- Floating Systems
- Grounding Connections For Two Or More Buildings Supply From A Single Service
- Two Ground Faults On Different Lines On A 3-Phase Ungrounded Delta
- Simplified Electrical Distribution System Typical Of Commercial & Industrial Facilities

### **Session 4: Resistance Grounding**

- Resistance Grounding, Low & High Resistance (HRG)

- High Resistance Grounding Considerations
- High Resistance Of Medium Voltage Systems
- HRG Benefits
- HRG Current Sensing Alarm Relays
- HRG, Advantages & Disadvantages
- HRG Fault Location Tracking
- HRG Design Considerations. System Charging
- Zero Sequence Current Transformer
- Zero Sequence Charging Current
- CEC 10-1108 Conductors Used With Neutral Grounding Devices

### **Session 5: Grounding of Generator to Supply Emergency Power**

- Grounding Emergency Supply Systems (Generators & Motors)
- Objectives
- Sources Of Power Supply
- Isolation Transformer Grounding
- Emergency Supply Grounding, 3 And 4 Pole ATS Systems
- Power From Two Sources With Neutral Grounded In One Location
- Multiple Emergency Power Supplies Grounding
- UPS Grounding For Various Configurations
- Generators, Generator Disconnects Emergency Loads & Other Loads
- Grounding A Portable Generator

## **DAY TWO**

### **Session 6: Bonding**

- Objective, Rule 10-002 Bonding & Grounding
- Bonding Conductor- Bonding Jumpers
- Bonding Conductor Sizing- Table 16A & 16 B
- Types Of Bonding
- Means Ensuring Continuity At Service Equipment

- Interlocking Armor Of MC Cable/CSA Tech 90 Cable
- Color Of Bonding Conductor
- Electrical Shock/Severity Of An Electrical Shock
- Touch & Step Potential
- Grounding/Bonding Myths & Fatal Consequences
- Personal Protective Equipment
- Ground Fault Circuit Interrupter (GFCI)
- Bonding Indoor Metal Piping Systems
- Effective Grounding- Code Requirement
- Effective Grounding Fault Current Path- Diagram
- Star Point Grounding- Petrochemical Industry
- Industrial Automation Wiring, Bonding & Grounding
- Grounding & Bonding AC Power Distribution System With Master Control Relay
- Bonding To Racks/Cabinets In The Telecommunications Industry

### **Session 7: Renewable- Solar Photovoltaic Systems (PV) and Wind Power System**

- Renewable Energy Systems
- System Grounding- Section 50
- Ungrounded Solar PV Systems
- Equipment Grounding In DC-Only Systems
- Grounding Options, New Bonding Conductor From Inverter
- Grounding In A Grid-Tied PV System
- PV Array/AC Service Equipment/Generator/Inverter/Battery System
- Charge Controllers/ DC Subpanels
- PV Arrangement/PV Inverter & Service Equipment Grounding Electrode System
- Renewable Energy Source/ DC Disconnect/Inverter/Utility Disconnect

### **Session 8: Grounding Computer Rooms/SCADA Systems**

- Objectives
- Isolated Grounding Subsystem- Rule 10-904
- Isolated Bonding Conductors Serving A Receptacle
- Isolated Grounds With & Without Metallic Conduits

- Signal Reference High Frequency Subsystems
- Signal Reference Grounding Systems For ADP High Frequency Equipment
- Design & Installation Of A Signal Reference Grid
- SRG For Sensitive Electronic Equipment Grounding
- Power Supply Installation & Placement For ADP/Computer Room Power Center
- Equipment Mesh/Mats For SRG Systems
- Cable Management

