Peak Reliability

TECHNICAL SPECIFICATIONS DOCUMENT

Operational Services and Infrastructure Requirements for Reliability Coordination in the Western Interconnection

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PEAKRELIABILITY
assuring the wide area view

Executive Summary

Peak has created this objective, fact-based document listing Peak Reliability's (Peak) current RC capabilities, performance metrics and associated quality levels. The document is provided as an aid for Balancing Authorities (BA) and Transmission Operators (TOP) to evaluate the relative capabilities of competitive RC offerings or determine whether or not to develop an their own RC compliant with NERC standards.

This document articulates the detailed operational and technical specifications required to effectively execute reliability coordination in the Western Interconnection.

The evaluation criteria is informed by Peak's decade-long experience of:

- meeting applicable regulatory requirements (NERC, WECC, FERC)
- refining the tools, practices and methodologies necessary to create unprecedented Interconnection-wide situational awareness
- building and retaining a highly skilled and experienced workforce committed to reliability, and
- creating a culture of continuous improvement that captures opportunities and implements lessons learned from diverse and complex operational experiences

Peak's history of success is founded upon strong technical tools, continuous improvement of business practices and retention, development and investment in its people. Moreover, this document also calls attention to a distinctive element of Peak's success: independence from any single entity in the Western Interconnection. One of the original drivers of creating a single RC in the West in 2009 was the desire to create an independent entity to perform RC services. Due to its independent governance construct, Peak has been a fair and impartial RC, helping to resolve complicated reliability issues across a variety of entities with complex relationships. Peak has always held the reliability of the grid as the highest priority above any single entity's interests.

The reliability of the Western Interconnection requires RC service providers that can meet or exceed the operational and technical requirements, as well as the fact-based evaluation criteria, described in this document. A detailed understanding of services provided by Peak, as described in this document, will demonstrate and prove the high quality RC service Peak provides today. Peak encourages entities to use and apply the contents of this document in their evaluation of all prospective RC providers.

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1. West-wide System Model (WSM) & Situational Awareness Tools

The WSM is a representation of the Bulk Electric System (BES) in the Western Interconnection and is the foundation of all wide-area situational awareness tools. The WSM has a significant amount of detail, ranging from 500kV transmission to sub-100kV BES and non-BES facilities. The WSM also includes generator representation generally for units with maximum output greater than 10 MW. As required by FERC and NERC and described in their FERC/NERC Staff Report, Arizona-Southern California Outages Sept. 8, 2011 Causes and Recommendations ("Outage Report") recommendations #10 and #16, Peak has been diligently aligning its WSM with the WECC planning model and validating models against PMU data. This alignment enables multiple capabilities such as the ability to run transient stability and to provide system models for model validation purposes (MOD-033-1 requirement). Peak puts out reports quarterly to Transmission Operators (TOP) that identify differences between the WSM and the WECC planning model; this helps ensure the quality of both of the models.

1.1 BES Monitoring and Visualization Requirements

Peak monitors all BES facilities within Peak's RC Area as well as impacting facilities outside Peak's RC Area. In addition, non-BES equipment and sub-transmission networks are monitored and visualized for their potential impact to the BES. The nature of the Western Interconnection transmission, with long lines and large transfers across the system, makes it extremely important to be aware of the potential impacts of both BES and non-BES equipment. Below are several key requirements for ensuring the appropriate level of monitoring and visualization that are available to Peak's Reliability Coordinator System Operators (RCSO).

Requirement	Peak Transitional RC Solution	Standard/Other Driver
Full Western Interconnection Model	Peak will maintain a model of the entire Western Interconnection, including both BES equipment and non-BES equipment that are critical to the operation of the BES.	IRO-002-5 IRO-008-2 Outage Report (Recommendation #3)
Alignment of network model with WECC planning model	Peak maintains a translation between Peak's WSM and the WECC planning model. This enables model validation activities and transient stability studies which depend on the dynamic models maintained by WECC. This also enables comparison of the equipment and their attributes, leading to more accurate planning and operational models for Peak and all entities that use these models.	Outage Report MOD-033-1

(cont.) Requirement	Peak Transitional RC Solution	Standard/Other Driver
Balancing Authority (BA) overview displays	Each BA has multiple displays for use by RCSOs to assess the health of the BA, specifically related to Area Control Error (ACE), Balancing Authority ACE Limit (BAAL) exceedances, frequency, reserves, generation, load and interchange.	IRO-002-5 IRO-008-2 EOP-011-1
Transmission overview displays	Peak has several transmission line overview maps including a "WECC Map" which represents all transmission 230 kV and above plus selected transmission lines below 230 kV in the entire Western Interconnection (includes layering for effective visualization). Peak also has area-wide regional overview maps which include multiple BAs/TOPs in a region. In addition, each BA/TOP has at least one overview transmission display which shows key attributes of their system, including dynamic outage indications, cranking paths, system topology, voltages, flows, transmission limits (System Operating Limits (SOL) and Interconnection Reliability Operating Limits (IROL)).	IRO-002-5 IRO-008-2 EOP-011-1
Substation one line diagrams	Each substation in Peak's model (more than 8,800 substations) has its own unique substation one line diagram. Peak's and the BAs' operating procedures associated with substation or area are linked to station one line diagrams for easy access by RCSOs.	IRO-002-5 IRO-008-2 EOP-011-1
Remedial Action Scheme (RAS) overview displays	RAS displays are critical for RCSOs and Real-time Operating Engineers (ROE) to understand details of the RAS, such as arming status, triggering conditions and other important RAS attributes. Without the ability to visualize the RAS configuration, it is extremely difficult and time consuming for RCSOs and ROEs to properly understand the potential impact due to RAS as identified in real-time contingency analysis or study tools.	IRO-002-5 IRO-008-2 EOP-011-1
Post all models for use in TOP external areas	Peak posts all of its models on www.peakrc.org for use by the BAs and TOPs in the West. This includes network models in multiple formats, as well as	Outage Report (Recommendation #2)

	PDF one line diagrams and facility ratings information.	
Event alarming	Prioritization of information is critical for the optimal performance of an RCSO. Peak organizes all alarms into eight categories to help the RC prioritize the information coming to them.	IRO-002-5
Trending and one click detail access	Trending and immediate access to detailed information (one line diagrams, overviews, procedures, etc.) is critical functionality for RCSOs. Peak has "one click" access to all of this information from any SCADA display that has analog or digital information.	IRO-002-5

