ELECTRICAL SUBSTATION AND SWITCHYARD DESIGN

YOU WILL LEARN HOW TO:

- Select an optimised location for a substation being set up to fulfil a given set of needs
- Choose the most appropriate configuration and type of substation for this requirement
- Design a detailed layout taking into account all essential aspects
- Develop a set of conditions for which detailed system studies need to be carried out
- Specify the equipment required based on the studies
- Design the individual subsystems for control and protection of the power system which the substation serves
- Design earthing and lightning protection systems to ensure safety of equipment and personnel in the event of abnormal system conditions such as faults and lightning events
- Design the required electrical interconnections to ensure correct functioning of the substation equipment
- Draw up a list of design inputs for building and structural design engineers
- Plan the support facilities required for the substation

WHO SHOULD ATTEND:

This course is aimed at engineers are already working as electrical system designers as well as those who belong to any of the fields listed below and wish to prepare themselves for moving into the role of a substation designer.

- Utility engineers dealing with power transmission and distribution systems
- Electrical engineers involved in power generating plants with utility scale generators
- Electrical engineers in large industries who are associated with power distribution
- Consulting engineers involved in design of substations
- Contractors executing projects involving electrical HV substations
- Electrical commissioning engineers

IDC TECHNOLOGIES

Technology Training that Works

The Workshop

Electrical substations form important nodal points in all power networks. Substations can be of various capacities, voltages, configurations and types depending on what is the application for which the substation is being designed. Location and layout of a substation present a number of challenges to the designer due to a large variety of options available to a designer. There are ever so many constraints too that need to be kept in mind; technical, environmental and naturally financial. Arriving at an optimum design within these constraints is as much an art as it is a science. Designing a substation which will operate with utmost reliability for at the least three or four decades involves a thorough knowledge of the current state-of-the art equipment, emerging technologies, the tools for presenting and evaluating all available options and a good appreciation of power system operation and maintenance. This course will present a comprehensive capsule of all the knowledge essential for a substation designer and walk the participants through the substation design process using a set of interlinked case studies.

Pre-requisites

- A good basic knowledge of electrical transmission and distribution equipment
- Experience in operating, maintaining and troubleshooting of substation equipment
- Some exposure to design will be an advantage but not essential
- A good theoretical background of electrical engineering and willingness to use and upgrade their numerical and computer skills
- A basic appreciation of the related engineering disciplines such as civil, structural and data communications

The Program

ROLE OF SUBSTATIONS IN AN ELECTRICAL NETWORK, TYPES AND CONFIGURATIONS OF SUBSTATIONS

- Networks-an introduction
- Different voltages in a network
- Substations as network nodes
- Substation types based on their position in the network
- Optimising the location of a substation
- Substation options: Outdoor air insulated, GIS, Indoor air insulated
- Configurations of HV substations based on their bus arrangement (typical SLD)
- Data on the industrial loads required for the design of the electrical supply substation
- Load assumptions for residential and commercial consumers
- Environmental issues in the location of a switchyard and mitigation measures

SYSTEM STUDIES REQUIRED FOR FINALISING EQUIPMENT RATINGS

- Load flow study (active/reactive loads)
- Short circuit study
- Harmonic flow
- Voltage profile and reactive power compensation
- Stability study

OVERVIEW OF SWITCHYARD EQUIPMENT AND THEIR ORDERING SPECIFICATIONS

- Main (primary) equipment
  - Busbars
  - Disconnectors
  - Circuit breakers
  - Instrument transformers
  - Lightning arrestors
  - Power transformers
  - Structures
- Layout options
- Sectional and Safety clearances and their influence on the layout
- Design of busbars (strung/tubular) and interconnections between equipment
- Interconnecting cables and use of marshalling kiosks

SUBSTATION EQUIPMENT FOR FAULT LIMITING, PFC AND HARMONIC CONTROL

- Need for and application of:
  - Fault limiting reactors
  - Power factor compensation equipment
  - Static VAR compensators
  - Harmonic filters
- Equipment design and selection of ratings
- Layout of these equipment in a switchyard

PROTECTION DESIGN FOR SUBSTATION

- Brief overview of protection
- Over current protection
- Protection coordination
- Protection of transformers
- Busbar protection
- Feeder protection
- Current transformers requirements for protection
- Equipment requirements for substation automation
- PLCC applications in protection and communication
- PLCC hardware and integrating them with the switchyard equipment

EARTHING SYSTEM AND LIGHTNING PROTECTION OF SWITCHYARDS

- Basics of functional and protective earthing
- Touch and step voltages in substations
- Earth grid and its role in safety
- Switchyard fence-why it should be a part of the earth grid
- Design of earth grid-basic considerations in conductor sizing and mesh spacing
- Pros and cons of including the control building within the switchyard earth grid
- Earth mat laying and welding
- Safety mesh at operating points
- Role of gravel layer in safety
- Transferred voltage hazards
- Planning isolation of outgoing services to avoid transfer voltage
- Basics of lightning and hazards
- Role of shield wire and lightning masts
- Typical configurations of lightning protection of switchyards
- Analysis of hazard using cone of protection and rolling sphere methods
- Selection of lightning arrestors-Types, class and ratings

SWITCHYARD CONTROL AND INTERLOCKING

- Dc power requirements for switchyard equipment
- Dc equipment configuration and specifications
- Dc distribution for switchyard equipment
- Battery calculations basis
- Space planning and related facilities for a battery installation
- Ac auxiliary power for switchyard systems-loads which require ac power
- Possible source options
- Ac auxiliary distribution for switchyard equipment and support systems
- Control scheme of disconnectors and circuit breakers
- Control interconnection approach
- Use of optical fibre-based control scheme
- Role and location of marshalling kiosks in different bays

SWITCHYARD-FACILITY PLANNING

- Site preparation, levelling
- Earth resistivity measurement and its role in design verification
- Civil works such as equipment foundations, cable trenches, control building, storm drains, transformer oil collection pit
- Structures and their design requirements
- Substation fence and physical security
- Surveillance
- Planning water requirements and supply arrangement
- Fire protection, lighting and ventilation of control room and other equipment

GAS INSULATED SWITCHGEAR (GIS) AS AN ALTERNATIVE TO OUTDOOR SWITCHYARD

- Why gas insulated substation?
- SF6 properties, advantages and environmental impact
- Typical substation configurations in SF6
- Indoor/outdoor options
- Gas safety considerations
- Equipment for handling SF6
- SF6 substation layout planning
- Cable terminations to SF6 equipment

SUMMARY, OPEN FORUM AND CLOSING