### **Session 9: Electro Magnetic Interference (EMI) on Electronic Circuits**

- Susceptibility Of Components & Electronic Circuits
- Shielding/By Absorption & Reflection
- Considerations For Utilizing Shields
- Data Processing Systems Protection
- Grounding Connections/Twin Axial & Coax Cable
- Shielding Of Shielded Cables
- Grounding For Differential Amplifiers
- Proper Bonding & Grounding For PLC Applications
- PLC Enclosure Grounding
- Grounding Systems For Programmable Controllers
- Grounding For Better Communications (Less Noise) With PLC
- Formation Of Ground Loops/Multiple Loops In Instrumentation Grounding
- Multiple Circuits Common Grounds
- Grounding Of Shielded Standard Cable & Cables Equipped With Inner Shields
- Typical Single Point Ground Network For A Control System
- Recommended Process Automation Grounding Scheme (Typical CCR Or PIB)
- How Not-To-Ground (IACS/DCS/PLC)

### **Session 10: Lightning Protection**

- Lightning Data/Isoceraunic Maps
- Lightning Protection Subsystem Diagram- Rule 10-706/CAN/CSA-B72
- Types Of Air Terminals



- Cable Supports, Bolted Connectors, Compression Lugs, Ground Bars, Conductors, Grounding Electrodes.
- Spacing & Interconnecting Grounding Electrodes
- Installation & Grounding Of Lightning Arresters/Surge Protection Devices (SPDs)
- Conventional Lightning Protection Systems Hardware
- Rule 10-706, NFPA 780, UL 96A, LPI 175, CAN/CSA-B72-M87, CEC 10-702 Requirements
- Metallic & Non-Metallic Tank's Lightning Protection
- Substation Shielding Design Methods
- Single Mast Or Shield Wire, Two-Masts & Principle Of The Rolling Sphere
- Telecommunications Lightning Protection System

## **DAY THREE**

### **Course #2: High Voltage Electrical Grounding and Bonding For Utility and Industrial Applications**

#### **OVERVIEW**

- Basics Of High-Voltage Grounding
- Electrical Bonding Of High Voltage Systems
- Proper Sizing Of Conductors
- Grounding Of Substations
- High-Voltage Surge Protection
- Electrical Grounding For Lightning Protection

#### **SUBSTATION GROUNDING DESIGN**

#### **SESSION 1: DEFINITIONS AND INTERPRETATIONS**

- Determination Of Need Of Personal Protective Grounding
- Basic Criteria For Safe Grounding Practices
- Electric Shock Hazard
- Grounding Practices
- Basic Design Options
- Soil Resistivity
- Ground Fault Currents
- Fault Clearing Time

## **SESSION 2: GROUNDING OPTIONS**

- Ground Cable Assemblies
- Grounding Cable Ampacities
- Grounding Cable Reactance
- Parallel Grounds
- Grounding Clamps
- Grounding Insulated Power Cable
- Ground Potential Rise (GPR) In Medium- And High-Voltage Systems

## **SESSION 3: GROUND GRID DESIGN FOR SUBSTATIONS**

- Determination Of Maximum Available Fault Current
- Exposure Voltage Calculations For Plants & Switchyards
- Touch And Step Potential
- Transferred Potential
- Elimination Of Step And Touch Potential
- Selection Of The Right Connector
- Horizontal Grid Design IEEE STD 80
- Introduction To 2-Layer Soil Model
- Vertical Rods Connected By A Grid
- Temporary Grounding

#### **SESSION 4: SWITCHYARD AND SUBSTATION PROTECTIVE GROUNDING**

- General Considerations For Placement Of Protective Grounds
- Power Circuit Breakers And Transformers
- Disconnect Switches And Bus
- Insulated High Voltage Cable
- Cable Terminations
- Midsections And Splices
- Grounding Transformers And Phase Reactors
- Capacitor Banks

#### **SESSION 5: POWER LINE PROTECTIVE GROUNDING**

- Grounding Of Metal Transmission Structures
- Slip Joints
- Steel Pole Structures
- Overhead Ground Wires
- Structure Footing Ground
- Grounding On Wood Pole Transmission Structures
- Transmission Line Terminal Ground Switches
- Grounding On Distribution Lines
- Surface Equipment And Vehicle Grounding

