Introduction

Over the last three years, WECC has conducted the Reliability Assurance Project to evaluate the operational practices in the Western Interconnection and gauge the level of improvement since the September 2011 Southwest Blackout. In 2017, the Assurance Team concluded that Transmission Operators had generally improved their practices since 2011, but there was still work to do. In 2018, the Assurance Team visited 11 Transmission Operators. Consistent with findings in 2016 and 2017, most entities have improved since the 2011 Southwest Blackout. However, the rate of improvement seems to have slowed. In addition, it is not clear that all the entities visited in 2018 have reviewed and addressed the concerns shared in previous assurance reports.

The goal of the Reliability Assurance Project is to conduct site visits to evaluate operational practices in the following areas:

- Next-day studies (NDS)
- Wide-area view
- Real-time Assessments (RTA)
- Communication, coordination, and data sharing
- Operational paradigm and relationships

This report contains a summary of the project findings from 2018 with respect to these areas.

Summary of Findings

Since 2016, the Assurance Team has visited 34 Transmission Operators (TOPS) in the Western Interconnection. Each entity is ranked based on scoring criteria (see Appendix). The ranking allows WECC to better understand the overall performance across the Interconnection. Ranking the entities also helps WECC share confidential, targeted feedback with each visited entity.

*Overall Entity Performance*

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<th>Top Performer</th>
<th>Group 1</th>
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Overall, average entity performance slightly increased in 2018, although the average performance of entities in Group 2 decreased. There was some increase in top performance, meaning the team observed some new best practices.

In 2018, the Assurance Team revisited two entities that were seen in 2016. These entities showed marked improvement with respect to deficiencies identified in previous visits. The key change evident at both TOPs was an improvement in company culture that promotes continuous improvement and a proactive approach to operations. This cultural change enables and encourages progressive solutions across the entities’ operational practices.
High-Level Concerns

- Operational practices have improved since 2011; there is still improvement to be made, however, and the team is concerned that the rate of improvement has slowed. Given the changing system dynamics and operational landscape, a slow rate of improvement may mean entities have difficulty keeping up with new challenges.

- The use of Real-time Contingency Analysis (RTCA) remains inconsistent. There is a large disparity between entities that effectively employ, train on, and develop their RTCA and those that do not. A small number of entities do not use their RTCA effectively. The Assurance Team assumes entities are compliant with TOP-001 R13 and focuses its evaluation on the use of the Real-time Assessment (RTA) tools. The team evaluates whether entities are using their RTA tools as check-the-box mechanisms or as part of a situational awareness strategy that allows reliable operation of the grid.

- The team saw a potential area for improvement in communication of expectations between entities regarding responsibilities. Some entities said that a neighboring entity, their Balancing Authority or the Reliability Coordinator, handled certain duties. These arrangements are acceptable but do not relieve TOPs from watching their systems and identifying potential threats. Each Transmission Operator is expected to perform thorough studies of upcoming system conditions and familiarize itself with potential weaknesses in its system through sensitivity and stability studies.

- A high volume of alarms is a concern for many entities. In some cases, entities receive thousands of alarms each day. Some operators reported an inability to read all the received alarms. The high volume of alarms can be attributed to several factors, including a failure to remove alarms that can be addressed by other departments (e.g., door alarms that company security personnel can address), and multiple alarms for single events (e.g., line trips). Entities should design an alarm philosophy that reduces the number of alarms to those that drive an operator to take action. Most alarms for informational purposes only do not need to be displayed or acknowledged by operators.

High-Level Growth

- Overall, the relationships among TOPs and between TOPs and Peak Reliability (Peak) are strong. The team observed a high level of respect and understanding of roles and responsibilities. There seems to be a widespread attitude of shared responsibility for system operations. Given the present operational configuration of the system, and the current Reliability Coordinator (RC) role, the Assurance Team is confident in the effectiveness of these relationships. Changes to the configuration of the Interconnection and RC function could alter the status of these relationships. This area should be monitored considering new operational roles at the RC level.

