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Fault Analysis in Power System

Course Introduction:

Power system planning, operation and control are usually affected by their stability and power quality. The power system networks are composed of expensive elements, such as generators and their associates, transformers, overhead transmission lines and underground cables that are transmitting the electrical energy from the center of generation to the load center. As such, these elements need to be protected against human and operation faults; otherwise they will be completely damaged. The electrical fault diagnosis is an important tool to fix the network in very short period of time, since the power interruption time becomes a measure of the network efficiency.

The protective and predictive maintenance takes the proper steps to reduce the fault rate in the network. Voltage stability concerns stable loads operation and acceptable voltage levels all over the network nodes (or buses). Its instability has been classified into steady-state and transient voltage instability, according to the time spectrum of occurrence of the phenomena. Voltage instability has been observed in several forms, which was reached to complete blackouts of power systems in several countries. This subject have turned great attention to power system security, reliability, planning, control methods and power system harmonics suppression.

This course deals with the factors contributing to voltage instabilities leading to blackouts and the conditions of triggering these phenomena. A brief idea about blackouts occurred in power systems and means of prevention of voltage instability in order to avoid their initiation. Preventive measures of partial or complete blackouts in distribution systems, in transmission systems and in large networks are briefly displayed. Analysis of a blackout experienced in a typical large power system is presented, together with the preventive measures effects on various system conditions. Emphasis is made on reactive power compensation by static VAR compensators, as they are the more recent means of prevention of voltage instabilities in large power systems and in industrial firms.

On the other hand it is essential to know the short circuit current and KVA that the system will carry under different fault conditions and at different points in the system. The faults may be single line to ground, double line to ground, three line fault or line to line fault. Selection of circuit breakers, protective devices are mainly required information about the short circuit current. Moreover fault analysis is essential in order to have safety operation of the power systems and to know the fault causes. It is important for engineers and technicians to be aware by fault causes, fault detection, fault protection and fault analysis.

This course is designed to provides the participants with the methods of short circuit calculation both hand and computer programs. Per-unit system, symmetrical components, earthing, transformer connection and their effects on short circuit calculation are included. Switchgears capacities are calculated regarding to the fault current. Different voltage level power systems are investigated and different power systems layouts are included.

Course Objectives:

The course is designed to support the participant with technical and practical knowledge required to represent, operate maintain and supervise the electrical power system during normal operation by power flow analysis and in short circuit condition by estimating the short circuit level at deferent point of the system. The main objective of the course is to take the proper actions to prevent cascading blackouts.

Good understanding of per unit system, symmetrical components, power system elements representation, short circuit calculation, power flow analysis, and software programs are our main objectives.

Who Should Attend?

The course is designed to Manager, Head of Department and Electrical Engineers whom working in the power system in general Transmission and Distribution, medium and low voltage Operation, maintenance and Protection of the Electrical Power Systems.

Course Outline:

Module (01) Power System Sources and Configurations

1.1 Electrical engineering basic concepts,
1.2 Voltage levels,
1.3 One line and three line diagram,
1.4 Generation system layout,
1.5 Transmission layout,
1.6 Distribution layout,
1.7 Substation layout,
1.8 Case study

Module (02) Utility Load Classifications

2.1 Residential loads
2.2 Commercial loads
2.3 Power factor
2.4 Power factor correction
2.5 Utility factor
2.6 Losses in lines

Module (03) The Per Unit System and Percentage System

3.1 Single-Phase System

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3.2 Three Phase System
3.3 Transformer Representation in the Per Unit System
3.4 System Analysis in the Per Unit System
3.5 Transformers with Off-Nominal Turns Ratios
3.6 Soled Resistive Earthing Systems.
3.7 Summary
3.8 Case Study

Module (4) Fault Diagnosis Technique in Electrical Power System

4.1 Fault Diagnosis Technique in Switchgear.
4.2 Fault Diagnosis Technique in Power Transformer.
4.3 Fault Diagnosis Technique in Electrical Motors.
4.4 Fault Diagnosis Technique in Power Cables.
4.5 Fault Diagnosis Technique in Grounding.
4.6 Fault Diagnosis Technique in Test Equipment.

