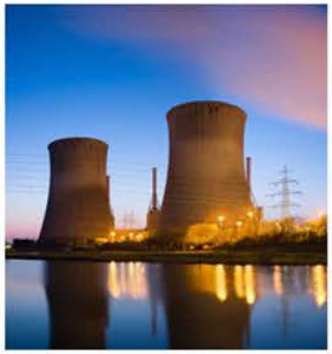
NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Project 2009-02

Real-time Monitoring and Analysis Capabilities

Technical Conference
June 4, 2015

RELIABILITY | ACCOUNTABILITY

Administrative

- Internet passcode: 3htw0br3wt1s (label located on desk)
- Presentations available on the project page:

  http://www.nerc.com/pa/Stand/Pages/Project-2009-02-Real-time-Reliability-Monitoring-and-Analysis-Capabilities-RF.aspx

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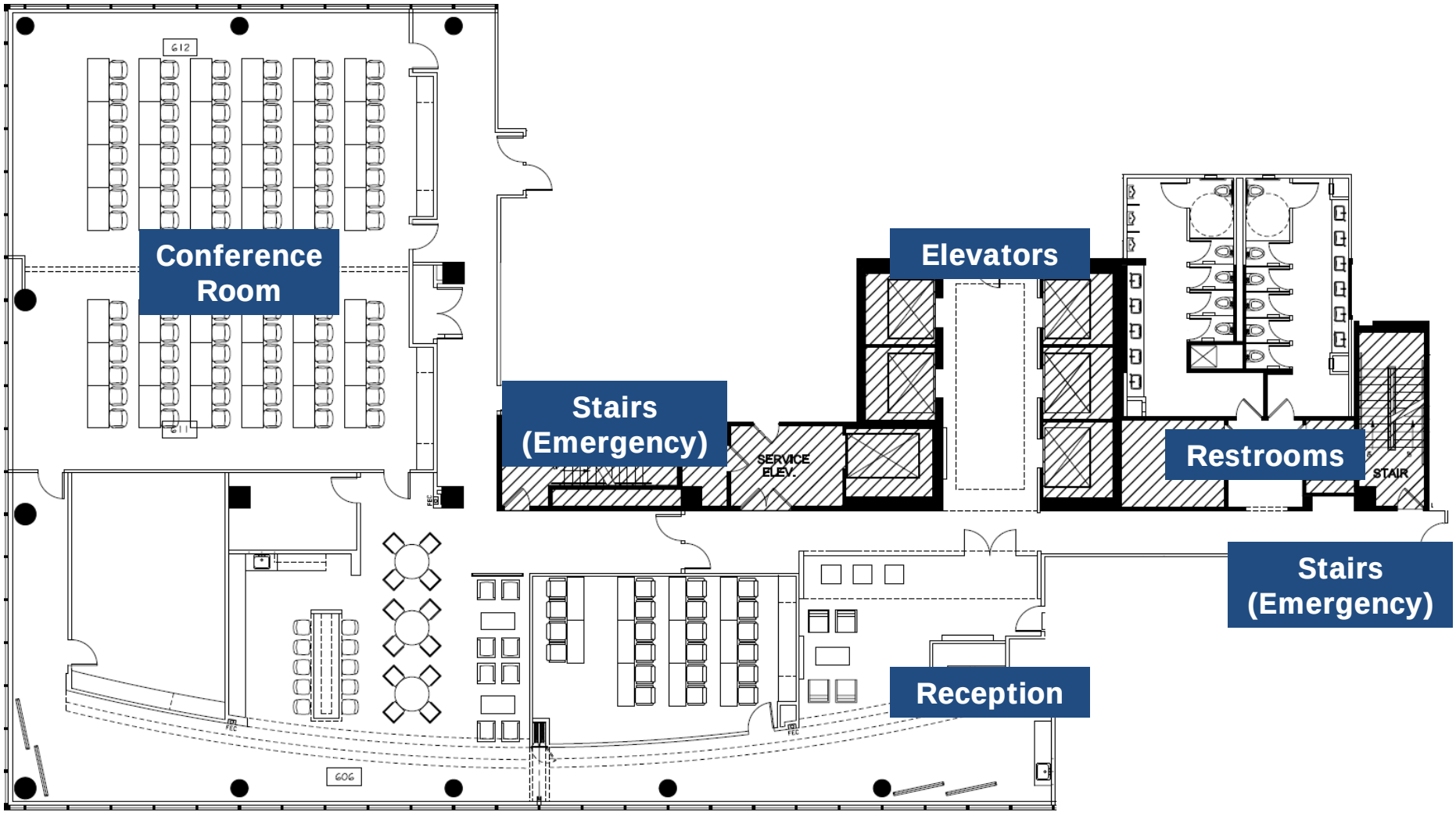
Meeting Space



