Standard Development Timeline

This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.

Development Steps Completed

1. SAR and supporting package posted for comment (July 19, 2013 – September 3, 2013).
2. Draft standard posted for comments and ballot. (August 19, 2013 – September 3, 2013).
3. Draft standard posted for additional comments and ballot (September 25, 2013 – November 9, 2013).

Description of Current Draft

Anticipated Actions	Anticipated Date
45-day Formal Comment Period with Ballot	July 2013
Additional 45-day Formal Comment Period with Ballot	September 2013
Final ballot	November 2013
BOT adoption	December 2013

Definitions of Terms Used in Standard

This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved.

Glossary Term:

When the standard becomes effective, this defined term will be removed from the individual standard and added to the Glossary.

Rationale for System Operator: The definition of the existing NERC Glossary Term "System Operator" has been modified to remove Generator Operator (GOP). The term control center was not capitalized as the proposed NERC Glossary Term "Control Center" is not consistent with the applicability of this standard.

System Operator: An individual at a control center of a Balancing Authority, Transmission Operator, or Reliability Coordinator, who operates or directs the operation of the Bulk Electric System in Real-time.

Standard Only Terms:

The following terms are defined for use only within PER-005-2 and, upon approval, will not be moved to the NERC Glossary of Terms:

Rationale for System Personnel: The term "System Personnel" has been created to identify specific personnel with applicable entities, and allows the standard to be more concise by preventing repetition of the long description throughout the standard.

System Personnel: System Operators of a Reliability Coordinator, Transmission Operator or Balancing Authority, and the Transmission Owner personnel described in the Applicability Section of this standard.

Rationale for Operations Support Personnel: This definition uses language from the FERC Orders 693 and 742 to define those operations support personnel subject to the standard. The definition clarifies that functional entities (Reliability Coordinator (RC), Balancing Authority (BA), Transmission Operator (TOP), and Transmission Owner (TO)) identify "Operations Support Personnel."

Operations Support Personnel: Individuals, as identified by the Reliability Coordinators, Balancing Authorities, Transmission Operators, or Transmission Owners, who perform outage coordination or assessments, or who determine SOLs, IROLs, or operating nomograms,[1] in direct support of Real-time, reliability-related tasks performed by System Operators.

[1] Nomograms are used in the WECC Region to describe element operating limits.

When this standard has received ballot approval, the text boxes will be moved to the Application Guidelines Section of the Standard.

A. Introduction

1. Title: **Operations Personnel Training**

2. Number: PER-005-2

3. Purpose: To ensure that personnel performing or supporting Real-time, reliability-related tasks on the Bulk Electric System are trained using a systematic approach to training.

4. Applicability:

4.1. Functional Entities:

4.1.1 Reliability Coordinator

4.1.2 Balancing Authority

4.1.3 Transmission Operator

Rationale for TO: Extending the applicability to TOs is necessary to address the FERC directive that the ERO develop formal training requirements for local transmission control center operator personnel. In Order No. 742 at P 62, the Commission clarified its understanding that local control center personnel *"exercise control over a significant portion of the Bulk-Power System under the supervision of the personnel of the registered transmission operator. The supervision may take the form of directive specific step-by-step instructions and at other times may take the form of the implementation of predefined operating procedures. In all cases, the Commission continued, the local transmission control center personnel must understand what they are required to do in the performance of their duties to perform them effectively on a timely basis. Thus, omitting such local transmission control center personnel from the PER-005-1 training requirements creates a reliability gap."* See FERC Order 693 at P 1343 and 1347. The word facility was intentionally left lower-case as there may be a facility that is not included in the NERC glossary term "Facility".

4.1.4 Transmission Owner that has:

4.1.4.1 Personnel at a facility, excluding field switching personnel, who act independently to carry out tasks that require Real-time operation of the Bulk Electric System, including protecting assets, protecting personnel safety, adhering to regulatory requirements and establishing stable islands during system restoration.

