NERC Training
Simulator Applications

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Simulator Benefits

Better trained operators
Engineers who better understand operations
Systems which are operated better
Systems which are designed and built better
Improved customer service
Improved ability to adapt to competitive changes
Improved ability to recruit and train new staff
PowerSimulator Components

- Model Importers
- EPRI OTS Power System Model
- Generic SCADA and AGC

EPRI Common Information Model (with PowerData Real Time Database)

Power Integrator – Application Integration Framework

- Power Visuals User Interface (JAVA Based - Web Enabled)
- Data Engineer
- PACE Infrastructure
- Application or System
PACE - Power Application Computing Environment

Rapid Integration of Third Party Applications
Open CIM Database Schema
Open Application Program Interface
Uses EPRI OTS as Software Test Bed
Scales to millions of measurements
Web enabled User Interface
Applications that are easy to install and use
PowerSimulator Functions

EPRI OTS Power System Model
Supervisory Control, Alarming, AGC
Instructor Capability, case manager, event scheduler
Model Importers: CIM XML, PSS/E
Graphical Model Management
Automatic Display Builder
CIM database and Open API
Options for Packaging PowerSimulator

CCM
- Emulate

PSM
- Generic
- Specific

- Replica Control Room PowerSimulator

Generic PowerSimulator
- Custom PowerSimulator
Custom PowerSimulator

Specific Power System Model

Emulated SCADA and AGC Functions

Trainee Workstation
Replica Control Room
PowerSimulator
Realism of Emotions

With good instructional support all PowerSimulator configurations can induce a full range of emotions; over confidence, humility, challenged, stressed, overloaded, confused, appreciation, satisfaction and joy.
Logical Phases to Learning and Training

Learn basic principles of power systems.
Study the operation of a particular power system.
Practice operating the control system in team with actual control equipment.
Generic PowerSimulator

**Best tool for learning basic principles**

Available at low cost

Generic model and displays available

Growing number of scenarios are available

Can be used in classroom

Can be used by students on PCs at work and at home

Catalyst for interaction between experts and novices
Power System Basics

AC voltage
AC current
Resistance
Capacitance
Inductance
Ohms law
Kirchoff’s current law
Kirchoff’s voltage law
Real power
Reactive power

Circuit for transmission line
Circuit for transformer
Voltage control with shunt capacitors
Voltage control with transformer taps
Voltage control with generators
Generator MVAR capability
Voltage collapse
Ferranti rise
## Power System Basics

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<th>Power Angle curve for lines</th>
<th>Load Voltage characteristics</th>
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<td>Black start of units</td>
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<td>Synchronizing islands</td>
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Custom PowerSimulator

*Best tool for studying behavior of an actual power system.*

Operator has full control of scenario. Can invoke actions of EMS operator, plant operator, neighboring utility operator, substation operator.

Displays show variables not seen on EMS, bus angles, load to be connected, droop, ramp rate.

Scenarios can be run in less time than real-world operation. E.g. system restoration.
Custom PowerSimulator

Tools available to assist operator that are not available on EMS; e.g. clear dead buses, line colorization, recording and playback.

Can be run on operator’s PC at work or at home

Can be used in quiet shift time.
Specific Power System Studies

Impact of transmission outages on flows and voltages.
Impact of generator outages on flows, voltages and frequency.
Impact of transactions on flows, voltages and angles.
Maintaining a good voltage profile.
Detection and prevention of voltage collapse.
Development and evaluation of system restoration plans.
Replica Control Room
PowerSimulator

*Best tool for training operator to work in a team with his/her actual EMS applications*

Simulation runs just like the real system in the same time frame of real system.

Provides training in coordination and communication with other control center, power plant and substation operators.

Provide training in use of EMS under stress
PJM Restoration Training 2010
Eight Simulation Sessions with 64 logged on users
ZAGOPS - Generic Simulators can be used to recruit new engineers and operators
Alberta Electric System Operator Restoration Drills
Northern California Restoration Drill
Iraq Ministry of Electricity National Dispatch Center

- Located Al Ameen, Iraq
- New and Incumbent Engineers
- Generic PSM for principles
- Custom Iraq Model
- Remedial Action Schemes
Knowledge Capture at PNNL EIOC
Nearly 1000 system operators use PowerSimulator online through the EOPS and MarketOPS Programs yearly.