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Public Meeting Guidelines

- Participants are reminded that this meeting is public. Notice of the meeting was posted on the NERC website and widely distributed. Participants should keep in mind that the audience may include members of the press and representatives of various governmental authorities, in addition to the expected participation by industry stakeholders.

Conference Objectives

- Obtain stakeholder input on scope of the standards project for Real-time Reliability Monitoring and Analysis Capabilities
- Develop a common understanding of issues that need to be addressed based on:
  - Past recommendations (Real-time Tools Task Force, BES Events, others)
  - Current and proposed reliability standards
- Obtain guidance that can assist a Standards Drafting Team (SDT)

Ground Rules

- Format is intended to encourage constructive dialogue
  - In-room participants – use microphones
  - Remote participants on phone – operator will assist you
  - Timekeeping during discussion and panel session to keep on schedule
- Focus on guidance that can assist the SDT: Recommendations and solutions
- NERC Staff is capturing themes for review at conclusion

Agenda

- Background topics
  - Situational Awareness Overview
  - Monitoring and Real-time Assessment in proposed TOP and IRO Standards
- Discussion of Technical Issues
  - FERC Directives
  - Real-time Tools Survey Analysis and Recommendations
  - 2011 Southwest Outage Report
  - Project 2009-02 Proposed Scope
- Panel Discussion
- Recap of themes to inform standards development

Introductions

SAR Drafting Team

Position	Participant	Entity
Chair	Saad Malik	Peak Reliability
Vice Chair	Andrew Pankratz	Florida Power & Light
Member	Charles Abell	Ameren
Member	Scott Aclin	Southwest Power Pool
Member	Phil Hart	AECI
Member	T.J. (Tim) Kucey	PSEG Fossil, LLC
Member	Alan Martin	Southern Company Transmission
Member	Bert Peters	Arizona Public Service
Member	Sarma Nuthalapati	Electric Reliability Council of Texas
Member	Jim Useldinger	Kansas City Power and Light

Background

- Project 2009-02 was initiated in response to work done by the NERC Operating Committee's Real-time Tools Best Practices Task Force (RTBPTF)
  - Click here to view the Real-time Tools Survey Analysis and Recommendations (March 2008)
- From 2009 to 2011, a SAR drafting team developed a SAR and technical white paper to establish requirements for the "functionality, performance, and maintenance of Real-time Monitoring and Analysis Capabilities."
- Formal development paused in 2011

SAR Development Process

- Project 2009-02 is included in the 2015-2017 Reliability Standards Development Plan approved by NERC Board
- Standards Committee (SC) appointed a SAR Drafting Team (SAR DT) in April 2015 to revise prior SAR
  - Web meetings conducted in April and May
  - In-person meeting May 30-31, 2015
- SAR will be posted for 30-day stakeholder comment period July 2015

Project Page:

