CPD INTERNATIONAL

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Fundamentals of Earthing for Power Systems

Who Should Attend?

Technical personnel who are involved in the design, installation, operation and maintenance of earthing systems for electricity networks, such as

- *Electrical power system engineers, managers and technical officers*
- *Power System Planners and Designers*
- *Power System Consultants and Contractors*
- *Construction and Project Managers*
- *Power System O&M Engineers*
- *Others who want a solid preparation in earthing design*

Fundamentals of

Earthing for Power Systems

Overview

This two-day seminar provides attendees with the fundamental concepts and practical aspects associated with electrical earthing for power systems, in particular power generating stations, substations, overhead lines and parts of industrial, commercial, institutional and mining facilities. Hence, the emphasis of the course is on the main principles for high voltage system earthing (1000 V AC and higher). The course not only covers the key concepts and principles in this domain, but also makes constant reference to applicable national and international standards and codes. The key topics of personnel safety and substation earthing system design form a major focus of the course. Attendees will be exposed to numerous examples and case studies, which will be investigated via tutorial questions and demonstrations with sophisticated software packages.

The seminar provides attendees with an introductory-to-intermediate level of understanding of earthing fundamentals. Amongst other things, course attendees will learn:

- The function of power system earthing and the various options available;
- The role of protective earthing in ensuring safety;
- How to measure soil resistivity, design earthing systems and measure earthing system resistance;
- The fundamental principles in the design of earthing systems for substations;
- The role of earthing in protecting power systems from lightning hazards; and
- How to apply a holistic, risk-based approach to earthing.

Why Should You Attend?

Earthing has often been, and still is, portrayed as a "difficult subject" and a "black art". The main goal of this seminar is to demonstrate to attendees that this is not the case, i.e., to go back to fundamentals and to systematically demystify the subject. Attendees will leave the course with a sound knowledge of the subject matter, fully equipped with the necessary understanding to deal with earthing issues in their own workplaces.

Effective earthing ensures that earth faults associated with the power system are detected so that the earth fault protection devices are effectively operated to disconnect the supply. When a fault causes current to flow to earth, the earthing system should also ensure that the voltage of conducting parts that may be touched by a person is not hazardous. Such voltages can occur within power system stations and on metallic structures along the length of, or close to power lines, under earth fault current conditions.

Hence, earthing systems must ensure *personnel safety* as well as the *safety of the general public*. With the introduction of the new Work Health & Safety Act 2011 for nationwide implementation on 1 January 2012, it is no longer acceptable to simply "apply a standard" and hope this is sufficient. The Act makes statements such as "reasonably practicable", "due diligence" and there is now more focus on "risk-based" approaches. It also defines a "person conducting a business or undertaking" and so has implications for the roles of consultants and other engineers. Hence, the new Act has a big impact on the whole subject of earthing because of its more onerous justification requirements for the assumed safety level. Therefore, attendees will gain sufficient knowledge to be able to do more than simply "apply a standard" – they will be equipped with the skills to complete earthing projects with full accountability. Finally, since earthing codes and standards are continually being revised, new concepts and design criteria are being introduced (e.g., risk-based earthing), and new research findings are being published on a continuous basis, this seminar provides attendees with the opportunity to keep up to date in this field and to avoid the pitfalls of outdated ideas and practices.

Course Leader's Profile

Franco D'Alessandro received the degrees of B.App.Sc. (majoring in mathematics and physics), B.Ed. (secondary teaching) and Ph.D. (experimental physics) from the University of Tasmania, Australia, in 1986, 1987 and 1996 respectively.

The first decade of his career was in university teaching & research. He then moved into the private sector where he worked for more than a decade on many aspects of lightning protection and earthing as a senior research scientist and R&D product engineer, both in Australia and the United States. In 2007, he became Managing Director & Principal Consultant for PhysElec Solutions Pty Ltd, providing independent consultancy services on lightning protection and earthing work to a wide range of clients globally.

Dr D'Alessandro has delivered many seminars and presentations on lightning protection and earthing within Australia and overseas and has published more than 80 technical papers. He is a Senior Member of the IEEE and a participating technical member of Standards and code-setting committees in Australia, Europe and the United States.

CPD Recognition

This training program is especially designed to meet the Continuing Professional Development (CPD) needs of participants. A Certificate of Attendance will be awarded at the end of the program. This serves as evidence of your personal and professional commitment to your career.

Course Contents

1. Introduction
- Course overview
- Purpose of earthing
- System earthing methods
- Types of electrical systems
- Differences between parts of the electrical system
- Fundamental earthing concepts
- Earthing electrodes – materials, types, sizes, current capacity etc.
- Earthing electrodes – corrosions and lifetimes issues
- Earthing electrodes – connections
- Earth enhancing materials

2. Earthing and Personnel Safety
- Electric shock – cause and effect
- Earth potential rise (EPR)
- Step potential, Touch potential and Transferred potential
- Probabilistic vs Deterministic approaches
- Calculation of the tolerable current
- Body resistance and current paths
- Calculation of the tolerable voltage (safe step and touch potential levels)
- Typical fault current duration
- Tutorial questions and/or case study

3. Soil Resistivity Measurement and Interpretation
- Definition of soil resistivity
- Soil structure / types
- Factors influencing soil resistivity
- Common measurement techniques
- Instrumentation and equipment
- Interpretation and modelling of soil resistivity measurements
- Pitfalls and solutions
- Tutorial questions and/or case study

4. Determination of the Fault Current
- Maximum fault current
- Typical current paths
- Splitting of the fault current
- Tutorial questions and/or case study

5. Earthing Codes and Standards
- Overview of key standards and their differences
  - Australian and New Zealand guides (ENA EG0, EG1, EEA)
  - Australian and New Zealand standards (AS/NZS 60479.1, AS/NZS 2067, AS/NZS 3000, AS/NZS3007, AS/NZS 7000)
  - IEEE standards (IEEE 80, IEEE 81, IEEE 367)
  - IEC standards (IEC 60479-1, IEC 61936-1)
- Australia's earthing risk management principles
- Earthing risk management example(s)

6. Earthing System Design, Modelling and Analysis
- Common configurations
- Basic design approach
- Earthing system resistance and EPR – modelling and design
- Importance of the soil resistivity model
- Earthing system safety – modelling and design
- Role of crushed stone layer for personnel safety
- Requirements regarding fences
- Interconnected vs Separate earths
- Adjacent earths – to bond or not to bond ?
- Use of reinforced foundations for earthing
- Tutorial questions and/or case study

7. Earthing System Measurement and Interpretation
- Measurement of earthing system resistance and EPR using fall-of-potential and other methods
- Method limitations and factors affecting measurement accuracy
- Measurement of prospective step and touch potentials
- Methods for "non-isolated" earthing systems
- Tutorial questions and/or case study

8. Earthing Systems and Frequency Effects
- Characteristics of lightning discharges of relevance to earthing
- Resistance vs Impedance – factors and dependencies
- The "critical length" when designing earthing systems for lightning
- Practical tips for designing earthing systems for lightning
- Soil ionisation and implications
- Tutorial questions and/or case study

9. Summary
- Review of the key points of the seminar
- Open forum / group discussion
- Seminar certificates and closure

Note: Since many tutorial questions will be undertaken which will require attendees to perform numerical calculations, attendees are advised to bring their own scientific **calculator** to the seminar.

Customised In-House Course Available

This program can be customised to suit specific needs of your organisation at significant savings.

Please contact us on (02) 8448 2078 or email enquiry@cpdint.com.au for more details.