



TECHNICAL ENGINEERING COURSES

System Restoration

Distribution System Reliability

Voltage Stability

Long Term Dynamics

Power System Restoration and Black Start

Introduction

The primary objectives of power system planning and operation are to minimize system outages, load interruptions and equipment damage under emergency conditions. These goals are becoming more difficult to achieve under current conditions, where competition, privatization and regulation of the electricity industry are ushering in a new era.

The main driving forces are becoming: to reduce operating and maintenance cost, to maximize profit and to work equipment harder and longer. This requires better understanding of the ways in which system components interact, under emergency conditions, in order to minimize outage probability and to recover normal system operation, when outage occurs, as fast as possible.

Power System Behavior under emergency conditions, as well during restoration processes, depends on its characteristics as related to real and reactive power balance, and the installed control and protective systems. The restoration process is also a function of pre-disturbance conditions, post-disturbance status and post-disturbance target systems. Therefore, the understanding of the factors involved in power system collapse and in the restoration procedure is crucial to the proper operation of modern power systems.

What you will learn

During this three-day course you will learn:

- Time frames for hot and cold restart of the variety of the generating units as well as prime movers' frequency response to sudden increase in load or to loss of an on-line generator.
- Sustained over-voltages, switching transients, harmonic resonance, and over-and under-excitation capabilities of generators.
- Black-start of steam-electric units, and correct operation of protective relays.
- Constant awareness of the probable effects of each action on the rest of the system and on subsequent actions.

In addition past major power system disturbances and their restoration problems will be discussed and a number of activities including: formation of a planning team, review of system characteristics, formulation of assumptions, establishment of goals, development of strategy and tactics, validation of the draft plan, and training in deployment of the plan will be described.

Audience

- Engineers responsible for development of power system restoration plans.
- Power system instructors responsible for training the operating personnel in restoring the system following possible major disturbance.
- Operating personnel responsible for power system restoration.

Course Language:

English

Duration:

3 days

Instructor:

M.M. Adibi

CYME Technical Engineering Courses Program Director:

Dr. Atef S. Morched

Further Information:

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Course Outline

Day 1

- **Morning Session:**
 - Course introduction
 - Overview of the restoration process
 - Major power disturbances and restoration issues
- **Afternoon Session:**
 - Power system characteristics and control of frequency
 - Frequency response of prime movers
 - General discussion

Day 2

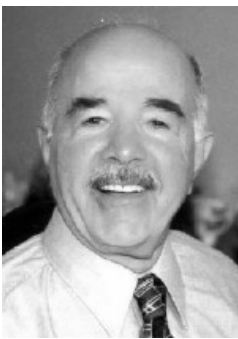
- **Morning Session:**
 - Power system characteristics and control of voltages
 - Energizing high and extra-high voltage lines
 - Generator reactive capability
- **Afternoon Session:**
 - Optimum tap selection of transformers
 - Remote cranking of power plants
 - General discussion

Day 3

- **Morning Session:**
 - Protective system issues
 - Negative sequence currents during restoration
 - Power system restoration planning
- **Afternoon Session:**
 - Estimating restoration duration
 - Analytical tool requirements
 - General discussion

Each participant will receive a set of course notes as well as a copy of the book Power System Restoration—Methodologies and Implementation of Strategies, by M.M. Adibi, IEEE Press in alliance with John Wiley & Sons, 2000.

Instructor



M.M. Adibi

Mr. Adibi earned the B.Sc.E.E. (honors) in 1950 from the University of Birmingham, U.K., the M.E.E. in 1960 from Polytechnic Institute of Brooklyn, New York City, and Nuclear Engineering in 1970 at the University of Santa Clara, California.

He spent over 50 years in the service of electric utilities in the areas of manufacturing and testing of heavy electrical equipment at General Electric Company, U.K. (1950-1951); operation and maintenance of large thermal power plants at British Petroleum, Iran (1952-1955) and power system planning at Ebasco International, New York (1956-1959).

In 1960, Mr. Adibi joined IBM Corporation, developing computer programs and participating in R&D projects related to power system and power plant operation. He was the recipient of the IBM Industry Grant to study the computer-based fuel model for the power industry.

He founded, and chaired, the IEEE System Restoration Working Group since 1979. He published 27 IEEE Transaction papers on the subject. Mr. Adibi is the author of "Power System Restoration – Methodologies and Implementation of Strategies," Published by the IEEE Press in alliance with John Wiley & Sons.

Mr. Adibi is the recipient of the IEEE Power Engineering Society's prize for his paper on "Power System Restoration Planning." He is an IEEE Life Fellow.



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