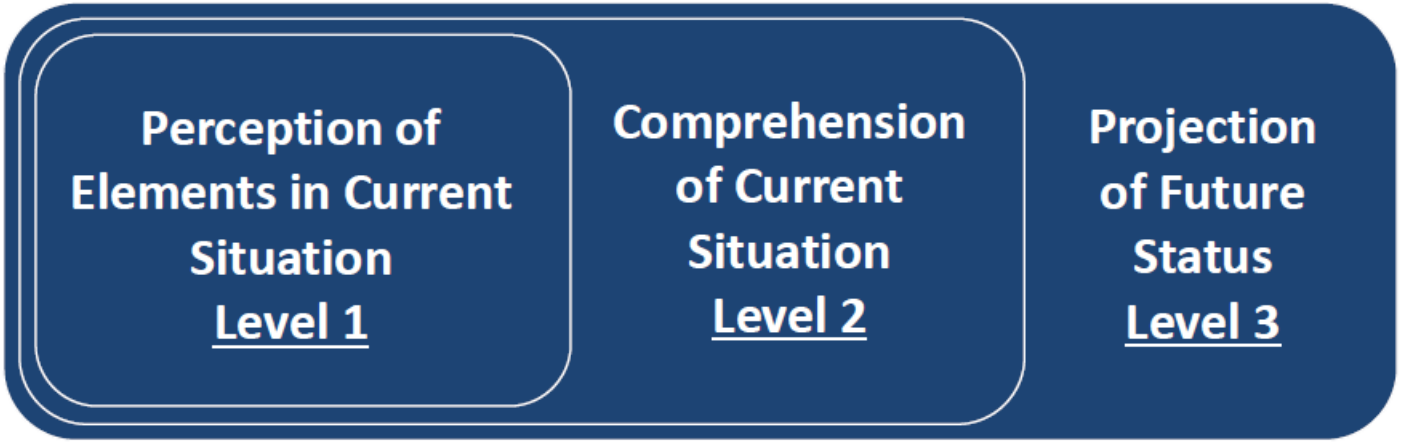
http://www.nerc.com/pa/Stand/Pages/Project-2009-02-Real-time-Reliability-Monitoring-and-Analysis-Capabilities.aspx

Background Topics

Why is Situational Awareness Important?

- July 19, 1965
  - "System control centers should be equipped with display and recording equipment which provide the operator with as clear a picture of system conditions as possible."
- July 2, 1996
  - "… review the need… to monitor operating conditions on a regional scale..."
- August 10, 1996
  - "…train operators to make them aware of system conditions and changes…"
- August 14, 2003
  - "…inadequate situational awareness…"
- September 8, 2011
  - "This failure stemmed primarily from weaknesses in two broad areas – operations planning and real-time situational awareness…"

Situational Awareness



Situational Awareness Concept

Situational awareness, as RTBPTF understands it, means ensuring that accurate information on current system conditions, including the likely effects of future contingencies, is continuously available in a form that allows operators to quickly grasp and fully understand actual operating conditions and take corrective action when necessary to maintain or restore reliable operations.

-RTBPTF Report, March 2008

FERC Order No. 693

- In approving the original TOP and IRO standards, FERC directed future improvements to ensure operating entities can perform their real-time reliability functions:
  - P 905: *Further, consistent with the NOPR, the Commission directs the ERO to modify IRO-002-1 to require a minimum set of tools that must be made available to the reliability coordinator. We believe this requirement will ensure that a reliability coordinator has the tools it needs to perform its functions.*
  - P 906*: [t]he Commission clarifies that the Commission's intent is to have the ERO develop a requirement that identifies capabilities, not actual tools or products. The Commission agrees that the latter approach is not appropriate as a particular product could become obsolete and technology improves over time.*

FERC Order No. 693

- In approving the original TOP and IRO standards, FERC directed future improvements … (continued) :
  - P 1660: *We adopt our proposal to require the ERO to develop a modification [to TOP standards] related to the provision of a minimum set of analytical tools. In response to LPPC and others, we note that our intent was not to identify specific sets of tools, but rather the minimum capabilities that are necessary to enable operators to deal with real-time situations and to ensure reliable operation of the Bulk-Power System.*

