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# Electrical Faults: Causes, Analysis, Detection & Remedies

17 - 21 February 2025

Amsterdam (Netherlands)

# Electrical Faults: Causes, Analysis, Detection & Remedies

course code: E6056 From: 17 - 21 February 2025 Venue: Amsterdam (Netherlands) - course Fees: 4500 Euro

## The Course

The course is concerned with the calculation of fault currents in practical electrical power systems. Short-circuit currents are associated with large amounts of very destructive energy and therefore calculations must be made to ensure that the short-circuit ratings of equipment are adequate to cater for these high currents. In addition, an accurate assessment of these currents is also essential for determining the settings of the system protection devices.

The methods of analysis, used throughout industry, are thoroughly explained in this seminar. A powerful engineering software package that makes complex and repetitive calculations easy to follow and document is used throughout the seminar to ensure that attention to detail is not compromised and minimum simplifications are made. A considerable portion of the course is devoted to the application of these methods to practical systems, starting from the preparation of the system for analysis through the calculation process, by manual calculation and by the use of computer analysis to the point of application of the results. The course is illustrated by practical examples of systems including ones as explained in detail in industrial standards that engineers need to be familiar and able to follow and apply. Finally, industrial software programmes are introduced that are capable of modelling complex electrical systems and make power system fault analysis a relative easy task for engineers provided that one is able to explain and understand the results a computer programme gives. This is important as with any computer software based application where if the input data are wrong, for whatever reason, the results are also wrong and one needs to be able to observe such errors and make engineering judgments for their correction.

## The Goals

### *The objectives of this seminar are to present:*

- The basic theory of three phase power system under balanced and unbalanced conditions.
- The per-unit system and analytical circuit based techniques to calculate industrial power systems for faults.
- Advanced engineering mathematical software that can be used to make difficult and complicated calculations an easy task.
- Balanced three-phase faults and unbalanced faults and their analysis using symmetrical components.
- Application of impedance reduction techniques and positive, negative and zero sequence circuits and their interconnection for faults.
- CAD driven PC based software that can be used to first confirm results of industrial power systems to be studied and analyzed during the course and its use for the analysis of more complicated systems.
- Case studies and industrial standards for medium and low voltage networks and how faults are calculated.

## The Process

The latest educational methods and strategies will be employed. The course is designed to maximize delegate benefit from the outset and any specific goals of each participant will be discussed to

ensure needs are fulfilled as far is as possible. Questions are encouraged throughout including at the daily wrap-up sessions. This provides opportunities for participants to discuss with the presenter and others, specific problems and appropriate solutions. All delegates take away a detailed and comprehensive copy of the material presented; therefore minimal note taking is encouraged to ensure maximum delegate participation and attention.

## The Benefits

***At the end of the seminar, each delegate will:***

- Learn how to collect in a structured way data and information needed for a power system prior to fault analysis.
- Be exposed to the analytical techniques to study a power system under various types of faults.
- Understand faults, their effect and different types of calculations involved with short, medium and long time of these phenomena affecting the power system.
- Be able to assess the design and functionality of protective equipment.
- Become familiar with the latest software based approaches to deal with complicated commercial and industrial power systems and their analysis under fault conditions.

## The Results

In many onshore and offshore industrial and commercial electrical plants, network operation relies heavily on the way the infrastructure is designed, built and protected. The technical skills of engineers and technical managers as far as the protection of the system is concerned rely on solid understanding of the faults and their analysis in electrical networks. These skills, as people reach their retirement age, are ever harder to be transferred to the new employees unless training on the latest technologies and methods of fault analysis using software is provided. Maintenance and operation of the plants on an efficient and reliable manner rely on strong skills of employees. The seminar addresses the fundamental topic of faults in electrical plants.

## The Core Competencies

At the end of the seminar, the delegates will have confidence and fully understand how the electrical plants are designed and studied under fault conditions and the theories and tools available to today's engineers to increase their productivity and secure the most efficient operation of the electrical plant. Exposure to industrial standards and industrial state-of-the-art computer software used throughout the world for the analysis of a given power system under fault conditions is also provided, giving the delegates the necessary knowledge and experience to make improvements in their own work practice should these are needed.

## The Programme Content

## Day One

***Introduction to fault analysis***

- Introductions
- Goals - discussion
- Source of fault current
- Fault statistics

- Basic assumptions
- Short-circuit rating of equipment
- Selecting the correct switchgear rating for fault duties
- Overview of per-unit system
- One-line diagrams
- Sources of impedance data for all items of plant
- Tutorial to demonstrate preparation of a system for study
- Introduction to the engineering software used throughout the course to make complex and repetitive calculations as accurate as possible
- Closing discussion

**Day Two**

***Three-phase short-circuit currents***

- Review - summary - discussion
- Manual calculation of three-phase short-circuit current
- Circuit reduction techniques
- Industrial systems
- Electricity supply systems
- Tutorial - based on attendees plant
- Cables subjected to short-circuit currents
- Compliance with regulations
- Closing discussion

**Day Three**

***Unsymmetrical fault conditions***

- Review - summary - discussion
- Overview of symmetrical components
- Consideration of various fault types
- Sequence networks
- Consideration of phase shift in two-winding transformers
- Consideration of earth impedance
- Consideration of three-winding transformers
- Closing discussion

**Day Four**

***Representation of unsymmetrical faults in power systems***

- Review - summary - discussion
- Fault diagrams
- Interconnected sequence networks
- Special considerations with reference to limitation of earth fault current
- Demonstration examples based on industrial power systems
- Closing discussion

**Day Five**

***Computer based calculation of faults***

- Review - summary - discussion
- Introduction to a scaled down industrial programme capable to model complex power systems under fault conditions
- Use of the software program in practical studies (checking manual calculations)
- Industrial standards
- Case studies of faults in a high voltage network
- Case study of faults in a low voltage network