- As in 2017, the Assurance Team noted improvement in NDS. With a few notable exceptions, the quality of NDS has improved and continues to improve as entities work to get ahead of potential issues on the system. This is where entity-to-entity discussion would aid in sharing excellent practices.
Next-day Studies

Next-day Studies allow entities to proactively identify potential issues on the system and develop operating solutions prior to real-time operations. Because all TOPs are required to perform NDSs (TOP-002-2b R11) or Operational Planning Analyses (TOP-002-4 R1 as of April 1, 2017), the assurance project focused on study quality, study processes, how studies are shared and used internally, and study validation.

All entities visited in 2018 perform a version of an NDS, through which entities evaluate their system and customize their study process to meet their needs. The process must result in a study that will identify any possible reliability challenges in the following day’s operations, and trigger appropriate mitigation actions. The team observed performance similar to previous years, including a lack of sensitivity studies to augment professional judgement when determining which external facilities to include in the studies.

Performance Summary

Excellence in Practice

The team observed the following excellent practices from one or more entities.

- Study output metrics: Running metrics on study outputs can help determine the accuracy of models and forecasts. Some entities are comparing forecasted to actual values daily and tracking accuracy over time. Ensuring the accuracy of forecasts is crucial because inaccurate or insufficient forecasts can invalidate the study results, and leave possible issues unidentified.

- Engineering and Operations Coordination: A formal handoff between the Study Engineer and the real-time Operations Team provides a forum to review the study results, clarify any operating plans, and foster feedback on the process. Entities that have formalized a hand-off for their NDSs have seen improved relationships between the two groups and improved studies.

Areas of Concern

- Only five of 34 entities have employed a systematic method—in addition to professional judgement—to identify impactful facilities in neighboring systems. These studies help identify impactful external facilities to include in the NDS process and system displays.

- Some entities lack a formal process for reviewing or validating the quality of their NDSs. Most entities use their RTCA results to validate their studies. This method compares the results of the NDS to the real-time tool, but does not account for the inputs to the NDS. Study validation should include inputs such as load and generation forecasts to improve their accuracy.

Groups 2 and 4 showed changes in their NDS practices. Group 2 showed a decline in performance, while Group 4 showed a slight decline in average performance but a large increase in top performance due to new top performers in this category.
Reliability Assurance Project 2018 Findings

Wide-area View

A wide-area view provides entities with real-time and planning information about what occurs outside their system that may impact their operations, as well as how events and conditions on their system impact the larger network. The Reliability Assurance Project focused on the quality and effectiveness of situational awareness tools, how external facilities are incorporated in these tools, how well displays communicate system status, and alarm philosophy.

Performance Summary

The team observed improvement in average performance across all but Group 2 entities, where there was a slight decrease in performance over the 2017 average. Group 3 saw a new top performer in 2018, increasing the top performance score in that category.

Excellence in Practice

- Smart Alarming with Compensatory Actions: Some entities have identified recommended actions for each alarm and built them into the alarming part of their energy management systems (EMS). Other entities have programmed responses into the RTCA, giving operators immediate access to compensatory actions. Both practices ensure that operators have an action associated with incoming alarms. This reduces the time and distraction associated with responding to alarms.

- Visual Displays: While overall system visualization remains an area of concern, there are some excellent practices that merit mentioning. By simplifying displays, muting colors, and showing only pertinent data, some TOPs have maximized the usefulness of their visualization tools and minimized clutter and information overload.

Areas of Concern

- All TOPs maintain an EMS model for their portion of the bulk electric system (BES) and have sufficient models of internal facilities. The extent to which entities model external facilities varies. As with past visits, the 2018 visits revealed a sole reliance on professional judgement and lack complementary sensitivity studies to develop external visibility. Only two of the ten TOPs visited in 2018 used a study to support their wide-area view development. The most common practice is to build out study models and displays to a predetermined number of external buses (e.g., 3 or 4) and then add other facilities that are deemed impactful or critical based on engineering judgment. Using periodic sensitivity studies with a defined distribution factor to augment engineering judgement will help entities determine the appropriate extent of their external visibility.