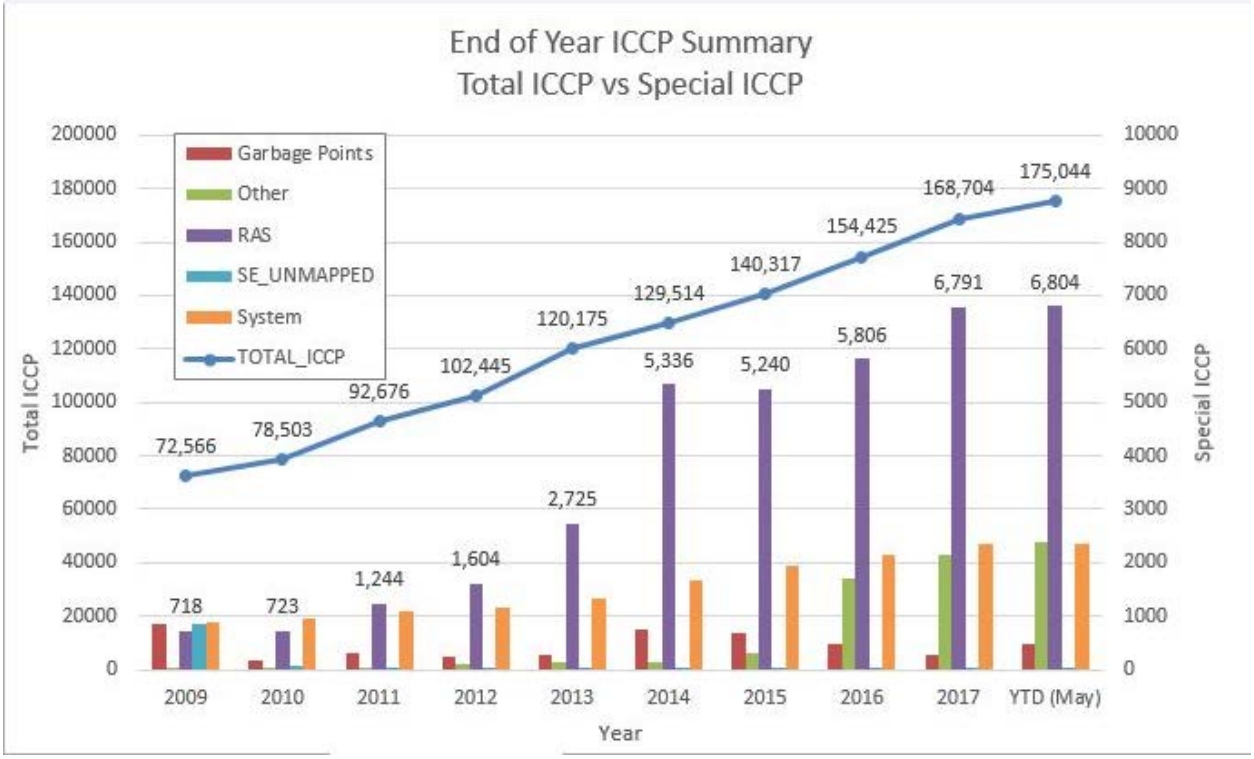
1.2 IRO-010-2 RC Data Request and Critical Operating Data

Peak maintains an RC data request, as required per Standard IRO-010-2, which is located **here** on Peak's public website www.peakrc.com. The RC data request describes in detail all of the data needed by Peak to perform its RC function and to support the monitoring and visualization needs of the RCSOs. Since 2009, Peak has worked with BAs and TOPs in the Peak RC Area to provide a clear and concise data request and to establish the processes needed for data exchange. Those years of collaboration and coordination by Peak and its BAs and TOPs have resulted in a very strong data request process that is well understood – resulting in high-quality data to perform Peak's RC function.

Requirement	Peak Transitional RC Solution	Standard/Other Driver
Maintain an RC data request process in coordination with the BAs, TOPs, Generator Operators (GOP) and other applicable entities	Peak coordinates with all BAs and TOPs in the West to ensure a consistent set of data is provided to Peak. Peak also facilitates TOP/BA data requests by maintaining the data request and posting in a secure area of www.peakrc.org as required by TOP-003-3, in order to provide the same consistency of data across all TOPs, BAs and Peak.	IRO-010-2 TOP-003-3
Receive analog and digital points via ICCP	Peak today receives more than 175,000 analog and digital points via Inter-Control Center Communications Protocol (ICCP). Analog points come every 1-10 seconds, digital points are received upon change of status.	IRO-002-5
Receive real-time RAS arming status	Peak uses more than 6,800 real-time status points to provide adequate RAS-related situational awareness to RCSOs. These arming status points are	IRO-002-5 IRO-008-2

	used by downstream applications like contingency analysis to properly simulate RAS actions following a contingency. RAS simulation without accurate real-time status information will result in inaccurate analysis results and will overburden operators by distracting them with poor quality information.	Required per NERC definition of “Real-time Assessment”
System Operating Limits (SOL)	Peak receives SOLs from TOPs as required per Peak’s SOL methodology. Peak calculates critical stability SOLs and IROLs using real-time voltage stability tools. Peak is further enhancing SOL and IROL calculation by implementing real-time transient stability. (See voltage stability section and transient stability section below for more details.)	IRO-002-5 IRO-008-2 IRO-009-2
BA parameters	Peak receives BA parameters for monitoring and assessing the health of each BA within Peak’s RC Area. Those parameters are visualized for RCSOs and alarmed when outside prescribed reliability thresholds. Required parameters include frequency, ACE, reserves, interchange, load and generation.	EOP-011-1
Forecast data (Load Forecast, Unit Commitment)	All BAs are using Electric Industry Data Exchange (EIDE) to provide Peak with forecast data for load, generation and interchange. Peak stores this information and uses it for study processes. Peak has developed quality metrics and regular reporting processes and has worked with entities over the years to continuously improve the quality of data provided and Peak’s processes for incorporating the data into studies. Peak also shares this data upon request via an automated interface.	IRO-008-2 Outage Report (Recommendation #2)

Figure 1. Peak WSM and Real-time Data Growth – Continuous Model Improvement



Peak performs model updates every 4-6 weeks, with some flexibility maintained to support specific deadlines, holidays or operating conditions. Peak receives model update information from BAs and TOPs in the West via formats agreed upon by Peak and the entity. Peak does not require models to be provided in a specific format; rather Peak works with the entity to receive formats that are native to their systems and in line with their capabilities. Peak has developed numerous automated processes to quickly identify differences in models to make the modeling process as efficient as possible.

1.3 Remedial Action Scheme Modeling, Real-time Arming Status & Simulation

Remedial Action Schemes (RAS) are the Achilles heel of the Western Interconnection. Peak's (WECC's) early experience performing the RC function prior to the implementation of RAS modeling created numerous operational challenges. Peak went on a major RAS modeling effort beginning after the Sept. 8, 2011 Southwest outage event; almost seven years later and after millions of dollars spent building RAS modeling capabilities in critical systems and applications, this RAS work is nearly complete and Peak seeks to continuously improve how RAS are modeled to ensure accuracy of real-time studies and contingency analysis. Today Peak has 268 RAS modeled with more than 6,800 real-time arming status and other real-time inputs used to drive the accuracy of studies and simulations using RAS.

Requirement	Peak Transitional RC Solution	Standard/Other Driver
A single contingency that has RAS action must only be modeled once; RAS action will trigger only if pre-identified conditions exist	Peak models all contingencies just once; there is no need to model a "contingency without RAS" and a second "contingency with RAS." In Real-time Contingency Analysis (RTCA), voltage stability and transient stability, the RAS is modeled outside of the contingency and the RAS will fire only when the RAS-triggering condition is seen in simulation.	IRO-002-5 IRO-008-2 RAS modeling required per NERC definition of "Real-time Assessment"
All RAS that have impacts to the BES must be modeled in RTCA	Peak has modeled almost all RAS (268 in RTCA); exceptions exist only where triggering conditions cannot be modeled (such as those with transient/time domain triggering conditions).	IRO-002-5 IRO-008-2 RAS modeling required per NERC definition of "Real-time Assessment"
RAS list or database must be maintained to support RAS coordination	Peak has worked with the WECC RAS Reliability Subcommittee (RASRS) to develop and maintain a comprehensive list of RAS in the Western Interconnection. Peak tracks which RAS are modeled and ensures through regular RAS reviews that the models are accurate over time.	PRC-012-2 (Future) Outage Report (Recommendations #19, #20)
RAS must be modeled in real-time voltage stability	Peak models RAS in real-time voltage stability if the RAS are impactful to the scenario being studied. Peak explicitly models those RAS conditions, and real-time voltage stability is able to accurately identify RAS-triggering conditions and perform the automatic actions.	IRO-002-5 IRO-008-2 IRO-009-2 RAS modeling required per NERC definition of "Real-time Assessment"
RAS must be modeled in real-time transient stability	Peak models critical RAS that are relevant to the real-time transient stability scenario being studied. Without RAS models, RTTSAT results are meaningless.	IRO-002-5 IRO-008-2 IRO-009-2 RAS modeling required per NERC definition of "Real-time Assessment"