Rationale for GOP: Extending the applicability to GOPs that have dispatch personnel at a centrally located dispatch center is necessary to address the FERC directive that the ERO develop specific requirements addressing the scope, content and duration appropriate for certain GOP personnel. The Commission explains in Order No. 693 at P 1359 that "*although a generator operator typically receives instructions from a balancing authority, it is essential that generator operator personnel have appropriate training to understand those instructions, particularly in an emergency situation in which instructions may be succinct and require immediate action.* Order No. 742 further clarified that the directive *applies to generator operator personnel at a centrally-located dispatch center who receive direction and then develop specific dispatch instructions for plant operators under their control. Plant operators located at the generator plant site are not required to be trained in PER-005-2."* Based on the FERC order, this applicability section clarifies which GOP personnel are not subject to the standard.

4.1.5 Generator Operator that has:

4.1.5.1 Dispatch personnel at a centrally located dispatch center who receive direction from their Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner and may develop specific dispatch instructions for plant operators under their control. This personnel does not include plant operators located at a generator plant site or personnel at a centrally located dispatch center who relay dispatch instructions, without making any modifications.

5. Effective Date:

5.1. This standard shall become effective the first day of the first calendar quarter that is 24 months beyond the date that this standard is approved by an applicable governmental authority or is otherwise provided for in a jurisdiction where approval by an applicable authority is required for a standard to go into effect.

Where approval by an applicable governmental authority is not required, this standard shall become effective on the first day of the first calendar quarter that is 24 months after the date the standard is adopted by the NERC Board of Trustees or as otherwise provided for in that jurisdiction.

B. Requirements and Measures

R1. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall use a systematic approach to training to develop and implement a training program for its System Personnel[2] as follows: *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

1.1. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall create a list of Bulk Electric System (BES) company-specific Real-time reliability-related tasks based on a defined and documented methodology.

1.1.1. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall review, and update if necessary, its list of Real-time reliability-related tasks identified in part 1.1 each calendar year.

1.2. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall design and develop training materials according to its

[2] As used in this standard, the term "System Personnel" is defined as System Operators of a Reliability Coordinator, Transmission Operator or Balancing Authority, and the Transmission Owner personnel described in the Applicability Section of this standard.

training program, based on the Real-time reliability-related task list created in part 1.1.

1.3. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall deliver training to its System Personnel according to its program.

1.4. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall conduct an evaluation each calendar year of the training program established in Requirement R1 to identify any needed changes to the training program and shall implement the changes identified.

M1. Each Reliability Coordinator, Balancing Authority, Transmission Operator and Transmission owner shall have available for inspection evidence of using a systematic approach to training to establish and implement a training program, as specified in Requirement R1.

M1.1 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection its methodology and its company-specific Real-time reliability-related task list, with the date of the last review, as specified in Requirement R1 part 1.1.

M1.2 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection training materials, as specified in Requirement R1 part 1.2.

M1.3 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection System Personnel training records showing the names of the people trained, the title of the training delivered, and the dates of delivery to show that it delivered the training, as specified in Requirement R1 part 1.3.

M1.4 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection evidence (such as instructor observations, trainee feedback, supervisor feedback, course evaluations, learning assessments, or internal audit results) that it performed a training program evaluation each calendar year, as specified in Requirement R1 part 1.4.

Rationale for changes to R2: System Personnel, as opposed to System Operator, is used to capture specific personnel of a Transmission Owner in addition to the Reliability Coordinator, Balancing Authority, and Transmission Operator in one term.

R2. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall verify, at least once, the capabilities of its System Personnel assigned to perform each of the Real-time reliability-related tasks identified under

Requirement R1 part 1.1. *[Violation Risk Factor: High] [Time Horizon: Long-term Planning]*

2.1. Within six months of a modification or addition of BES company-specific Real-time reliability-related tasks, each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall verify the capabilities of each of its System Personnel to perform the new or modified Real-time reliability-related tasks identified in Requirement R1 part 1.1.