- While a few entities have developed effective map boards, the majority display too much information and do not prioritize information based on its usefulness to the operator. Consistent with previous years, operators at most entities use the displays on their local machines rather than information from the map board. Map boards tend to use legacy
philosophies that no longer apply to video walls and EMS workstations with many displays. This is a topic that would benefit from entity-to-entity discussion to share excellent practices.

- Alarm overload is still an issue throughout the interconnection. Entities can filter and prioritize their alarms, but methods to do so are not consistent. Many entities do not include operations personnel in decisions on which alarms to display. In most cases, unnecessary alarms are kept to provide information; however, alarming is meant to trigger action and should not be used for information only. Eliminating unnecessary alarms will reduce the information load on operations personnel. Coupling alarms with procedures for addressing the alarms will help operators to respond appropriately and quickly. This is another area where entity discussion can reveal excellent practices.
Real-time Assessments

A Real-time Assessment is an evaluation of system conditions using real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions. This evaluation is typically performed with the aid of the RTCA, either hosted by the entity or via subscription. Real-time Assessments give information about potential contingencies on the system so operators can create mitigation plans beforehand. Real-time Assessments are a critical part of a proactive approach to system operations. All TOPs must conduct Real-time Assessments (TOP-001 R13), and the Assurance Team assumes entities are compliant. The assurance work focused on which tools entities use, how they select contingencies, and how they use the results in real-time operations.

All entities perform Real-time Assessments themselves, either through Peak’s Hosted Advanced Applications (HAA) tool or via an in-house tool.

Performance Summary

Groups 1 and 3 showed marked improvement in this category over 2017 averages, including new top performers in each group. Group 2 remained relatively the same as in 2017, but Group 4 saw a decrease in average performance, largely due to poor performance in this category by a large TOP.

Excellence in Practice

Operator training: One training department developed unique scenarios each week to challenge operators in the use of RTCA. These operators were familiar with the program and were comfortable running studies when an operations engineer was unavailable.

Areas of Concern

- The skills and training of the operators in using RTCA to facilitate a Real-time Assessment varied. About half of the entities visited in 2018 use some form of training for operators on the use of RTCA and/or state estimator, and the performance of studies. One entity had RTCA running but had not fully integrated it into their real-time operations.
- Only two entities visited in 2018 validate assumptions about external contingencies using a sensitivity study.
The communication of information and data, and review of that information, is critical to the reliability of the interconnected system. While it is necessary that all entities operate their own systems reliably, this alone is insufficient in ensuring the reliable operation of the Interconnection.

As with previous years, the 2018 visits showed that communication among entities, including the RC, is generally open and cooperative. Entities trust that their neighbors will contact them when a potential impactful issue is found. Communication with the RC, regardless of who starts the conversation, is most effective when contact is made early and entities work collaboratively to find the best solution. Entities recognize the importance of discussing reliability concerns and sharing information with neighbors to enhance system awareness.

With rare exception, external information necessary to reliably operate each system is available. Entities can obtain the necessary Inter-control Center Communications Protocol (ICCP) data points to enhance their wide-area view; and neighbors’ NDSs are available on the RC’s website or by some other medium.

Performance Summary

**Coordination and Data Sharing**

Excellence in Practice

Subregional Outage Coordination: Entities in close geographic or electrical proximity to one another have well-established relationships and methods for coordinating outages.

Areas of Concern

- There are many approaches to coordinating planned outages. One common approach relies on neighbors to initiate contact when impactful outages are scheduled. This assumes entities understand what outages will affect neighboring systems. Given that more than half of entities have not confirmed impactful external facilities through sensitivity studies, it is not likely that a neighbor would fully understand the effects that outages would have on their neighbors’ systems.
- Another common concern is that some entities are not validating outages in the Coordinated Outage System (COS). As the only central repository of outages in the Interconnection, COS is the logical place to validate planned outages. Some entities have chosen not to use this tool for validation for various reasons, while others have worked through challenges and use the COS tool.

Performance in this category remained relatively the same as 2017, with a slight increase in group 1. This category is still relatively stable as entity practices are fairly consistent.
Operational Paradigm

This topic includes two subtopics: the relationships between TOPs and the RC; and the operational paradigm around System Operating Limits (SOL).