2. Advanced Applications

The advanced applications at Peak are the workhorses that provide strong analytical capabilities to the RCSOs and the ROEs. The root of the value of these tools is that they are all based on the full Western BES as facilitated by the WSM. Having the ability to perform regular analysis on the entire BES in the West is unique to power system operations and is a tremendous benefit to reliability in the West.

Figure 2. Data Flow Between Applications at Peak

2.1 State Estimation

State Estimation (SE) is the base of all other advanced applications. SE applies measurements (such as voltage, MW, MVAR, switch/CB status) to the WSM and is able to calculate all system quantities to provide a complete snapshot of the power system in the Western Interconnection. SE assesses the pre-contingency state of the BES to ensure the system is operating reliably.

Requirements for SE	Peak Transitional RC Solution	Standard/Other Driver
State estimation of all BES facilities, including non-BES facilities that may be impactful to the BES	Peak runs the state estimator on top of the WSM, which includes all BES and non-BES facilities that are impactful to the BES. Peak uses more than 175,000 measurements applied to the network model to accurately assess the state of the Western Interconnection.	IRO-002-5 Outage Report (Recommendation #3, #17, #18)

(cont.) Requirements for SE	Peak Transitional RC Solution	Standard/Other Driver
High availability of state estimator solution	Peak's state estimator solves 99.95% of the time.	IRO-002-5
High degree of accuracy; metrics to ensure quality is regularly monitored	Peak has SE quality dashboards that provide immediate feedback to Real-time Operating Engineers about errors that have been introduced into the SE solution. State estimated line and transformers flows were within desired tolerances 97.16% of solutions for January – May 2018; state estimated voltages were within desired tolerances 99.45% of solutions for January – May 2018.	IRO-002-5
Integration of Phasor Measurement Unit (PMU) angle measurements to obtain value from synchrophasors and increase robustness of SE	Peak has implemented phase angle measurements from PMUs into its SE. Because PMU measurements do not depend on Inter-control Center Communications Protocol (ICCP) for data transfer, this provides a redundant data source for critical angle measurements which drive SE solution availability and accuracy.	IRO-002-5
Identification of thermal (MVA, MW, phase angle) and voltage limit exceedances	Peak's SE identifies SOL and IROL exceedances for BES facilities (including MVA, MW, kV and phase angle). Peak has been monitoring key phase angle pairs since 2011.	IRO-008-2 IRO-009-2 Outage Report (Recommendation #27)

2.2 Real-time Contingency Analysis (RTCA)

RTCA calculates the post-contingency state of the BES to ensure that the system can withstand the next credible contingency. This is a critical function in the Western Interconnection and is highly dependent on the quality of the models used, in particular the quality of the network model and RAS models used. Over time, Peak has reduced the level of inaccurate information presented by RTCA by focusing heavily on model and RAS improvements. Without the quality Peak has today, RC System Operators (RCSO) would be negatively impacted by a significant amount of RTCA-produced information that is not accurate or actionable.

Requirements for RTCA	Peak Transitional RC Solution	Standard/Other Driver
High availability of RTCA solution	RTCA is a critical tool needed to perform Real-time Assessments (RTA). Peak's RTCA runs once every five minutes, and provides valid results 99.95% of the time (since Jan. 1, 2018).	IRO-008-2 – RC required to perform RTA at least once every 30 minutes.
Simulate BES and impactful non-BES contingencies	Peak simulates roughly 8,000 contingencies every five minutes to assess the post-contingency state of the Peak RC Area.	IRO-008-2 – RC required to perform RTA at least once every 30 minutes.
Identification of post-contingency thermal (MVA, MW, phase angle) and voltage limit exceedances	Peak's RTCA and RC Workbook (custom tool to support monitoring) provide identification of post-contingency exceedances.	IRO-005-2 IRO-008-2 IRO-009-2
Visualization of RTCA results, including sorting, filtering, mitigation notes and workflow management	Peak's RTCA and RC Workbook (custom tool to support monitoring) support RTCA alarm management and management of mitigation plans and operator notes. RC Workbook also provides operators with sorting, filtering and identification of potential cascading outages (post-contingency exceedance > 125% of the highest available limit).	IRO-005-2 IRO-008-2 IRO-009-2
Remedial Action Scheme (RAS) modeling	Without RAS modeling, RTCA results cannot be accurate in the Western Interconnection. It is important to simulate expected RAS actions, thus the need for real-time arming information to accurately identify expected equipment and generator tripping. Peak has built out RAS models for 268 RAS and other non-RAS automatic schemes in the West, including more than 6,800 ICCP points which drive accuracy with correct real-time RAS information.	IRO-005-2 IRO-008-2 IRO-009-2 RAS modeling required per NERC definition of "Real-time Assessment"

2.3 Real-time Voltage Stability (RTVSA)

A core function of a Reliability Coordinator is to calculate Interconnection Reliability Operating Limits (IROL). Peak uses RTVSA to calculate several IROLs in the Western Interconnection. Each IROL has what is called a "scenario definition" which includes all critical information associated with the voltage stability study. Often these scenarios reach across multiple BA and TOP areas, requiring strong coordination and leadership to ensure the scenario definitions are correct.

Requirements for RTVSA	Peak Transitional RC Solution	Standard/Other Driver
Real-time analysis of voltage stability issues	Peak runs RTVSA once every five minutes to calculate voltage stability limits in the Western Interconnection. A new state estimator solution is provided each RTVSA run to ensure the most accurate and recent system conditions are studied.	IRO-008-2 IRO-008-2
RTVSA simulation of automatic devices such as RAS, capacitor switching and topology changes	RTVSA needs to be able to simulate the expected conditions following heavy power transfer scenarios and associated contingencies. Peak programs in detailed RAS models, capacitor switching, topology changes and other automatic actions that might actually occur.	IRO-002-5 IRO-008-2 IRO-009-2 RAS modeling required per NERC definition of "Real-time Assessment"
Regular RTVSA quality assessments	Peak reviews RTVSA results both in real-time by ROEs and after the fact every day as a part of Peak's Operational Excellence Day assessment.	IRO-002-5

2.4 Real-time Transient Stability (RTTSAT)

RTTSAT is an important tool that can be used in a variety of ways. As the power system changes due to more renewables and less traditional generation such as coal and nuclear, the system inertia is also changing. Peak currently calculates system inertia in real-time and provides that information to NERC, but in the future that information will be an important operational quantity to monitor. With the future characterized by a diverse set of renewable generation and still a large amount of RAS on the system, RTTSAT will be a critical tool for ensuring the system remains stable for large contingencies and to monitor frequency response for any risks of under frequency load shedding.