M2. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection evidence to show that it verified the capabilities of each of its System Personnel assigned to perform each of the Real-time reliability-related task identified under Requirement R1 part 1.1, as specified in Requirement R2. This evidence may be documents such as records showing capability to perform Real-time reliability-related tasks with the employee name and date; supervisor check sheets showing the employee name, date, and Real-time reliability-related task completed; or the results of learning assessments.

Rationale for changes to R3: The requirement mandates the use of specific training technologies. It does not require training on Interconnection Reliability Operating Limits (IROLs). The standard allows entities that gain operational authority or control over a facility a 12 month period to comply with the requirements of Requirement R3 to provide them sufficient time to obtain simulation technology.

The requirement to provide a minimum of 32 hours of Emergency Operations training has been removed since the appropriate time would be identified as part of the systematic approach to training process in Requirement R1 through the analysis phase of a systematic approach to training and outlined in a continuous education section of their training program. Any additional hours may be duplicative or repetitive for the entity in providing training to their personnel. Requirement R3.1 also covers the FERC directive for the creation of an implementation plan for simulation technology.

R3. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner that has operational authority or control over Facilities with established Interconnection Reliability Operating Limits (IROLs) or has established operating guides or protection systems to mitigate IROL violations shall provide its System Personnel with emergency operations training using simulation technology such as a simulator, virtual technology, or other technology that replicates the operational behavior of the BES, according to its training program. *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

3.1. When a Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner that did not have an IROL gains operational authority or control over a Facility with an established IROL or establishes operating guides or protection systems to mitigate IROL violations, it shall comply with Requirement R3 within 12 months of gaining that authority or control, or establishing such operating guides or protection systems.

M3. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection training records that provide

evidence that System Personnel completed training that includes the use of simulation technology, as specified in Requirement R3.

M3.1 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection training records that provide evidence that System Personnel completed training that included the use of simulation technology, as specified in Requirement R3, within 12 months of gaining that authority or control, or establishing such operating guides or protection systems.

Rationale for R4: The requirement requires the training of Operations Support Personnel on the impact of their job function to the Real-time reliability-related tasks identified under Requirement R1. It does not require training on the actual Real-time reliability-related tasks conducted by the System Operator.

This is a new requirement applicable to Operations Support Personnel as defined herein. In FERC Order No. 742, the Commission noted that NERC, in developing Reliability Standard PER-005-1, did not comply with the directive in FERC Order No. 693 to expand the applicability of training requirements to include operations planning and operation support staff who carry out outage planning and assessments and those who develop System Operating Limits (SOL), IROLs, or operating nomograms for Real-time operations. This requirement does not require that entities create a new, comprehensive systematic approach to training process for training Operations Support Personnel. Rather, the requirements contemplate that entities will look to the systematic approach to training process already developed for System Operators. The entity may use the list created from requirement R1 part 1.1 and select the reliability-related tasks that Operations Support Personnel support and therefore should be trained on.

R4. Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall use a systematic approach to training to develop and implement training for its Operations Support Personnel[3] on the impact of their job function(s) to those Real-time reliability-related tasks identified by the entity pursuant to Requirement R1 part 1.1. [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]

4.1 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall conduct an evaluation each calendar year of the training established in Requirement R4 to identify and implement changes to the training.

M4 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection evidence that Operations Support Personnel completed training in accordance with its systematic approach. This evidence may be documents such as training records showing successful completion of training with the employee name and date.

