CYME INTERNATIONAL T&D

TECHNICAL ENGINEERING COURSES

Generating Plant Dynamics and Grid Interaction

Introduction

Ever-increasing consumer appetite for energy has led to a proliferation of generating units – large and small – on the grid. While large-capacity power plants provide scale of economy, they are usually located far from load centers due to site and environmental constraints. Their size, combined with their distance from load centers, makes the grid vulnerable to their malfunctions. On the other hand, smaller capacity plants can be installed nearer to load centers and, due to their smaller capacity, are *grid-friendly*. Grid stability analysis in a short time frame (few seconds) need not be too concerned with plant dynamics and/or maneuverability. However, longer-term (minutes to hours) grid stability study would require a thorough understanding and modeling of plant dynamics.

Course Language:
English

Duration:
3 days

Instructor:
Dr. Prahbat Kar

CYME Technical Engineering Courses Program Director:
Dr. Atef S. Morched

Further Information:
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What you will learn

This course will focus on:

- Introducing various types of generating units (Fossil – coal, oil, gas, Combustion turbines and Combined Cycle units), their operating principles and major-subsystems and advantages and disadvantages vis-à-vis grid behavior.
- Understanding of types of load (resistive, inductive, capacitive) and load-generation mismatch and effect on grid behavior (frequency, voltage, phase)
- Participation of generating units on grid frequency control (e.g., capacity, maneuverability, governor droop characteristics).
- Automatic Control Systems and their importance in plant dynamics (e.g. fuel control, turbine power control, boiler follow and turbine follow modes, feed-water and condensate control, voltage and reactive power control).
- Effect of plant type on grid behavior and load management.
- Grid islanding and recovery from a blackout.

Audience

- Power plant design, operation and maintenance engineers.
- Power plant Instrumentation and control engineers.
- Power system planning and operation engineers.
- Energy management and dispatching personnel.

Course Outline

Day 1

- **Course Introduction and Organization**
  - Focus on modeling to understand and analyze behavior.
- **Fossil-fired Power Plant Processes**
  - Furnace and associated dynamics (Fuel and air systems, combustion, convective and radiant heat transfer mechanisms, air heaters)
  - Fuel dynamics (coal fired - pulverizer management, oil/gas fired)
  - Flue gas processes
  - Steam generation
  - Drum type (natural/forced circulation) and once through boilers
  - Sub-critical and super-critical boilers
  - Main (superheat) and reheat steam
  - Condensate and feed water systems (condenser, feed-heaters, economizer)
  - Condensate pumps, deaerator, boiler feed pumps
  - Turbine (stages (HP, IP, LP), shaft and casing arrangements: single casing, tandem-compound and cross-compound)
  - Generators
  - Major control and protection systems (overall unit control)

Day 2

- **Fossil Plant Control Systems**
  - Overall plant control (MW and steam pressure)
  - Boiler following/turbine following/ coordinated control
  - Variable pressure control
  - Steam flow (governor) control
  - Superheat/reheat temperature control
  - Generator exciter control (pf, voltage)
  - Condenser pressure control (condenser cooling water flow)
  - Deaerator (level/pressure) control
  - Feed water flow and condensate flow control
  - Fuel (coal/oil/gas) and air control (coal belt, oil/gas valve)
  - Pulverizer management (coal)
  - Primary/secondary air flow/temperature control (hot/cold air dampers, gates, inlet guide vanes)
  - Air/fuel ratio, excess O2, cross-limiting, calibrating integral
  - Furnace pressure control (induced draft fans)
- **Combustion Turbine Units (gas/ oil/diesel) Processes and Control**
  - Starting Motor
  - Compressor
  - Combustor
  - Turbine (single or multiple)
  - Control systems (air flow and temperature, turbine power)
  - Protection systems
- **Combined Cycle Units**
  - Advantages – increased efficiency
  - Combustion turbine cycle
  - Heat recovery steam generator cycle
  - Gas turbine and steam turbine – single and dual shaft
  - Control systems including start-up, loading
  - Protection systems

Day 3

- **Generator and Grid Operation**
  - Main transformer, switchyard, grid
  - Station service, unit service transformers
  - Generation and load matching
  - Active and reactive power control
  - Governor control and governor droop
  - Excitation systems and voltage regulation
  - Power system stabilizer
  - Reactive power compensation
  - Synchronizing effect
  - Automatic generation control
  - Tap changing, grid voltage control (brown-outs)
  - Load rejection
  - Over and under generated Island operation
  - Black-out and restoration

Instructor

Dr. Prabhat Kar has about 30 years experience in the power industry working for Ontario Hydro / Ontario Power Generation. His specializations include nuclear and fossil-fuelled power plant operations, analysis and computer simulation of plant processes and controls. He provided consulting services to Hydro-Quebec in Canada, ABB in Finland and EPRI in the US in these areas. He has authored several papers and technical reports.

Dr. Kar holds a B. Tech. (hons.) degree from Indian Institute of Technology, Kharagpur in India, a Ph. D. degree from the University of Waterloo, Canada and an M.B.A. from York University, Canada. He is a member of the Professional Engineers of Ontario.

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