Module (05) Short Circuit Faults Calculations

5.1 The per unit System
5.2 Symmetrical components
5.3 Symmetrical and Asymmetrical Fault Currents
5.4 Three phase Faults
5.5 Line to Line Faults
5.6 Line to Line to Ground Faults
5.7 Line to Ground Faults
5.8 Line to Ground Faults through Impedance
5.9 Equivalent System Impedance
5.10 Current-Limiting Inductors
5.11 Short circuit level
5.12 Effect of induction machines on short circuit level
5.13 CB rupture capacity
5.14 Numerical Examples of Short-Circuit calculations

Module (06) Blackouts Preventive Measures

6.1 Causes of Blackouts in Power Systems.
6.2 Triggering Voltage Instability Leading To Blackouts
6.3 Blackouts in Power Systems.
6.4 Means of Voltage Stability Enhancement.
6.5 Preventive Measures of Blackouts.
6.6 Preventive Measures of Blackouts In A Typical Large Power System.

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Module (07) Power Flow Studies

7.1 Introduction
7.2 Basic Considerations
7.3 Formulation of the System [Y] Array
7.4 Statement of the Power Flow Problem
7.5 Operating and Controlling Power Systems
7.6 The Economic Dispatch Problem
7.7 System Voltage Control
7.8 Generator Voltage Control
7.9 Voltage Control by Reactive-Power Insertion
7.10 Controlling through-Power Flow by Means of Magnitude- and Phase-Changing Transformers

Module (08) Symmetrical Components

8.1 Transformation of Phase Quantities to Sequence Quantities
8.2 Line and Cable Sequence Impedances
8.3 Transformer Sequence Networks
8.4 Rotating Machine Sequence Networks (generators and Motors)
8.5 Sequence Filters
8.6 Study case

Module (09) Switchgear Ratings & Types of Circuit Breakers

9.1 Switchgears
9.2 Circuit Breaker Selection and Application
9.3 Low Voltage Circuit Breaker
9.4 Medium Voltage Circuit Breaker
9.5 High Voltage Circuit Breaker
9.6 Specifications of CB

Module (10) Fault Current Level and its Transient Recovery Voltage

10.1 Effect of Fault Location on Fault Current Level
10.2 Calculation of the Transient Recovery Voltage
10.3 Making Current
10.4 Breaking Current
10.5 Rate of Rise of Restriking Voltage

Module (12) Protective Equipment in Power Systems

12.1 Fuses

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12.2 Auto-Reclosers
12.3 Automatic Sectionalizer
12.4 Breakers and Isolators
12.6 Load Switches
12.7 Relays
12.7.1 Thermal Relays
12.7.2 Electromagnetic Relays
12.7.3 Static Relays
12.7.4 Digital Relays

Course Methodology:

A variety of methodologies will be used during the course that includes:

- (30%) Based on Case Studies
- (30%) Techniques
- (30%) Role Play
- (10%) Concepts
- Pre-test and Post-test
- Variety of Learning Methods
- Lectures
- Case Studies and Self Questionaires
- Group Work
- Discussion
- Presentation

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Course Certificate:

International Center for Training & Development (**ICTD**) will award an internationally recognized certificate(s) for each delegate on completion of training.

Course Fees:

To be advised as per course locations. This rate includes participant's manual, Hand-Outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Timings:

Daily Course Timings:

08:30 - 08:50	Morning Coffee/Tea
08:50 - 10:20	First Session
10:20 - 10:40	Recess (Coffee/Tea/Snacks)
10:40 - 12:20	Second Session
12:20 - 12:40	Recess (Coffee/Tea/Snacks)
12:40 - 14:30	Last Session

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