M4.1 Each Reliability Coordinator, Balancing Authority, Transmission Operator, and Transmission Owner shall have available for inspection evidence (such as instructor observations, trainee feedback, supervisor feedback, course

[3] As used in this standard, the term "Operations Support Personnel" is defined as Individuals, as identified by the Reliability Coordinators, Balancing Authorities, Transmission Operators, or Transmission Owners, who perform outage coordination or assessments, or who determine SOLs, IROLs, or operating nomograms, in direct support of Real-time, reliability-related tasks performed by System Operators.

evaluations, learning assessments, or internal audit results) that it performed a training program evaluation each calendar year, as specified in Requirement R4 part 4.1.

Rationale for R5: The requirement requires the training of certain GOP dispatch personnel on their job function(s) as it pertains to the reliable operations of the BES. This requirement mandates the use of a systematic approach to training which allows for each entity to tailor its training program to the needs of its organization. This requirement does not necessitate a systematic approach to training process that is as comprehensive as that used for RCs, BAs, and TOPs.

This is a new requirement applicable to certain GOPs as described in the applicability section. In FERC Order No. 742, the Commission noted that in developing proposed Reliability Standard PER-005-1, NERC did not comply with the directive in FERC Order No. 693 to expand the applicability of training requirements to include GOPs centrally-located at a generation dispatch center with a direct impact on the reliable operation of the BES. The Commission acknowledged that the training for GOPs need not be as extensive as the training for TOPs and BAs. FERC also stated that the systematic approach to training methodology is flexible enough to build on existing training programs by validating and supplementing the existing training content, where necessary, using systematic methods.

R5. Each Generator Operator shall use a systematic approach to develop and deliver training to its personnel described in Applicability Section 4.1.5 of this standard on the impact of their job function(s) as it pertains to reliable operations of the BES during normal and emergency operations. *[Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

5.1 Each Generator Operator shall conduct an evaluation each calendar year of the training established in Requirement R5 to identify and implement changes to the training.

M5. Each Generator Operator shall have available for inspection evidence that its applicable personnel completed training in accordance with its systematic approach. This evidence may be documents such as training records showing successful completion of training with the employee name and date.

M5.1 Each Generator Operator shall have available for inspection evidence (such as instructor observations, trainee feedback, supervisor feedback, course evaluations, learning assessments, or internal audit results) that it performed a training program evaluation each calendar year, as specified in Requirement R5 part 5.1.

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

As defined in the NERC Rules of Procedure, “Compliance Enforcement Authority” means NERC or the Regional Entity in their respective roles of monitoring and enforcing compliance with the NERC Reliability Standards.

1.2. Evidence Retention

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the compliance enforcement authority may ask an entity to provide other evidence to show that it was compliant for the full-time period since the last audit.

Each Reliability Coordinator, Balancing Authority, Transmission Operator Transmission Owner, and Generator Operator shall keep data or evidence to show compliance for three years or since its last compliance audit, whichever time frame is the greatest, unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

If a Reliability Coordinator, Balancing Authority, Transmission Operator Transmission Owner, or Generator Operator is found non-compliant, it shall keep information related to the non-compliance until found compliant.

The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

1.3. Compliance Monitoring and Assessment Processes:

As defined in the NERC Rules of Procedure, "Compliance Monitoring and Assessment Processes" refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with the associated reliability standard.

1.4. Additional Compliance Information

None

D. Regional Variances

None.

E. Interpretations

None.

F. Associated Documents

None.

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	**Long-term Planning**	**Medium**	**None**	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner, failed to review its company-specific Real-time reliability-related task list to identify new or modified Real-time reliability-related tasks each calendar year. (1.1.1.) OR The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner, failed to implement the identified changes to the Real-time reliability-related task. (1.1.1.) OR The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner, failed to evaluate its training program each calendar year to identify needed changes to its training program(s). (1.4)	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to design and develop training materials based on the Real-time reliability-related task lists. (1.2)	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to prepare a Real-time reliability-related task list. (1.1 or 1.1.1.) OR The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to deliver training based on the Real-time reliability-related task lists. (1.3)