Requirements for RTTSAT	Peak Transitional RC Solution	Standard/Other Driver
Ability to simulate critical contingencies that will not solve in traditional RTCA	Peak has a subset of significantly large contingencies that have RAS actions associated with them. Often these contingencies won't solve in RTCA, therefore RTTSAT is a way to verify system stability following the contingencies. This is in use today in Peak's control rooms.	IRO-002-5 IRO-008-2 IRO-009-2
Calculate frequency response	Peak is evaluating the use of RTTSAT to study frequency response of the system. This will provide an understanding of the risk of under frequency load shedding for large contingencies, in particular those that trigger RAS and large amounts of generation dropping.	Changing generation mix requires future real-time monitoring of frequency response

(cont.) Requirements for RTTSAT	Peak Transitional RC Solution	Standard/Other Driver
Validate system models	Peak uses synchrophasor data to validate RTTSAT results (by comparing the actual synchrophasor signal to the simulated RTTSAT value) and more importantly to validate and improve the model used in the RTTSAT simulation. Because Peak uses the WECC planning cases' dynamic data and generator models, this validation benefits all that use Peak's and WECC's study models.	MOD-033-1
Ensure system stability prior to post-contingency RAS induced generation dropping	RTTSAT can be used to ensure the appropriate amount of post-contingency generation dropping is being implemented via RAS to ensure the system remains stable. Today, excess generation is typically dropped, which contributes to the inefficient operation of the BES.	IRO-002-5 IRO-008-2 IRO-009-2 RAS modeling required per NERC definition of "Real-time Assessment"

2.5 Dispatcher Training Simulator

The Dispatcher Training Simulator (DTS) is an operator training tool based on the West-wide System Model that is able to accurately simulate power system operations. DTS is used today by Peak to train operators on past events, training scenarios or even large-scale system restoration practices. Restoration drills are done in conjunction with BAs and TOPs, which maximizes training value as all parties attempt to restore the system in a realistic simulation environment.

Requirements for DTS	Peak Transitional RC Solution	Standard/Other Driver
Capability to train RC operations staff	Peak regularly trains RC operations and engineering team members.	PER-005-2 EOP-006-2
Capability to train BA and TOP operations staff	Peak supports BA and TOP operations staff training for various training opportunities using the DTS. For the 2017 RC Area Restoration Drills alone, more than 1,140 trainees from 53 other Western entities participated without having to travel, by using Peak's cloud services. All combined, Peak provided 12,986 Continuing Education Hours (CEH) to external members, representing a 2017 regional value of $584,370 for NERC-certified personnel (assumes generic cost of $45 per CEH).	EOP-006-2
Perform emergency operations training (SOL	SOL and IROL exceedance training is a common use of Peak's DTS. Balancing	PER-005-2 EOP-006-2

and IROL exceedance, energy emergencies and other operating emergencies)	emergencies such as energy emergencies are also common training scenarios for Peak's operators and engineers.	
Perform restoration training	Restoration drills are performed and offered to RCs, BAs and TOPs in the Western Interconnection.	PER-005-2 EOP-006-2

3. Seasonal Coordination

Peak leads the seasonal operations planning coordination process to serve as a bridge between TPL Planning Assessments performed by Planning Coordinators and Peak's IRO-017 Outage Coordination process. This process is intended to identify potential major operational reliability issues for the upcoming season so that appropriate Operating Plans could be coordinated between Peak and other operating entities prior to Real-time operations.

The following sub-regional study groups participate in the seasonal coordination process:

- Northwest Operational Planning Study Group (NOPSG-Northwest/Canada region)
- Rocky Mountain Operating Study Group (RMOSG-Rocky Mountain region)
- Southwest Area Sub-regional Group (SASG-Arizona/New Mexico/Nevada)
- Operations Study Subcommittee (OSS-California/Mexico)

3.1 Long-range Seasonal Studies

The following types of analyses are included as part of long-range seasonal studies:

- Studies to identify reliability issues between TOPs
- Studies to review existing or identify new interaction between major transmission interfaces
- Studies to identify reliability risks associated with instability, cascading or uncontrolled separation

Requirements for Long-range Seasonal Studies	**Peak Transitional RC Solution**	**Standard/Other Driver**
Participate in sub-regional meetings	Peak participates in sub-regional meetings to support the study processes and to be sure Peak's SOL methodology and long-range study processes are understood and followed. Peak's participation also ensures better integration of seasonal studies across the four study regions in the West.	Outage Report (Recommendation #5)

(cont.) Requirements for Long-range Seasonal Studies	Peak Transitional RC Solution	Standard/Other Driver
Coordinate study plans and results among the TOPs and BAs	Peak strives to ensure consistency in study plans among various sub-regional groups. This consistency helps to build agreement about what studies are to be performed and what criteria is deemed to be unacceptable system conditions that need to be mitigated.	Outage Report (Recommendation #5)
Facilitate resolution of outstanding reliability issues among TOPs and develop Operating Plans	Coordination and resolution of SOLs, IROLs and any outstanding issues is a critical step in the seasonal study process and Peak often plays referee in this scenario, working out mitigation plans and validating study results in support of the TOPs and BAs in the West.	IRO-009-2

4. Operations Planning

Peak's operations planning process ensures that Peak's RCSOs and ROEs are prepared to handle upcoming operational issues. This process also involves extensive coordination with BAs and TOPs to ensure their System Operators and Engineers are also prepared for upcoming operational issues and are extensively involved in the planning/coordination process.

4.1 Outage Coordination (IRO-017-1 Management/Compliance)

As per the requirements of IRO-017-1 and in coordination with BAs, TOPs and GOPs, Peak has developed a robust Outage Coordination process that ensures outages can be taken reliably and associated Operating Plans are developed, coordinated and communicated appropriately. This is a strength for Peak as an independent RC for the West because we are able to look exclusively at the reliability of the system and not concern ourselves over how our specific interests are being impacted.

Requirements for Outage Coordination	Peak Transitional RC Solution	Standard/Other Driver
Develop and maintain an Outage Coordination process per IRO-017-1	Peak put in significant effort to collaboratively build an Outage Coordination process for Peak's RC Area.	IRO-017-1

(cont.) Requirements for Outage Coordination	Peak Transitional RC Solution	Standard/Other Driver
Maintain and improve Coordinated Outage System (COS), the data dictionary and COS features	Maintenance of COS, which facilitates sharing of scheduled outages for Peak, TOPs and BAs. Peak maintains the data dictionary for COS, and Peak maintains the association between the WSM and COS records to support automation of outage inputs into study tools for any TOPs that uses Peak's WSM for external model representation.	IRO-017-1 IRO-008-2
Coordinate and approve scheduled outages	When studies indicate issues associated with planned outages, Peak takes a leadership role to coordinate among the impacted entities and address the issue.	IRO-008-2 IRO-017-1
Coordination and communication of Operating Plans	Coordination of Operating Plans is an area that requires significant effort. Peak leads these efforts, coordinates with impacted entities, and ensures that plans are in place and communicated for the upcoming operating day(s).	IRO-008-2
Conflict resolution	Conflicts arise and when they do, Peak looks at the conflict solely from the perspective of reliability. Peak has demonstrated numerous times over the past decade that it is a fair, impartial voice for reliability when conflicts do arise.	IRO-008-2

4.2 Coordinated Outage System (COS)

The Coordinated Outage System is the primary source of scheduled outage data in the Western Interconnection. Peak maintains this system and all of its data for the benefit of Peak in performing the RC function, as well as for TOPs and BAs performing their own reliability functions.