Project 2014-03

- Revised TOP and IRO standards include key provisions for real-time situational awareness and operations planning
- Nine standards filed for approval in March 2015
- Project 2014-03 considered a broad range of inputs:
  - FERC Notice of Proposed Rulemaking (NOPR)
  - Projects 2006-06 and 2007-03
  - Order 693 directives
  - 2011 Southwest Outage Report
  - Independent Experts Review Project (IERP) report
  - Technical conferences
  - Comments
- Many recommendations in the RTBPTF report are addressed by Proposed TOP and IRO standards developed in this project

Impacted Standards

- Revised Standards (will retire all previous versions):
  - TOP-001-3, TOP-002-4, TOP-003-3
  - IRO-001-4, IRO-002-4, IRO-008-2, IRO-010-2, IRO-014-3
- Retired Standards:
  - TOP-004-2, TOP-005-2a, TOP-006-3, TOP-007-0, TOP-008-1
  - IRO-003-2, IRO-004-2, IRO-005-3.1a, IRO-015-1, IRO-016-1
- New Standard:
  - IRO-017
- Revised definitions
  - Real-time Assessment
  - Operational Planning Analysis

Definition of Operational Planning Analysis

Operational Planning Analysis: An evaluation of projected system conditions to assess anticipated (pre-Contingency) and potential (post-Contingency) conditions for next-day operations. The evaluation shall reflect applicable inputs including, but not limited to, load forecasts; generation output levels; Interchange; known Protection System and Special Protection System status or degradation; Transmission outages; generator outages; Facility Ratings; and identified phase angle and equipment limitations. (Operational Planning Analysis may be provided through internal systems or through third-party services.)

Definition of Real-time Assessment

Real-time Assessment (RTA): An evaluation of system conditions using Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions. The assessment shall reflect applicable inputs including, but not limited to: load, generation output levels, known Protection System and Special Protection System status or degradation, Transmission outages, generator outages, Interchange, Facility Ratings, and identified phase angle and equipment limitations. (Real-time Assessment may be provided through internal systems or through third-party services.)

IRO-002-4

- **Title: Reliability Coordination – Monitoring and Analysis**
- **Purpose:** Provide System Operators with the capabilities necessary to monitor and analyze data needed to perform their reliability functions.
- **R1.** Each Reliability Coordinator shall have data exchange capabilities with its Balancing Authorities and Transmission Operators, and with other entities it deems necessary, for it to perform its Operational Planning Analyses, Real-time monitoring, and Real-time Assessments.
- **R2.** Each Reliability Coordinator shall provide its System Operators with the authority to approve planned outages and maintenance of its telecommunication, monitoring and analysis capabilities.

IRO-002-4

- **R3.** Each Reliability Coordinator shall monitor Facilities, the status of Special Protection Systems, and non-BES facilities identified as necessary by the Reliability Coordinator, within its Reliability Coordinator Area and neighboring Reliability Coordinator Areas to identify any System Operating Limit exceedances and to determine any Interconnection Reliability Operating Limit exceedances within its Reliability Coordinator Area.
- **R4.** Each Reliability Coordinator shall have monitoring systems that provide information utilized by the Reliability Coordinator's operating personnel, giving particular emphasis to alarm management and awareness systems, automated data transfers, and synchronized information systems, over a redundant infrastructure.

IRO-008-2

- **Title: Reliability Coordinator Operational Analyses and Real-time Assessments**
- **Purpose:** Perform analyses and assessments to prevent instability, uncontrolled separation, or Cascading.
- **R4.** Each Reliability Coordinator shall ensure that a Real-time Assessment is performed at least once every 30 minutes.
- **R5.** Each Reliability Coordinator shall notify impacted Transmission Operators and Balancing Authorities within its Reliability Coordinator Area, and other impacted Reliability Coordinators as indicated in its Operating Plan, when the results of a Real-time Assessment indicate an actual or expected condition that results in, or could result in, a System Operating Limit (SOL) or Interconnection Reliability Operating Limit (IROL) exceedance within its Wide Area.