Overall, TOPs have good working relationships with their neighbors. Entities communicate openly and often and are very comfortable contacting neighbors and the RC about issues. Most entities say Peak’s model has improved and, because of this, they increasingly trust Peak’s ability to monitor and operate the system. Directives from the RC are rare—in part due to Peak’s cooperative and understanding approach. All parties involved want to make sure the best course of action is taken, and that course is usually identified collectively.

Performance Summary

**Operational Paradigm**

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Overall, performance in this category stayed relatively the same as 2017. However, Group 2 saw a decrease in average performance, which was balanced by an increase in Group 4 performance.

Excellence in Practice

Communication around system disturbances: TOPs and Peak have very effective communication processes to address system disturbances. Through a relationship of trust and shared goals, TOPs and Peak share information and discuss solutions that allow them to manage system disturbances effectively.

Area of Concern

The Assurance Team’s review of SOL mitigation practices examined the approach taken when potential violations were found in studies or through Real-time Assessments. Most entities noted they develop mitigation plans for violations of normal and emergency limits, and entities would only take pre-contingency action for exceedances of emergency (or highest rating) limits. During the visits this year, a few entities reported having only one approved set of ratings; with no emergency ratings. This is acceptable, but requires the entity to take pre-contingent action, including shedding load, if loading is predicted to exceed these normal limits.
Appendix: Scoring Methodology

To compare performance across entities, the team scored entities in each of the key operational areas. The scoring method described below allows the team to examine relative performance and look for common characteristics and indicators of performance. To calibrate the scoring method, the Assurance Team visited three entities in the Eastern Interconnection. These Eastern Interconnection visits helped the team evaluate both the common and best practices identified in the Western Interconnection relative to those in other parts of the United States. The visits to the East revealed a high concentration of best practices in each of the entities and at least one promising new practice yet to be seen in the Western Interconnection. The results of the visits helped the team decide how to assign scores.

In each of the five topic areas, entities are given a score from one to five, based on the criteria described below. Note that the team uses a scoring system as one mechanism for quantifying its qualitative evaluation of entity performance. The scores are a simple ranking tool and the significance of the scores is in their relativity to each other.

For each topic, top, average, and bottom performance scores are defined. Entities are grouped based on the equivalent MVA of their transmission footprint value (in 1,000 MVA), using data from the Transmission Availability Data System. The groups allow WECC to share general trends in performance while maintaining confidentiality.

- **Group 1** is < 10
- **Group 2** is 10-35
- **Group 3** is 35-70
- **Group 4** is > 70

### Next-day Studies

**5—Top Performer**

- Quality: Systematic process for the identification and inclusion of all model inputs.
- Frequency: Study performed daily for next day.
- Process: Well documented and includes thresholds that trigger new studies; impactful facilities and contingencies validated and included.
- Dissemination and Use: Study reviewed prior to operating day; formal handoff and discussion between engineering and operations; well-defined mitigating actions for identified violations.
- Review and Validation: Results validated against Peak Operations Planning Analysis (OPA) and neighbor studies.

**3—Average**

- Quality: Moderate study performed.
- Frequency: Study performed daily for next day.
- Process: Lacking systematic process to validate judgement and experience. Lacking documented thresholds to trigger new study.
- Dissemination and Use: Informal handoff between engineering and operations.
- Review and Validation: Reviews Peak OPA daily, only review neighbors when contacted to do so.

**1—Bottom Performer**

- Quality: No study validation; outage and contingency list based solely on judgement and experience.
- Frequency: Study not performed or evaluated daily.
- Process: Lacks documentation and thresholds for running a new study.
- Dissemination and use: No formal handoff.
- Review and Validation: Do not review neighbors’ studies or Peak OPA.
Reliability Assurance Project 2018 Findings

Wide Area View

5–Top performer
- External visibility: Impacted facilities identified through sensitivity analysis incorporated in all system views and studies.
- Tools: System overview and analysis tools that effectively provide visibility of key factors and impactful facilities validated through sensitivity analysis.
- Visualization: System overview shows percent line loading, voltage views, flow directions, and other information. Layout accounts for human factors.
- Alarming: Intentional approach in which unnecessary or duplicative alarms are filtered out, associated compensatory actions.