EOPS released 2005
MarketOPS released 2008
EOPS and Market OPS

- EOPS - 38 Modules
- MarketOPS - 15 Modules
- Each module has a flash tutorial presentation
- Nearly all modules have simulator exercises
- Accessed over high-speed internet connection
- Available 24 hours a day, 7 days a week
- Customer support available 24/7
EOPS and MarketOPS Online

Online Self Paced
Wide Range of Simulation Scenarios
• System Restoration
• Voltage collapse
• Governing response to unit trips
• AGC
• Ferranti rise
• Cold load pick up
• Load Shedding
• Balancing
• Interchange
Accessible 24/7 (on the desk too)
EOPS Curriculum

Course SCP – Simulator and Comm. Protocols – 4 Modules
  Fundamentals of system monitoring and how to implement detailed switching orders accurately

Course RSO – Reliable Switching Operations – 5 Modules
  Fundamentals of transferring equipment, opening lines, restoring lines, and dramatization of line switching accidents

Course MMF – Managing MW Flows – 11 Modules
  Principles for operating in the interconnection, managing power flow and phase angles, generation redispatch, unscheduled flow calculation and mitigation

Course PVC – Preventing Voltage Collapse – 9 Modules
  Understanding how voltage collapse occurs, characteristics of components in the system, and how you can avoid voltage collapse under various contingencies
EOPS Curriculum

Course SS – System Shutdown – 4 Modules
  How system shutdown occurs – including module on WECC July 2, 1996 system disturbance

Course SR – System Restoration – 5 Modules
  How to develop and implement a solid restoration plan
MarketOPS Curriculum

Course EGM – Generation Management – 5 Modules

North American generation markets, fuel characteristics, power plants, economic dispatch, unit commitment

Course EBAL – Balancing – 4 Modules

Frequency control, AGC, Reserve monitoring

Course EINT – Interchange – 3 Modules

Scheduling, tagging and TLR procedures

Course FPM – Fundamentals of Power Markets – 3 Modules

Scheduling, tagging and TLR procedures
Market OPS Curriculum

- **EGM** Generation Management
- **EBAL** Balancing Operations
- **EINT** Interchange Transactions
- **FPM** Fundamentals of Power Markets
Generation Management

Course
EGM Generation Management
Trains you to recognize the cues and patterns necessary for optimizing a generation portfolio.

Module
- EGM-801: Introduction to North American Generation Markets
- EGM-802: Fuel and Energy Source Characteristics
- EGM-803: Types of Power Plants
- EGM-804: Economic Dispatch
- EGM-805: Preparing a Daily Dispatch Plan
Balancing Operations

**Course**

**EBAL Balancing Operations**

Trains you to effectively balance and/or rebalance your generation according to NERC criteria including use of automatic Generation Control and reserves.

**Module**

- **EBAL-901**
  - NERC Balancing Structure and Principles
- **EBAL-902**
  - Frequency Control
- **EBAL-903**
  - Automatic Generation Control
- **EBAL-904**
  - Reserve Monitoring and Scheduling
Interchange Transactions

Course

[EINT] Interchange Transactions

Trains you to implement interchange schedules in a timely and accurate fashion.

Module

- EINT-1001
  - Open Access to North American Transmission Systems

- EINT-1002
  - ATC Calculations

- EINT-1003
  - Transmission Reservations and Tagging Operations
Fundamentals of Power Markets

Course

**FPM** Fundamentals of Power Markets

Trains you to recognize the dangers and opportunities in modern power markets and maximize your profits while coping with an uncertain environment.

Module

- **FPM-101**
  - Introduction to Power Markets
- **FPM-102**
  - Electricity Economics & FTRs
- **FPM-103**
  - Locational Marginal Pricing
- **FPM-104**
  - Security Constrained Economic Dispatch
Summary

OTS Technology is now affordable.
Time to implement OTS is reduced
Utility staff levels to support OTS can be minimized
Generic PowerSimulator is widely available to operators, engineers and students