TOP-001-3

- **Title: Transmission Operations**
- **Purpose:** To prevent instability, uncontrolled separation, or Cascading outages that adversely impact the reliability of the Interconnection by ensuring prompt action to prevent or mitigate such occurrences.
- **R10.** Each Transmission Operator shall perform the following as necessary for determining System Operating Limit (SOL) exceedances within its Transmission Operator Area:
  - **10.1.** Within its Transmission Operator Area, monitor Facilities and the status of Special Protection Systems, and
  - **10.2.** Outside its Transmission Operator Area, obtain and utilize status, voltages, and flow data for Facilities and the status of Special Protection Systems.

TOP-001-3

- **Title: Transmission Operations**
- **R11.** Each Balancing Authority shall monitor its Balancing Authority Area, including the status of Special Protection Systems that impact generation or Load, in order to maintain generation-Load-interchange balance within its Balancing Authority Area and support Interconnection frequency.
- **R13.** Each Transmission Operator shall ensure that a Real-time Assessment is performed at least once every 30 minutes.
- **R14.** Each Transmission Operator shall initiate its Operating Plan to mitigate a SOL exceedance identified as part of its Real-time monitoring or Real-time Assessment.

TOP-001-3

- **Title: Transmission Operations**
- **R16 (R17).** Each Transmission Operator (Balancing Authority) shall provide its System Operators with the authority to approve planned outages and maintenance of its telemetering and control equipment, monitoring and assessment capabilities, and associated communication channels between affected entities.
- **R19 (R20).** Each Transmission Operator (Balancing Authority) shall have data exchange capabilities with the entities that it has identified that it needs data from in order to maintain reliability in its Transmission Operator Area (Balancing Authority Area).

TOP-003-3

- **Title: Operational Reliability Data**
- **Purpose:** To ensure that the Transmission Operator and Balancing Authority have data needed to fulfill their operational and planning responsibilities.
- **R1.** Each Transmission Operator shall maintain a documented specification for the data necessary for it to perform its Operational Planning Analyses, Real-time monitoring, and Real-time Assessments. The data specification shall include, but not be limited to:
  - **1.1.** A list of data and information needed by the Transmission Operator to support its Operational Planning Analyses, Real-time monitoring, and Real-time Assessments including non-BES data and external network data as deemed necessary by the Transmission Operator.
- R2 is analogous for BAs

- **R2.** Each Balancing Authority shall maintain a documented specification for the data necessary for it to perform its analysis functions and Real-time monitoring. The data specification shall include, but not be limited to:
  - **2.1.** A list of data and information needed by the Balancing Authority to support its analysis functions and Real-time monitoring.

Discussion of Technical Issues

Technical Issues

- Real-time Tools Survey Analysis and Recommendations
- 2011 Project 2009-02 Concept White Paper
- 2011 Southwest Outage Report
- FERC Directive

FERC Order No. 693

- In approving the original TOP and IRO standards, FERC directed future improvements to ensure operating entities can perform their real-time reliability functions:
  - P 905: *Further, consistent with the NOPR, the Commission directs the ERO to modify IRO-002-1 to require a minimum set of tools that must be made available to the reliability coordinator. We believe this requirement will ensure that a reliability coordinator has the tools it needs to perform its functions.*
  - P 906*: [t]he Commission clarifies that the Commission's intent is to have the ERO develop a requirement that identifies capabilities, not actual tools or products. The Commission agrees that the latter approach is not appropriate as a particular product could become obsolete and technology improves over time.*