3–Average
- External visibility: Facilities are included and studied for varying reasons, typically because of historical impact or engineering consensus.
- Tools: System overview may include some quick view of loading, voltage, flow direction, and other information, but not all. Example: Real-time line loading without a corresponding limit. Consideration of human factors is not applied to all factors of the display. Example: overuse of color.

1–Bottom Performer
- External visibility: Impactful facilities not validated or included in system views and studies.
- Tools: System overview and analysis tools not effectively used.
- Visualization: System overview lacks a quick view of line loading, voltage, flow direction, and other information. Poor implementation of overviews that lacks consideration of human factors.
- Alarming: Lack of intentional approach. Alarm overload with unnecessary or duplicative alarms.

Real-time Tools

5–Top Performer
- Tools: RTCA tool with identified back up, continuously validating results in real-time.
- Quality: Impactful contingencies are validated and included in assessments. Results validated against actual system values. Contingencies validated using sensitivity analysis.
- Use: Real-time contingency analysis results displayed and always monitored; real-time personnel comfortable with using RTCA. Management sets expectation for real-time operations use of the tool. Compensatory actions integrated with RTCA.
- Process in case of failure: Proactive, demonstrable process with prompt actions for loss of RTCA, prompt communication of failure to appropriate parties.

3–Average
- Tools: RTCA lacks consideration for human performance factors. Example: lengthy list of potential violations displayed with resolutions to be performed by automatic actions.
- Quality: Contingencies based on judgement. Have an established method for validating results.
- Use: Only high-level RTCA violations are validated. Management expectations for use of RTCA are undefined or vague.
- Process in case of failure: Training around process lacking, will communicate failure with appropriate parties.

1–Bottom Performer
- Tools: RTCA tool is buried behind other screens, audible alarm turned off or does not exist, and RTCA is not referred to by real-time operations. Rely on another entity to notify of operating issues rather than actively monitoring.
- Quality: No ability to perform real-time contingency analysis by on-shift operations.
- Use: Do not actively monitor or perform Real-time Assessments using RTCA.
Reliability Assurance Project 2018 Findings

- Process in case of failure: Lack internal process, rely on another entity’s process, do not communicate failure to appropriate parties such as neighbors and the RC.

Communication, Coordination, and Data Sharing

5–Top Performer
- Data Sharing: Process for reviewing and updating facility ratings established and includes informing Peak and neighboring entities of changes. Post studies to the RC website, and notify neighbors of any possible conflicts. Share data points in a timely manner when requested.
- Coordination: Participate in outage coordination efforts with neighbors and the RC. Have an established process for outage coordination and validate outages with COS.
- Inter-entity communication: Open communication with the RC and neighboring entities.

3–Average
- Data Sharing: Post studies to the RC website and notify neighbors of any conflicts. Share data points in a timely manner when requested.
- Coordination: Participate in outage coordination efforts, but internal tools/processes are lacking. Use COS for outage validation.
- Inter-entity communication: Open communication with the RC and neighboring entities.

1–Bottom Performer
- Data sharing: Do not post studies to the RC website. Do not notify neighbors of possible issues.
- Outage Coordination: Do not interface with COS for validation in studies.
- Communication: Restricted communication with external entities. Do not proactively interact with neighbors and RC.

Operational Paradigm and Relationship

5–Top performer
- Trust and Respect: Trustful working relationships with neighbors, regular interaction on issues with neighbors and RC, trust RC model and respect Peak’s role.
- Operational Authority: Clear understanding of Peak’s authority and entity roles for path operations.
- SOL Mitigation: Implementation of SOL methodology and operate to individual facility SOLs.

3–Average
- Trust and Respect: Willing to work with neighbors and RC.
- Operational Authority: Will work with the RC when necessary.
- SOL Mitigation: Implementation of SOL methodology and operate to individual facility SOLs.

1–Bottom Performer
- Trust and Respect: Internal focus, closed to external opinions and suggestions.
- Operational Authority: Question expertise and value of the RC.
- SOL Mitigation: Operate to historical Path SOLs.