Requirements for COS	Peak Transitional RC Solution	Standard/Other Driver
Maintain a platform for Outage Schedules for the Western Interconnection	Peak maintains the COS system and the submission of outages for the Western Interconnection, including both BES equipment and non-BES equipment that are impactful to the BES. Peak has put in a great deal of effort to improve outage reporting, improving the quality of RC and TOP Operations Planning studies and therefore directly improving reliability in the West.	IRO-017-1 Outage Report (Recommendation #3)

(cont.) Requirements for COS	Peak Transitional RC Solution	Standard/Other Driver
Provide awareness of upcoming scheduled outages to RCSOs	Peak has developed tools for RCSOs to be aware of upcoming outages over an operator-defined period of time. Also, Peak has implemented a look-ahead study tool that allows RCOs and ROEs to have a final assessment of the potential impact of upcoming outages before they happen.	IRO-008-2
Maintenance of outage states	Peak's COS system provides an up-to-date repository of outage information for BAs and TOPs. Approval status of scheduled outages is updated once Peak has completed its study process and coordination efforts.	IRO-017-1 IRO-008-2
Maintenance of outage records	COS supports TOP study processes by allowing them to see neighboring TOP planned outages. Exact switching points are maintained in COS, making it possible to directly apply them to TOP studies.	IRO-017-1 IRO-008-2 Outage Report (Recommendation #11)

4.3 SOL Methodology

As per the requirements of FAC-011-3, Peak has led the development of its SOL Methodology in coordination with TOPs. SOL methodology development has been very challenging for Peak; this is an area where Peak's independent leadership and strong focus on reliability has helped Peak in collaboration with the TOPs to come up with solutions that meet our reliability needs. Going forward, it is important to have common principles within the multiple RC's SOL methodologies so that the system is being operated in a consistent, reliable fashion.

Requirements for SOL Methodology	Peak Transitional RC Solution	Standard/Other Driver
Definition of Acceptable System Performance	Peak's collaborative processes helped create a definition of pre- and post-contingency Acceptable System Performance (steady-state and transient system performance criteria) that is the basis for system operations in the West.	FAC-011-3 Outage Report (Recommendation #13)
Multiple Contingency criteria	Peak's SOL methodology puts parameters around the credibility of Multiple Contingencies, but ultimately leaves it up to the TOP to determine credibility of those contingencies.	FAC-011-3

(cont.) Requirements for SOL Methodology	Peak Transitional RC Solution	Standard/Other Driver
Allowed uses of automatic mitigation schemes (RAS, etc.)	RAS and other automatic schemes are invaluable for the efficient and reliable operation of the BES, however they also create risk for all BAs and TOPs in the West. Peak's SOL Methodology addresses appropriate uses of and communication requirements for automatic mitigation schemes.	FAC-011-3
Coordination responsibilities	Peak's SOL methodology lists specific coordination responsibilities, to ensure SOLs are coordinated among TOPs. In cases of conflict, Peak helps coordinate differences and serves as an independent third party to help resolve issues.	FAC-011-3
Types of SOLs used in operations horizon	Peak's SOL methodology defines what different types of SOLs are to be used in the operations horizon. For example, a TOP cannot declare a parameter such as temperature of a conductor to be a SOL.	FAC-011-3
Communication of SOLs used in operations horizon	Peak collects SOLs from all TOPs and populates them in its model, then distributes the SOLs and model for use by all entities. Similarly, www.peakrc.org serves as a hub for SOL information sharing.	FAC-011-3 FAC-014-2
System stressing methodology	Peak has a system stressing methodology to help Peak and TOPs study potential IROL conditions. This helps to draw a clear line between SOLs and IROLs.	IRO-008-2 FAC-011-3 Outage Report (Recommendation #18)
Management of IROLs	Management of IROLs contains several activities, such as coordinating with impacted entities, creation of the IROL calculation, development and maintenance of IROL procedures and the IROL definition card.	IRO-008-2 IRO-009-2

4.4 Next-day Studies

Peak performs an Operational Planning Analysis (OPA) for each operating day. Selection of appropriate cases, implementation of input data, contingency analysis, evaluation of results, coordination, and communication of Operating Plans are critical components of the OPA.

Requirements for Next-day Studies	Peak Transitional RC Solution	Standard/Other Driver
Select appropriate cases for study	Performing a study with the entire Western Interconnection is important to assess impacts across the wide area. Peak leverages a recent state estimator case and applies necessary forecast and scheduled outage data to make a realistic scenario for study.	IRO-008-2
Perform contingency analysis	Peak performs contingency analysis simulating roughly 8,000 contingencies across the entire Western Interconnection. Peak also analyzes possible cascading conditions when post-contingency SOL exceedance exceeds 120% of the highest available facility rating.	IRO-008-2 IRO-009-2
Next-day study results evaluation	Peak closely evaluates study results and reviews findings with impacted BAs and TOPs. Often this coordination identifies a study issue that can be resolved. Peak also reviews study result quality on a daily basis to drive continuous improvement.	IRO-008-2
Provide platform for coordinating study results and Operating Plans	Peak provides a platform for sharing, using the secure www.peakrc.org site. Peak ensures TOPs and BAs have mitigation plans and mediates in times of disagreement.	IRO-008-2 Outage Report (recommendation #1)
Lead and support Operations Planning Work Group to improve study quality	Peak has a work group that is working to improve study practices in the Western Interconnection.	N/A

4.5 IROL Calculations

For voltage stability-based IROLs, Peak performs an IROL calculation as part of each OPA. If the analysis shows a potential IROL exceedance or an operating margin below a set threshold then appropriate Operating Plans are coordinated among impacted BAs and TOPs specific to the operating conditions for the next day's operations.

Requirements for IROL Calculations	Peak Transitional RC Solution	Standard/Other Driver
Calculate IROL for next operating day	Peak calculates voltage stability-limited IROLs using V&R's Region of Stability Existence (ROSE) voltage stability application (same tool behind RTVSA).	IRO-008-2 IRO-009-2
Coordinate and communicate IROL for next operating day	Peak coordinates with impacted entities when procedural thresholds are met to ensure a plan is implemented to prevent exceedance of the IROL. Peak communicates IROLs for the next day through detailed operating plans and next-day study reports.	IRO-008-2 IRO-009-2
Create and maintain IROL scenario definitions for voltage stability simulation	Peak leads and collaborates on tool scenario definitions, which require a high degree of agreement on details such as generation and load definitions, RAS involvement and capacitor switching.	IRO-008-2 IRO-009-2

5. Real-time System Operations

Peak's Real-time System Operations is responsible for the continuous monitoring of the Western Interconnection BES with the exception of the Canadian Province of Alberta. Reliability of the Peak RC Area is the only focus of Real-time System Operations, which performs its duties in two separate, but fully redundant control centers. The control centers, located in Vancouver, Wash., and Loveland, Colo., utilize Polycom technology to maintain a continuous open line of communication. At all times, Peak has a Working Shift Foreman, six RC System Operators (RCSOs) and one Real-time Operations Engineer (ROE) on shift to cover the RC Area, which today is divided into three different sub-areas. Each sub-area has two RCSOs focused on the reliability of that specific area. One RCSO provides Real-time monitoring, while the other performs study responsibilities for that specific sub-area. The RCSOs rotate through the different sub-areas on a daily basis and move from study to Real-time responsibilities every two weeks. This ensures that every RCSO is fully trained and maintains expertise in each function for the entire RC Area. This level of staffing was a direct response to the complexities of operating the Western Interconnection, specifically associated with recommendation #14 of the Outage Report. Peak Real-time System Operations

continuously utilize the tools and processes covered in this document to perform their responsibilities.