#### **SESSION 6: TECHNICAL CONSIDERATIONS IN PROTECTIVE GROUNDING IN SUBSTATIONS AND SWITCHYARDS**

- Substation Grounding System
- Typical Shock Situations - Conditions Of Danger
- Structure Touch
- Electric Circuit For Switch Operator Sources Of Hazardous Current On De-Energized Equipment
- Grounding And Jumpering Requirements

- IEE Std 80

## **INTERNATIONAL AND LOCAL REGULATIONS**

- CSA
- IEEE 80, IEEE Guide For Safety In AC Substation Grounding
- ASTM F 855 Standard Specifications For Temporary Protective Grounds
- IEEE 1246, IEEE Guide For Temporary Protective Grounding Systems Used In Substations
- IEEE 1048, IEEE Guide For Protective Grounding Of Power Lines

## **DAY FOUR**

### **Course #3: Electrical Grounding and Bonding For Telecommunications Networks**

#### **OVERVIEW**

- Grounding Concepts For The Telecommunications Industry
- How The Telecommunications Industry Developed The Concept Of "Single Point Ground" System
- Utilization Of Banks Of Batteries And Their Grounding In A Telecommunication Site
- How To Ground Telecommunications Towers.
- How To Ground Equipment And Communications Antennas Installed On A Communications Tower
- Proper Ground Resistance Values Required By The Telecommunications Industry
- The Most Common Grounding Electrodes Utilized In A Telecommunications Site
- Proper Grounding And Bonding Of Equipment Installed In A Telecommunications Rack.
- The "Master Ground Bar' And Other Auxiliary Copper Bars Used In The Telecommunications Industry And Their Proper Grounding.
- Review Of Four Case Histories Performed In Cellular And Digital Microwave Sites

## **SESSION 1: TELECOMMUNICATIONS GROUNDING OVERVIEW**

- Grounding- Definitions
- Grounding Methods Used In The Telecommunications Industry
- Grounding Practices For Cellular And Digital Microwave Sites
- System Grounding For Transformers Used In A Communications Site
- Telecommunications Single Point Grounding
- Why The Telecommunications Industry Uses A Solid Grounding System
- Impedance Grounding For A Telecommunication Tower
- Why Ground Circuits And Systems
- Grounding Systems Options For A Telecommunications Site
- Grounded Systems
- The Telecommunications Industry TIA/EIA Cabling Grounding

## **SESSION 2: GROUNDING ELECTRODE SYSTEM**

- Grounding Electrodes: Construction And Installation
- Ground Resistance And Resistivity
- Grounding Electrode Conductor
- Electrical Grounding And Corrosion
- Materials-Splicing
- Installation And Protection
- Sizing The Grounding Electrode Conductor

## **SESSION 3: SYSTEM GROUNDING**

- Circuit Grounding
- Why Systems And Circuits Are Grounded
- Grounded Conductor
- Direct Current Systems

- Alternating-Current System
- Systems Less Than 50 Volts
- Grounding Of Transformers
- Grounding For Telecommunications Site

#### **SESSION 4: TOWER INSTALLATIONS**

- Self-Supporting Tower Installations
- Bonding The Tower Ground To The Central Office Ground
- Pole Mounted Antennas
- Antenna Towers Mounted On Top Of Buildings
- Antennas And Connecting Coaxial Transmission Lines And Waveguides
- Protection Of Radio Equipment
- Guyed Tower Installation
- Pole Mounted Installation
- Building Mounted Installation

#### **SESSION 5: TELECOMMUNICATIONS ELECTRICAL BONDING SYSTEM**

- Equipment Bonding And Grounding
- Rack Bonding
- Major Requirements: Leakage Current, Proper Sizing
- Generators
- Transformers
- UPS Systems: Online, Standby, Line Interactive, Alternative
- Installation
- Sizing The Equipment Grounding
- Identification Of The Equipment Grounding Conductor
- Electric Shock
- Grounding And Electric Shock