FERC Order No. 693

- In approving the original TOP and IRO standards, FERC directed future improvements … (continued) :
  - P 1660: *We adopt our proposal to require the ERO to develop a modification [to TOP standards] related to the provision of a minimum set of analytical tools. In response to LPPC and others, we note that our intent was not to identify specific sets of tools, but rather the minimum capabilities that are necessary to enable operators to deal with real-time situations and to ensure reliable operation of the Bulk-Power System.*

Real-time Tools Survey Analysis and Recommendations

- RTBPTF was formed by the NERC Operating Committee following the *Final Report on the August 14, 2003 Blackout in the United States and Canada*
- Charter was to study situational awareness practices in use and make recommendations on establishing minimum capabilities
- *Real-time Tools Survey Analysis and Recommendations (2008)* is the result of extensive information gathering and analysis
- Current SAR DT is focused on identifying recommendations that should be considered in Project 2009-02
  - Have not been addressed in other standards
  - Provide reliability benefit that should be required by standards

Review of RTBPTF Report

- Since the report was written, many recommendations have been addressed or evolved into common practice
- Current TOP and IRO standards and proposed standards and definitions from Project 2014-03 contain many real-time situational awareness provisions
  - Explicit definitions for Real-time Assessment and Operational Planning Analysis
  - Requirements to perform monitoring and Real-time Assessments
  - Data specification requirements

Recommendation S1

RTBPTF Report Recommendation	SAR DT Proposal
S1 - Mandate the following reliability tools as mandatory monitoring and analysis tools. • Alarm Tools • Telemetry Data Systems • Network Topology Processor • State Estimator • Contingency Analysis	Project 2009-02 will address requirements for Real-time monitoring and analysis capabilities. Prescription of specific tools is not in scope.

Recommendation S7-8, S11-12

RTBPTF Report Recommendation	SAR DT Proposal
S7 - S8, S11-S12 - Availability of various monitoring and analysis capability processes	Project 2009-02 will address the recommendation from the RTBPTF report to provide operator awareness when key monitoring, alarming, and analysis tools are not available (i.e. not performing their intended function)

- RTBPTF recommendation for a reliability standard requirement focused on providing operator awareness of ‘stalled’ state

Recommendation S4 and S5

RTBPTF Report Recommendation	SAR DT Proposal
S4 - Develop data-exchange standards. S5 - Develop data-availability standards and a process for trouble resolution and escalation.	Addressed in proposed TOP-001-3, IRO-002-4, TOP-003-3 and IRO-010-2 as well as approved IRO-010-1.

Proposed IRO-002-4

R1. *Each Reliability Coordinator shall have data exchange capabilities with its Balancing Authorities and Transmission Operators, and with other entities it deems necessary, for it to perform its Operational Planning Analyses, Real-time monitoring, and Real-time Assessments.*

- Proposed TOP-003-3 and IRO-010-2 (and approved IRO-010-1) require RCs, TOPs, and BAs to have a data specification to meet Operational Planning Analyses, Real-time monitoring, and Real-time Assessments needs.

Recommendation S6

RTBPTF Report Recommendation	SAR DT Proposal
S6 - Develop a new weather data requirement related to situational awareness and real-time operational capabilities.	EOP-010-1 covers space weather dissemination. SAR DT views monitoring other weather information as common good utility practice that does not require a reliability standard.

Recommendation S14

RTBPTF Report Recommendation	SAR DT Proposal
S14 - Perform one-hour-ahead power-flow simulations to assess approaching SOL and IROL violations and corresponding measures.	Requirements for assessing pre- and post-contingency system conditions are addressed in Real-time Assessment (RtA) and Operational Planning Analysis (OPA) definitions. Requirements for performing RtA and OPA are contained in proposed TOP-001-3, TOP-002-4, IRO-008-2, and approved IRO-008-1.

Recommendation S16 – S17

RTBPTF Report Recommendation	SAR DT Proposal
S16 - Require BAs to monitor contingency reserves and calculate contingency reserves at a minimum periodicity of 10 seconds. S17 - Revise the current-day operations requirements to delineate specific, independent requirements for monitoring operating and reactive reserves.	Addressed through BAL standards and revisions.