5.1 Real-time Assessments

Peak continuously performs Real-time Assessments to ensure the reliability and security of the RC Area. Real-time Assessments consist of evaluating both pre- and post-Contingency system conditions. Pre-Contingency conditions are assessed via real-time SCADA and State Estimation to ensure flows and voltages remain within Facility Ratings and voltage limits. SCADA scan rates vary but are generally 10 seconds or less. State Estimator calculates power system values for the Western Interconnection once every minute. Post-Contingency conditions are assessed via RTCA to evaluate expected post-Contingency conditions in the event of credible Contingencies and via RTVSA to ensure acceptable system performance upon occurrence of Contingencies associated with identified stability limits. Both RTCA and RTVSA applications run every five minutes.

Requirements for Real-time Assessments	**Peak Transitional RC Solution**	**Standard/Other Driver**
Act to address reliability issues identified within its RC Area	Peak at all times acts to address the reliability of its Reliability Coordinator Area via direct actions or by issuing Operating Instructions.	IRO-001-4
Real-time Assessment of pre-contingency system conditions must be done at least once every 30 minutes	Pre-Contingency assessments are conducted by the Real-Time RCSO utilizing SCADA and State Estimator.	IRO-008-2
Real-time Assessment of post-contingency system conditions must be done at least once every 30 minutes	Post-contingency assessments are conducted by the Study RCSO utilizing RTCA and RTVSA; study power flow and contingency analysis are also available for more detailed RCSO analysis.	IRO-008-2
Maintain a backup method for performing RTA in event of tool or data failures	Peak can continue to perform a RTA even when primary tools are unavailable.	EOP-008-1 IRO-002-5

5.2 Wide-area View (WAV)

The WAV of the RC Area gives Peak the distinct advantage of being able to monitor and respond to events beyond the bounds of a single BA or TOP Area. Peak monitors system frequency via its Energy Management System (EMS) and PI displays, and receives audible EMS alarms when Frequency Error exceeds Frequency Trigger Limits.

Peak also monitors individual BA performance by evaluating BA ACE, total generation, total load, actual/scheduled interchange and Contingency reserves. Peak's WAV allows it to identify sources of large ACE that may be contributing to Frequency Error, SOL or IROL exceedances, or excessive unscheduled flow, and works with its BAs on rebalancing to address the reliability of the BES.

Although Peak divides its RC Area into multiple desks to allow detailed focus on each region, the RCSOs coordinate issues, events and resolutions collectively regardless of their assigned desk. Because Peak has the ability to oversee the entire footprint, it never loses sight of the impact across multiple boundaries.

Requirements for Wide-area View	Peak Transitional RC Solution	Standard/Other Driver
Provide System Operators with the capabilities necessary to monitor and analyze data needed to perform their reliability functions	WAV, as well as the WSM and associated tools, applications and processes utilized today will continue.	IRO-002-5
Monitor critical power system parameters and implement Operating Plans to address issues as they arise	This is a core function of an RC. Peak will continue performing this function and will coordinate with adjacent RCs to address issues that are impactful to neighboring systems.	IRO-002-5 IRO-008-2 IRO-009-2
Manage alarms and coordinate with impacted entities	RCSOs manage power system alarms that come into Peak's EMS. Once those alarms are in, they are acknowledged and addressed.	IRO-002-5 IRO-008-2 IRO-009-2
Interconnection-wide Real-time communications	Peak uses the Reliability Messaging Tool (RMT) to communicate with all entities within Peak's RC Area. RMT allows for three-way communications via message acknowledgments between Peak and the BA or TOP. Peak also uses RCIS as a tool for RC-to-RC communications.	COM-002-4
Notify TOPs of space weather (Geomagnetic Disturbances (GMD))	Peak notifies TOPs when significant GMD events occur.	EOP-010-1

5.3 SOL & IROL Management

Unanticipated real-time events can place the BES into a state where Real-time Assessments indicate that the system is not secure for the next single Contingency or credible multiple Contingency. By analyzing the results of its Real-time Assessments, Peak is continually aware of unacceptable system performance in real-time operations

and the conditions that exist when exceedances occur (in both the pre- and post-Contingency system).

Peak notifies impacted TOPs, BAs and adjacent RCs when indications of actual or expected conditions result in, or could result in, sustained SOL or IROL exceedances within its RC Area. Peak collaborates with the impacted entities to identify appropriate mitigation actions to alleviate the SOL and IROL exceedances, monitors the effectiveness of the mitigation actions, and ultimately may issue instructions as appropriate to return the system to within limits, thereby ensuring the security and reliability of the RC Area.

Requirements for SOL and IROL management	**Peak Transitional RC Solution**	**Standard/Other Driver**
Identify any SOL exceedances and determine any IROL exceedances within its Reliability Area	WAV, as well as the tools, applications, procedures and processes utilized today will continue.	IRO-002-5 IRO-008-2 IRO-009-2
Prevent instability, uncontrolled separation or cascading outages that adversely impact the reliability of the Interconnection	Peak ensures prompt action to prevent or mitigate instances of exceeding IROLs. The WAV, as well as the tools, applications, procedures and processes utilized today, will be continued.	IRO-009-2
Provide leadership to BAs and TOPs when SOL or IROL exceedances exist	Peak has an independent and reliability-focused mindset when addressing SOL or IROL exceedances.	IRO-001-4 IRO-008-2 IRO-009-2

5.4 Energy Emergencies

Energy Emergencies normally result from insufficient resource availability for a BA. Peak monitors individual BA performance by evaluating BA ACE, total generation, total load, actual/scheduled interchange and Contingency reserves, and receives audible EMS alarms for deficiencies. Peak communicates with BAs to determine causes of deficiencies and actions being taken to mitigate them. Based upon its own judgment or if requested by the BA, Peak declares Energy Emergency Alerts as appropriate in order to assist the deficient BA in finding available resources. As the situation warrants, Peak also works with BAs, TOPs and adjacent RCs to return to service any facilities that may provide relief and evaluates the risks of revising SOLs and IROLs for the possibility of delivery of energy to the deficient BA.

Requirements for Energy Emergencies	Peak Transitional RC Solution	Standard/Other Driver
Review TOP/BA Operating Plan(s) to mitigate operating Emergencies regarding any reliability risks	Operations Coordination will continue to review the Operating Plans of TOPs and BAs within the RC Area to identify reliability risks.	EOP-011-1
Initiate Energy Emergency Alerts (EEA) as needed	Peak will continue to evaluate potential and actual EEAs in its RC Area, and initiate the correct level of EEA.	EOP-011-1

5.5 Seams Coordination & UFMP

Peak's Enhanced Curtailment Calculator (ECC) was developed to provide an Interconnection-wide process to perform orderly, efficient allocation of relief between impacting parties based on the coordinated criteria outlined in the WECC Unscheduled Flow Mitigation Policy (UFMP) for Qualified Transfer Paths in the Western Interconnection. ECC minimizes seams issues between entities by providing a common platform for the Interconnection instead of entity-to-entity independent processes. ECC places priority on reliability using a flow-based approach by using Peak's SCADA and Real-time Assessment inputs to accurately determine the origins of unscheduled flows and provide fair, equitable, efficient and effective solutions.