## **SESSION 6: TELECOMMUNICATIONS STAND-BY/EMERGENCY GENERATORS**

- Separately Derived Systems (SDS)
- When An Emergency Generator Is Not A SDS
- Main Bonding Jumper
- Portable Generators
- Vehicle Mounted Generators

## **DAY FIVE**

## **SESSION 7: LIGHTNING PROTECTION SYSTEM FOR A TELECOMMUNICATIONS SITE**

- The Phenomenon Of Lightning
- Development Of Lightning Flash
- Flash Parameters
- Lightning- Characteristics
- Electrical Effects
- Basic Protection Requirements
- Protection Systems
- Electro-Geometric Method
- Tower Lightning Protection System
- Rolling Sphere Concept
- Lightning Protection System Specifications

## **SESSION 8: TELECOMMUNICATIONS INDUSTRY GROUNDING PRACTICES**

- Telecommunication Site Grounding
- Single Point Ground System

- Grounding Subsystems
- Exterior Ground Ring
- Exterior Structural Metal Elements
- Interior Ground Ring- Halo Ground
- Master Ground Bar
- Cable Entrance Ground Bar
- Telecommunications Closets
- Cable Trays Or Raceways
- Low Frequency Networks
- High Frequency Networks
- Waveguides Grounding
- Racks, Cabinets And Enclosures
- Central Office Battery System

## **SESSION 9: GROUNDING AGAINST ELECTROMAGNETIC INTERFERENCE (EMI/ESD/RFI)**

- Electronic Equipment Grounding
- Introduction And Definitions
- Telecommunication Rooms And Closets
- Data Processing Equipment Grounding
- Electronic Security Equipment Grounding
- EMI (Electromagnetic Interference)
- Inductive, Capacitive And Radiation Coupling
- RFI (Radio Frequency Interference)
- Electrostatic Discharge
- Shields Grounding
- Cable Shielding And Grounding
- Coaxial Cables
- Telephone Lines

## **SESSION 10: TELECOMMUNICATIONS EQUIPMENT PROTECTION**



- System Reference Zero
- Detection Of A Faulty Neutral-Ground System
- Sizing Wiring To Meet Computer Industry Standards
- Grounding Line Treatment Devices
- Transient Overvoltage Protector Grounding
- Gas Tubes
- Metal Oxide Varistors
- Silicon Avalanche Diodes
- Data Lines Grounding- RS232

**CASE HISTORIES 4 case histories included: Four Telecommunications Case Histories will be reviewed and analyzed.**

#### **STANDARDS AND CODES REFERNCES FOR THIS COURSE**

- National Electrical Code/IEEE Standards/ANSI Stds, Industry STDS
- Canadian Standards Association:
- CSA Grounding And Bonding (C22.1 E98, Section 10)
- CSA Protection And Control (C22.1 E98, Section 14)
- CSA Installation Of Electrical Equipment (C22.1 E98, Section 26)
- CSA Electrical Communication Equipment (C22.1 E98, Section 60)
- Canadian Electrical Code:
- Bonding And Grounding Of Electrical Equipment (C22.2 No. 0.4 EM1982 R1993)
- Grounding And Bonding Equipment (C22.2 No. 41 EM1987 R1993) (C22.2 No. 0.4 EM1982 R1993)
- NEC National Electrical Code

#### **REFERENCES**

- Communications:
- TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard

- TIA/EIA - 607: Commercial Building Grounding And Bonding Requirements For Telecommunications
- ISO/IEC IS 11801: Generic Cabling For Customer Premises
- BICSI: BICSI Telecommunications Cabling Installation Manual
- BICSI: BICSI Customer-Owned Outside Plant Design Manual (CO-OSP)

**Review of expectations  
Questions and Answers**

**COURSE TIMETABLE**

**All days:**

Start: 8:00 a.m.

Coffee Break: 10:00 a.m.

Lunch: 12:00 noon (included with course)

Restart: 1:15 p.m.

Finish: 4:30 p.m.

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