R2	**Long-term Planning**	**High**	**None**	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner verified at least 90% but less than 100% of its System Personnel's capabilities to perform all of their assigned Real-time reliability-related tasks. (R2)	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner verified at least 70% but less than 90% of its System Personnel's capabilities to perform all of their assigned Real-time reliability-related tasks. (R2) OR The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to verify its System Personnel's capabilities to perform each new or modified task within six months of making a modification to its Real-time reliability-related task list. (2.1)	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner verified less than 70% of its System Personnel's capabilities to perform all of their assigned Real-time reliability-related tasks. (R2)
R3	**Long-term Planning**	**Medium**	**None**	**None**	**None**	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner did not provide its System Personnel with any form of simulation technology training such as a simulator, virtual technology, or other technology that replicates the operational behavior of the Bulk Electric System. (R3) OR The Reliability Coordinator, Balancing Authority, Transmission Operator, or

						Transmission Owner did not verify its System Personnel capabilities to perform each new or modified Real-time reliability-related task within twelve months of gaining operational authority or control over a Facility with an established IROL or establishes operating guides or protection systems to mitigate IROL violations. (R3.1)
R4	**Long-term Planning**	**Medium**	**None**	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to evaluate its training established in Requirement R4 each calendar year. (4.1)	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to use a systematic approach to training to establish training requirements as defined in Requirement R4.	The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to develop training for its Operations Support Personnel. (R4) OR The Reliability Coordinator, Balancing Authority, Transmission Operator, or Transmission Owner failed to implement training for its Operations Support Personnel. (R4)
R5	**Long-term Planning**	**Medium**	**None**	The Generator Operator failed to evaluate its training established in Requirement R5 each calendar year. (5.1)	The Generator Operator failed to use a systematic approach to develop training as defined in Requirement R5.	The GOP failed to deliver the training as defined in Requirement R5.

Guidelines and Technical Basis

Requirement R1:

Any systematic approach to training will determine: 1) the skills and knowledge needed to perform Real-time reliability-related tasks; 2) what training is needed to achieve those skills and knowledge; 3) if the learner can perform the Real-time reliability-related task(s) acceptably in either a training or on-the-job environment; and 4) if the training is effective, and make adjustments as necessary.

Reference #1: Determining Task Performance Requirements

The purpose of this reference is to provide guidance for a performance standard that describes the desired outcome of a task. A standard for acceptable performance should be in either measurable or observable terms. Clear standards of performance are necessary for an individual to know when he or she has completed the task and to ensure agreement between employees and their supervisors on the objective of a task. Performance standards answer the following questions:

How timely must the task be performed?

Or

How accurately must the task be performed?

Or

With what quality must it be performed?

Or

What response from the customer must be accomplished?

When a performance standard is quantifiable, successful performance is more easily demonstrated. For example, in the following task statement, the criteria for successful performance is to return system loading to within normal operating limits, which is a number that can be easily verified.

> Given a System Operating Limit violation on the transmission system, implement the correct procedure for the circumstances to mitigate loading to within normal operating limits.

Even when the outcome of a task cannot be measured as a number, it may still be observable. The next example contains performance criteria that is qualitative in nature, that is, it can be verified as either correct or not, but does not involve a numerical result.

> Given a tag submitted for scheduling, ensure that all transmission rights are assigned to the tag per the company Tariff and in compliance with NERC and NAESB standards.

Reference #2: Systematic Approach to Training References:
The following list of hyperlinks identifies references for the NERC Standard PER-005 to assist with the application of a systematic approach to training:

(1) DOE-HDBK-1078-94, A Systematic Approach to Training

http://www.publicpower.org/files/PDFs/DOEHandbookTrainingProgramSystematicApproach.pdf

(2) DOE-HDBK-1074-95, January 1995, Alternative Systematic Approaches to Training, U.S. Department of Energy, Washington, D.C. 20585 FSC 6910

http://www.catagle.com/112-1/download_php-spec_DOE-HDBK-1074-95_003254_1.htm

(3) ADDIE – 1975, Florida State University

http://www.nwlink.com/~donclark/history_isd/addie.html

(4) DOE Standard - Table-Top Needs Analysis
DOE-HDBK-1103-96

http://www.cms.doe.gov/sites/prod/files/2013/06/f2/hdbk1103.pdf

Reference #3: Normal and Emergency Operations Topics
These topics are identified as meeting the topic criteria for normal and emergency operations training.