Upon receipt of a UFMP request, Peak evaluates the potential impact to system conditions (area voltages, adjacent Path loading, etc.). As system conditions allow, Peak evaluates BA ACEs to identify those that are significantly contributing to unscheduled flow on the Qualified Transfer Path and issues Operating Instructions for corrective action as required. Peak utilizes ECC and its other real-time tools to determine available relief and expected system conditions upon adjustment of Qualified Controllable Devices, while ensuring acceptable pre- and post-Contingency system performance.

Requirements for Seams Coordination & UFMP	Peak Transitional RC Solution	Standard/Other Driver
Assess phase shifter effectiveness and impacts for UFMP step 4 requests	Phase shifter movements can have impacts across wide areas of the Western Interconnection. Peak performs studies to assess the reliability impacts of phase shifter movements before step 4 phase shifter tap changes are allowed.	IRO-006-WECC-2 IRO-008-2
Approve or deny a request within five minutes of receiving the request for unscheduled flow transmission relief from the TOP of a Qualified Transfer Path	Continue to utilize ECC for UFMP.	IRO-006-WECC-2

(cont.) Requirements for Seams Coordination & UFMP	Peak Transitional RC Solution	Standard/Other Driver
Manage RC-to-RC seams in a reliable manner	The ECC is being enhanced to support SOL management and seams coordination beyond Qualified Paths. Peak is leading this effort in conjunction with the ECC Task Force.	IRO-006-WECC-2 IRO-008-2

5.6 System Restoration

Peak facilitates the restoration process by coordinating, compiling and disseminating information while maintaining system stability in order to prevent relapse. This is accomplished by coordinating the actions of the BAs and TOPs over a wide area. The WAV gives Peak the ability to recognize how widespread a problem is, what needs to be done to stabilize the remaining portion of the Interconnection, and how to efficiently restore and resynchronize any islands that may have been formed during the disturbance.

Peak ensures that there are common strategies for impacted entities involved in the restoration effort, that communications are coordinated to facilitate restoration activities, that the system is operated within secure limits, and that a coordinated resynchronization process is used to re-establish the Interconnection.

Peak provides multiple interactive restoration training sessions for the Interconnection annually through the use of its Dispatch Training Simulator (DTS). The DTS training sessions are accessed through Peak cloud services so BAs and TOPs can train in their own location using the WSM. In recent years, Peak has provided an average of 10,000 Continuing Education Hours annually to BA and TOP operators within its RC Area.

Requirements for System Restoration	Peak Transitional RC Solution	Standard/Other Driver
Shall have a Reliability Coordinator Area restoration plan	Peak will maintain a restoration plan and coordinate the plan with neighboring RCs.	EOP-006-2
RC shall include within its operations training program, annual System restoration training for its System Operators	Training will continue to be provided to Peak operators and BA/TOP operators within the RC Area utilizing Peak's DTS. Neighboring operators will also be included as necessary.	EOP-006-2

5.7 Operational Excellence Days (OED) Measures

Several metrics are tracked on a daily basis that are associated with both human and tool performance in Peak's Operations, Engineering and IT departments. Individual department metrics include, but are not limited to:

- Operations
  - RCSO Communication during Operating Instructions
  - RCSO Actions during IROL and stability limit exceedances
- Engineering
  - State Estimator solution availability
  - State Estimator solution accuracy
  - Day ahead study accuracy
- Information Technology
  - BES Critical Cyber System availability
  - Non-BES and Internet Applications availability

Each metric is weighted based on its impact to reliability, totaled daily and compared to the maximum total allowable in order to establish the day's OED score. Each workday, the three departments meet to review the score and discuss any potential lessons learned from the prior day. Mitigation plans are developed and assignments made accordingly to ensure a culture of continuous improvement is maintained.

Requirements for OED Measures	**Peak Transitional RC Solution**	**Standard/Other Driver**
Continuous Improvement	Peak will continue to conduct the daily scorecard meeting to establish its OED score for each day. Metrics will continue to be looked at to determine what needs to be included, or removed, from the process.	Operational Excellence

6. Compliance

Peak operates a mature, robust and risk-based compliance program in accordance with NERC's Compliance Monitoring and Enforcement Program. Peak is pursuing WECC Internal Control Evaluation and expects to achieve this goal by the end of 2018.

6.1 Culture of Compliance

A strong culture of compliance is at the core of an effective RC. Some practices that define a strong culture of compliance included in the following table.

Requirements for Culture of Compliance	Peak Transitional RC Solution	Standard/ Other Driver
Strong internal controls	Peak is focused on internal controls to reduce risk to Peak and to BAs and TOPs in the Western Interconnection.	Culture of Compliance
Leadership in compliance activities	Peak routinely takes a leadership role in compliance engagements by participating on NERC and WECC Standard Drafting Teams, NATF Practices Groups, NATF Peer Review Teams, WECC Certification Review Teams, the WICF Steering Committee, WICF Focus Groups and stakeholder mock audits.	Culture of Compliance
Accountability for compliance to NERC standards	Peak frequently engages WECC in discussions related to compliance impacts for Peak and its stakeholders to proactively ensure understanding of WECC's audit approach.	Culture of Compliance
Minimize compliance activity impact on stakeholders	Peak recognizes that its compliance activity may impact stakeholders. In accordance with Peak's Compliance Impact Stakeholder Engagement Plan, Peak assesses and identifies compliance impacts resulting from the development or revision of its documentation. The plan documents Peak's stakeholder engagement approach when creating awareness for, or collaborating with stakeholders when development or revision of Peak's documentation may lead to compliance impacts for Peak's stakeholders.	Culture of Compliance

7. IT Infrastructure

IT infrastructure is the backbone of Peak and supports the tools, applications and data necessary to perform the RC function. Peak has numerous critical systems that are used by the RCSOs to maintain situational awareness, including robust analysis capabilities. The EMS is one of those critical systems, along with Peak's historian, voltage stability tool and COS, to name a few. This section lists some of the features of systems needed to perform the RC function, along with key availability, redundancy and test system requirements.

7.1 High Availability of Systems

The systems used by any RC must be designed for an appropriate level of reliability and availability. Peak has taken great care to design its system availability based on the functions those systems support. High availability requirements for performing the RC function are listed in the following table.

Requirements for High Availability	Peak Transitional RC Solution	Standard/Other Driver
Core infrastructure availability > 99.999%	100% up time, no historical outages for critical services.	IRO-002-5
Critical systems availability > 99.999%	Peak's critical systems are engineered to deliver 99.999% up time; Peak continuously exceeds the availability measure.	IRO-002-5
Non-critical systems availability > 99.9%	Peak's non-critical systems are engineered to deliver 99.9% availability; Peak continuously exceeds the availability measure.	IRO-002-5

7.2 System Redundancy

Having redundancy of systems is extremely important in performing the RC function. This includes items such as redundancy geographically, redundancy of communications circuits and redundancy of systems.