Recommendation S19

RTBPTF Report Recommendation	SAR DT Proposal
S19 - Restore system operations from an unknown operating state to proven and reliable limits within 30 minutes.	Addressed in project 2014-03.

- TOP-004-2 Requirement R4 is replaced by proposed TOP-001-3 R12, 13, and 14.
  - **R12**. Each Transmission Operator shall not operate outside any identified Interconnection Reliability Operating Limit (IROL) for a continuous duration exceeding its associated IROL T_v.
  - **R13**. Each Transmission Operator shall ensure that a Real-time Assessment is performed at least once every 30 minutes.
  - **R14.** Each Transmission Operator shall initiate its Operating Plan to mitigate an SOL exceedance identified as part of its Real-time monitoring or Real-time Assessment.

Recommendation S20-S32

RTBPTF Report Recommendation	SAR DT Proposal
S20-S32 – Various recommendations pertaining to development of operating guides (mitigation plans)	Addressed in project 2014-03.

- Proposed TOP-002-4 and IRO-008-2 require entities to develop Operating Plans to address potential SOL and IROL exceedances identified as a result of its Operational Planning Analysis

Recommendation S33

RTBPTF Report Recommendation	SAR DT Proposal
S33 - Provide the location, real-time status, and MWs of load available to be shed.	Addressed in proposed EOP-011-1 and proposed TOP-003-3.

Recommendation S35

RTBPTF Report Recommendation	SAR DT Proposal
S35 - Provide information to operators to maintain awareness of the availability and capability of the blackstart generators and transmission restoration paths.	Covered in approved IRO-010-1 and proposed TOP-003-3 and IRO-010-2.

Recommendation S36

RTBPTF Report Recommendation	SAR DT Proposal
S36 - Plan and coordinate scheduled outages of blackstart generators and transmission restoration paths.	Addressed in proposed IRO-017-1 - Outage Coordination.

Recommendation S37-S40

RTBPTF Report Recommendation	SAR DT Proposal
S37 - 40 Various recommendations to identify, monitor, log, and maintain Critical Equipment	Project 2009-02 is not addressing specific tools. Recommendation is not in scope.

- RTBPTF report considered *critical equipment* to be installed equipment that makes up infrastructure and systems (including communication networks, data links, hardware, software applications, and data bases) that are directly used as critical real-time tools

2011 Concept White Paper

- Concept White Paper (2011) was developed early in Project 2009-02 based on RTBPTF Report
- Outlined requirements and parameters under consideration for monitoring and analysis capability standards
  - Monitoring
  - Data Exchange
  - Alarming
  - Analysis
- Significant changes in existing and proposed Reliability Standards and operating practices since the 2011 Concept White Paper was written

2011 Southwest Outage Report

- 2011 Southwest Outage Report highlighted operations planning and real-time situational awareness issues from the September 8, 2011 Arizona-Southern California outage.
- Project 2014-03 TOP/IRO Revisions addressed most situational awareness recommendations
- Some recommendations related to monitoring and analysis capabilities should be considered in Project 2009-02

2011 Southwest Outage Report

SW Outage Report Recommendation	SAR DT Proposal
Recommendation 12 - [entities] should take measures to ensure that their real-time tools are adequate, operational, and run frequently enough to provide their operators the situational awareness necessary to identify and plan for contingencies and reliably operate their systems.	Project 2009-02 will develop requirements to improve the adequacy and operation of real-time monitoring and analysis capabilities. Requirements addressing the frequency that real-time tools are run are contained in other standards and are not in the scope of this project.

- Proposed TOP-001-3 Requirement R13 specifies performance of a Real-time Assessment for TOPs:

  Each Transmission Operator shall ensure that a Real-time Assessment is performed at least once every 30 minutes.