A. Recognition and Response to System Emergencies

1. Emergency drills and responses
2. Communication tools, protocols, coordination
3. Operating from backup control centers
4. System operations during unstudied situations
5. System Protection
6. Geomagnetic disturbances weather impacts on system operations
7. System Monitoring – voltage, equipment loading
8. Real-time contingency analysis
9. Offline system analysis tools
10. Monitoring backup plans
11. Sabotage, physical, and cyber threats and responses

B. Operating Policies and Standards Related to Emergency Operations

1. NERC standards that identify emergency operations practices (e.g. EOP Standards)
2. Regional reliability operating policies

3. Sub-regional policies and procedures
4. ISO/RTO policies and procedures

C. Power System Restoration Philosophy and Practices

1. Black start
2. Interconnection of islands – building islands
3. Load shedding – automatic (under-frequency and under-voltage) and manual
4. Load restoration philosophies

D. Interconnected Power System Operations

1. Operations coordination
2. Special protections systems
3. Special operating guides
4. Voltage and reactive control, including responding to eminent voltage collapse
5. Understanding the concepts of Interconnection Reliability Operating Limits versus System Operating Limits
6. DC tie operations and procedures during system emergencies
7. Thermal and dynamic limits
8. Unscheduled flow mitigation − congestion management
9. Local and regional line loading procedures
10. Radial load and generation operations and procedures
11. Tie line operations
12. E-tagging and Interchange Scheduling
13. Generating unit operating characteristics and limits, especially regarding reactive capabilities and the relationship between real and reactive output

E. Technologies and Tools

1. Forecasting tools
2. Power system study tools
3. Interchange Distribution Calculator (IDC)

F. Market Operations as They Relate to Emergency Operations

1. Market rules
2. Locational Marginal Pricing (LMP)
3. Transmission rights
4. OASIS

5. Tariffs
6. Fuel management
7. Real-time, hour-ahead and day-ahead tools

Definitions of Simulation and Simulators

Georgia Institute of Technology

Modeling & Simulation for Systems Engineering

http://www.pe.gatech.edu/conted/servlet/edu.gatech.conted.course.ViewCourseDetails?COURSE_ID=840

Simulation is the process of designing a model of a system and conducting experiments to understand the behavior of the system and/or evaluate various strategies for the operation of the system. The modeling & simulation life cycle refers to steps that take place during the course of a simulation study, which include problem formulation, conceptual model development, and output data analysis. Explore modeling & simulation, by using the M&S life cycle as an outline for exploring systems engineering concepts.

University of Central Florida – Institute for Simulation & Training

http://www.ist.ucf.edu/overview.htm

Just what is "simulation" anyway (or, Simulation 101)**?**
And what about "modeling"? (see below)
But what does IST do with simulations? (answer)

In its broadest sense, simulation is imitation. We've used it for thousands of years to train, explain and entertain. Thanks to the computer age, we're really getting good at using simulation for all three.

Simulations (and models, too) are abstractions of reality. Often they deliberately emphasize one part of reality at the expense of other parts. Sometimes this is necessary due to computer power limitations. Sometimes it's done to focus your attention on an important aspect of the simulation. Whereas models are mathematical, logical, or some other structured representation of reality, simulations are the specific application of models to arrive at some outcome (more about models, below).

Three types of simulations
Simulations generally come in three styles: live, virtual and constructive. A simulation also may be a combination of two or more styles.