Requirements for System Redundancy	Peak Transitional RC Solution	Standard/Other Driver
Control centers and data centers must be geographically diverse	The Western Interconnection is subject to a variety of risks such as earthquakes, fires and severe storms. To mitigate these risks, an RC responsible for large portions of the West must have a strong design for control center and data center geographic diversity. Peak meets this requirement by having facilities in Loveland, Colo. and Vancouver, Wash.	IRO-002-5
Critical system site failover capability	Peak has a "hot" standby site with the ability to failover between sites within minutes.	IRO-002-5
Proven site redundancy	Peak ensures that both sites are fully functional at all times. That is verified regularly by performing a failover of critical systems between sites every 5-6 weeks.	IRO-002-5
Communication circuit redundancy	Communication circuits used by Peak are redundant and diversely routed. This ensures high availability of critical data used by Peak's reliability systems and tools.	IRO-002-5

7.3 Test Environments

Test environments are an important component to change management and ensuring that changes are properly tested and validated before they hit production environments. Peak has a progression across multiple test environments, with the last Test/QA system

being identical to production environments to support a wide array of testing, including failover testing and end-to-end testing.

Requirements for Test Environments	Peak Transitional RC Solution	Standard/Other Driver
Test/QA environment which mirrors production for thorough testing	Peak's test environment is set up identical to production systems, which ensures reliable testing and deployment of new/updated applications and models.	IT Best Practice
Test/QA environments must be separate from production environments	Peak has test environments set up separate from the production environment, which ensures reliability of systems is maintained and meets industry best practices.	IT Best Practice

8. Vision and Future Direction

Peak's vision is to provide the highest level of reliability and service to the BAs and TOPs and membership, taking advantage of technology, innovations and our robust operational experience. That vision is enabled through the development and implementation of tools and data that are not yet available to operators in the West. Peak was recently recognized by the North American Synchrophasor Initiative (NASPI) as the 2017 RC of the Year for our work developing and implementing synchrophasor technologies. Peak envisions a time where wide-area tools used for the greater good of the West are supported and enhanced, even in a time where multiple RCs are the norm. These common tools are the foundation of reliability for the West, and are available to all operators whose mission first and foremost is reliability. Some of the tools and capabilities that are a part of Peak's future technology offering are listed below.

8.1 Linear State Estimation

Linear State Estimation (LSE) is the synchrophasor version of the traditional state estimator. In the LSE, because angle measurements are directly available, all other power system quantities such as voltage, MW and MVAR flows can be directly calculated at a very high rate of speed – up to 30 times per second, which is roughly the same rate of speed as the PMUs are sampling the data. It is likely that the future of state estimation is LSE once there is sufficient PMU coverage in the Western Interconnection. Peak's current focus is to implement LSE as a backup to SCADA data to support situational awareness of the West. LSE data can also feed downstream applications as the observable footprint grows over time.

Requirements for LSE	Peak Transitional RC Solution	Standard/Other Driver
Calculate system state 30 times per second	Peak's LSE runs at a rate of 30 times per second.	IRO-002-5 – improves situational awareness
Provide LSE calculated data as secondary measurement for RCSOs	LSE data is being integrated into situational awareness screens by the end of 2018. If desired by BAs, TOPs and other RCs, Peak could stream the LSE data to other entities for similar situational awareness.	IRO-002-5 – improves situational awareness

8.2 Oscillation Detection & Mode Meter

Oscillation Detection and Mode Meter are two synchrophasor-based tools that will significantly benefit the West. In 1996, an event that broke up the West was analyzed after the fact with these tools (from existing PMUs at that time) and it was determined that both of these tools could have prevented the system break-up and outages if they had been in place.

Requirements for Oscillation Detection & Mode Meter	Peak Transitional RC Solution	Standard/Other Driver
Monitor inter-area modes for potential reliability impacts (such as seen in the 1996 Western Interconnection event)	Peak's Mode Meter tool can monitor inter-area modes in order to detect wide-area issues.	IRO-002-5 – improves situational awareness
Forced oscillation detection	Forced (local) oscillations due to single plants or units can trick operators if they oscillate at the right frequency. Forced oscillation detection is critical to provide operators with clarity that an event is a wide-area issue and needs to be addressed. Peak has developed a forced oscillation detection engine in collaboration with Washington State University, which is being tested in Peak's test environments for future implementation into the RC control center.	IRO-002-5 – improves situational awareness

(cont.) Requirements for Oscillation Detection & Mode Meter	Peak Transitional RC Solution	Standard/Other Driver
Detect harmful oscillation energy levels	High oscillation energy may cause secondary system actions (generator trips, for example), which often perturb the system even further. Peak has baselined oscillation energy to identify alarmable levels and is working with WECC's Joint Synchronized Information Subcommittee and the Synchronized Measurements and Advanced Real-time Tools working group to determine the pathway to implement these tools.	IRO-002-5 – improves situational awareness

8.3 Phase Angle Monitoring

Phase angle monitoring is one of the signatures of the 2003 NE blackout. Peak performs phase angle pair monitoring in the state estimator and contingency analysis applications today, but in the future will have the capability to drive that analysis directly from phase angle measurements.

Requirements for Phase Angle Monitoring	Peak Transitional RC Solution	Standard/Other Driver
Monitor and alarm critical phase angle pairs using PMU-measured angles	Peak has been studying the value of monitoring and alarming key node pairs for monitoring key areas of heavy power transfer such as those associated with IROLs in the Western Interconnection. Peak continues to investigate and will implement solutions when the technology is ready.	IRO-002-5 – improves situational awareness Outage Report (Recommendation #27)

8.4 BA, TOP, External RC Services

Peak sees tremendous value in centralizing certain wide-area tools for the benefit of the entire Western Interconnection. With the advent of RC footprint fragmentation in the West, tools and services that benefit the greater good of the West should not be abandoned. It has been said many times by many people that we should not lose sight of reliability among the sweeping changes that are occurring in the West; maintaining wide-area tools that benefit the Interconnection is in line with reliability for the West and reduces duplication of tools and efforts across the RCs, TOPs and BAs.

Peak tools that are designed to support the greater good of the Western Interconnection include but are not limited to:

- Reliability Messaging Tool
- WECC Interchange Tool
- Enhanced Curtailment Calculator
- Dispatcher Training Simulator
- Synchrophasor tools and data
- Coordinated Outage Scheduling Tool
- Voltage and Transient Stability Tools
- Geo-spacial visualization tools
- Hosted Advanced Applications

Peak believes that by providing these types of tools to BAs, TOPs and other RCs in the West, we can collectively support reliability entities in performing Real-time Assessments and Operational Planning Assessments, and can comply with recommendations from the Outage Report, many of which are now industry knowledge, where lack of external system awareness and real-time tools were specifically identified as key contributors to the outage.

9. Conclusion

Peak provides a high degree of reliability for the West through tools, processes and, most importantly, through the people that work at Peak.

Peak's intent in providing this fact-based set of requirements for performing the RC function in the West is to arm BAs and TOPs with the knowledge about what they need from their RC provider of choice and to assist them in making an informed decision that is right for reliability and right for their organization.

Peak recognizes that reliability, cost and independence are the three key factors currently in play in Western Interconnection BES reliability. Since 2009, Peak has provided exceptional tools and RC service to the BAs and TOPs in the West. It has achieved this in large part through the knowledge and commitment of the Peak team members and in collaboration with the BAs, TOPs and Peak's members. Working together, we have built an RC that is second to none in terms of scope and skill sets. Together we have invested in the sophisticated set of tools described in this document that meet the unique needs of the Western Interconnection.

With reliability services now a competitive option in the West, Peak continues its commitment to preserving as much of the West-wide view as possible, and to maintaining the highest level of reliability, all while significantly reducing costs.

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