2011 Southwest Outage Report

SW Outage Report Recommendation	SAR DT Proposal
Recommendation 27 - TOPs should have: (1) the tools necessary to determine phase angle differences following the loss of lines; and (2) mitigation and operating plans for reclosing lines with large phase angle differences.	This recommendation was addressed in Project 2014-03 proposed revisions to TOP and IRO standards.

- Consideration of phase angle limitations is included in the proposed definitions of Real-time Assessment (RTA) and Operational Planning Analysis (OPA).

SAR Discussion

Project Scope

- Project 2009-02 will develop new requirements and definition(s), as needed, for real-time monitoring and analysis capabilities to ensure effective operator situational awareness
  - Address FERC directives and recommendations from 2003 Blackout Report, 2011 Southwest Outage Report, and RTBPTF Report
- Requirements and definition(s) will accomplish the following:
  - Establish a common understanding of *monitoring* as it applies to real-time situational awareness of the BES
  - Provide operators with indication(s) of the quality of information being provided by *monitoring* and *analysis* capabilities
  - Provide operators with notification(s) during unplanned loss of *monitoring* and *analysis* capabilities
- Applicable entities: RC, TOP, and BA

Monitoring

- Project 2009-02 will promote a common understanding of *monitoring* to provide greater clarity and consistency
  - Accomplished through formal definition or white paper
- Monitoring should include alarming and visualization
- Consistent understanding of *monitoring* enhance reliability benefits of existing and proposed TOP and IRO standards

Proposed IRO-002-4

R3. Each Reliability Coordinator shall monitor Facilities, the status of Special Protection Systems, and non-BES facilities identified as necessary by the Reliability Coordinator, within its Reliability Coordinator Area and neighboring Reliability Coordinator Areas to identify any System Operating Limit exceedances and to determine any Interconnection Reliability Operating Limit exceedances within its Reliability Coordinator Area.

Monitoring

- Consistent understanding would enhance reliability benefits of existing and proposed TOP and IRO standards (cont.)

Proposed TOP-001-3

R10. Each Transmission Operator shall perform the following as necessary for determining System Operating Limit (SOL) exceedances within its Transmission Operator Area:

10.1. Within its Transmission Operator Area, monitor Facilities and the status of Special Protection Systems, and

10.2. Outside its Transmission Operator Area, obtain and utilize status, voltages, and flow data for Facilities and the status of Special Protection Systems.

Analysis

- The *analysis* component of real-time situational awareness is described by the definition of Real-time Assessment
  - Revised definition is pending FERC approval

Real-time Assessment *- An evaluation of system conditions using Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions. The assessment shall reflect applicable inputs including, but not limited to: load, generation output levels, known Protection System and Special Protection System status or degradation, Transmission outages, generator outages, Interchange, Facility Ratings, and identified phase angle and equipment limitations. (Real-time Assessment may be provided through internal systems or through third-party services.)*

Additional Project Objectives

Table 2: Project 2009-02 Reliability Objectives		
	Monitoring Capabilities	**Analysis Capabilities**
Quality	Provide operator with indication of information quality.	Provide operator with indication of information quality.
Availability	Provide operator with notification any time monitoring system is not operating normally.	Provide operator with notification any time Real-time Assessment capabilities are not available.

Discussion

Panel Discussion

Panelists

- Liem Hoang – PJM Interconnection
- Jason Smith – Southwest Power Pool
- Stephen Solis – ERCOT
- Brett Wangen – Peak Reliability

Recap

Conclusion

Voltage Stability Analysis

- In approving VAR-001-1 - Voltage and Reactive Control, the Commission directed NERC to develop modifications to the standard to require periodic performance of voltage stability analysis to assist in real-time operations.

  P1875: *...[w]e direct the ERO, through its Reliability Standards development process, ...to include requirements to perform voltage stability analysis periodically, using online techniques where commercially-available, and offline simulation tools where online tools are not available, to assist real-time operations.*

- Voltage stability limits are SOLs and should be determined performed per SOL Methodology required by FAC standards