Live simulations typically involve humans and/or equipment and activity in a setting where they would operate for real. Think *war games* with soldiers out in the field or manning command posts. Time is continuous, as in the real world. Another example of live simulation is testing a car battery using an electrical tester.

Virtual simulations typically involve humans and/or equipment in a computer-controlled setting. Time is in discrete steps, allowing users to concentrate on the important stuff, so to speak. A flight simulator falls into this category.

Constructive simulations typically do not involve humans or equipment as participants. Rather than by time, they are driven more by the proper sequencing of events. The anticipated path of a hurricane might be "constructed" through application of temperatures, pressures, wind currents and other weather factors.

A simulator is a device that may use any combination of sound, sight, motion and smell to make you feel that you are experiencing an actual situation. Some video games are good examples of low-end simulators. For example, you have probably seen or played race car arcade games.

The booths containing these games have a steering wheel, stick shift, gas and brake pedals and a display monitor. You use these devices to "drive" your "race car" along the track and through changing scenery displayed on the monitor. As you drive, you hear the engine rumble, the brakes squeal and the metal crunch if you crash. Some booths use movement to create sensations of acceleration, deceleration and turning. The sights, sounds and feel of the game booth combine to create, or simulate, the experience of driving a car in a race.

Most people first think of "flight simulators" or "driving simulators" when they hear the term "simulation." But simulation is much more.

Because they can recreate experiences, simulations hold great potential for training people for almost any situation. Education researchers have, in fact, determined that people, especially adults, learn better by experience than through reading or lectures. Simulated experiences can be just as valuable a training tool as the real thing.

Simulations are complex, computer-driven *re*-creations of the real thing. When used for training, they must recreate "reality" accurately, otherwise you may not learn the right way to do a task.

For example, if you try to practice how to fly in a flight simulator game that does not accurately *model* (see definition, below) the flight characteristics of an airplane, you will not learn how a real aircraft responds to your control.

Building simulator games is not easy, but creating simulations that *accurately* answer such questions as *"If I do this, what happens then?"* is even more demanding.

Over the years, government and industry, working independently with new technologies and hardware, developed a wide range of products and related applications to improve simulation science. This independence, however, often led to sporadic or redundant research efforts.

To benefit from each other's latest advances, researchers from across the country needed better communication and, ideally, a common source of supporting academic studies. The State of Florida recognized these needs and in 1982 established the Institute for Simulation and Training at the University of Central Florida.

What we do at IST

IST's mission is to advance the state of the art and science of modeling and simulation by

- performing basic and applied simulation research
- supporting education in modeling and simulation and related fields
- serving public and private simulation communities

We don't produce simulator hardware. That's a job for industry. But we've successfully developed working prototype hardware that provides new uses for simulations. We'll also help develop new applications for existing hardware, and scientifically test the results using human factors and other criteria for effective human-machine

interface and learning. Too often overlooked, human factors testing is crucial to ultimate simulation effectiveness. We're fortunate to be closely connected, through joint faculty appointments and working relationships, with one of the top, if not the leading human factors department in the nation—right here at UCF.

We also explore the frontiers of simulation science, expanding our knowledge of ways to stimulate the human senses with advanced optical, audio and haptic technologies.

Still obfuscated? Go here...

Modeling: a model definition

A computer model, as used in modeling and simulation science, is a mathematical representation of something—a person, a building, a vehicle, a tree—any object. A model also can be a representation of a process—a weather pattern, traffic flow, air flowing over a wing.

Models are created from a mass of data, equations and computations that mimic the actions of things represented. Models usually include a graphical display that translates all this number crunching into an animation that you can see on a computer screen or by means of some other visual device.

Models can be simple images of things—the outer shell, so to speak—or they can be complex, carrying all the characteristics of the object or process they represent. A complex model will simulate the actions and reactions of the real thing. To make these models behave the way they would in real life, accurate, real-time simulations require fast computers with lots of number crunching power.