August 13, 2012

Texas RE Final Draft Report to NERC on the Follow-Up Actions for the September 8, 2011 Southwestern Blackout Recommendations

Texas RE is responding to NERC’s “Follow-Up Actions for September, 8, 2011 Southwestern Blackout” sent to Texas RE on June 5, 2012.

Below is Texas RE’s Final Report which provides the status on actions by Registered Entities, technical committees, or other work groups within the ERCOT Interconnection to address the applicable findings and recommendations from the NERC/FERC Joint Staff Inquiry report on the Arizona – Southern California Outages on September 8, 2011. While many of the recommendations are specific to WECC and the companies involved in the event, Texas RE initiated several discussions among stakeholders to seek broader application or confirm practices in place to evaluate or minimize the possibility of similar occurrences within the ERCOT Interconnection. Texas RE attended and or conducted multiple meetings with stakeholders and Regional technical working groups further developing the initial responses and identifying possible improvements to Regional operations and planning.

Based on these discussions with stakeholders, Texas RE will continue dialogue on several topics to improve understanding of Regional practices and possibly develop specific recommendations:

* Handling of relay settings in ratings, particularly when these are most limiting series elements
* Operational use of facility owner’s ratings when different values are not available for continuous, 2 hour and 15 minute capability
* Consideration of overload relay trip times when establishing post-contingency mitigation plans
* Review process for coordination of SPS and UVLS with other protection schemes, especially overload relays

Texas RE will conduct outreach following the conclusion of this dialogue describing the findings, which should be completed during the fourth quarter of 2012. This will include identifying whether any modifications to Regional practices or their documentation is warranted, along with a schedule for that effort.

All but one of the Transmission Operators (TOPs) in the ERCOT Interconnection is registered pursuant to a Coordinated Functional Registration (CFR) agreement for TOP functions. The CFR agreements are executed by and assign specific responsibilities for TOP functions to (1) ERCOT ISO and (2) certain transmission-owning entities that each operates a control center for a discrete portion of the bulk-power system within the ERCOT Interconnection. These transmission entities are defined in the CFR as Local Control Centers (LCCs). ERCOT ISO is the only Reliability Coordinator (RC) and Balancing Authority (BA) for the ERCOT Interconnection and is party to all of the TOP CFRs. One additional transmission-owning entity elected to be registered as a TOP without a CFR. The NERC questions have been answered based on the assignment of responsibilities within the TOP CFR agreements.

**Texas RE Response to NERC Request for**

**Follow-Up Actions for September 8, 2011 Southwest Blackout**

Group A: Next-Day Planning and Real-Time Operating Issues

Recommendations 1 – 4 address the responsibilities of RCs, TOPs, and BAs in the next-day planning timeframe. They stress the importance of accuracy in next-day planning models, including sharing, across the entire RC footprint, generation and transmission outages and transactions that could impact the reliability of the bulk power system (BPS); comprehensiveness of studies with respect to facilities that can impact bulk power system reliability, including sub-100 kV facilities; and the free and unrestricted exchange of next-day operations data and studies between and among operating reliability entities.

**Response to Recommendations 1 – 4:**

1. How do the TOPs in the ERCOT Interconnection conduct next-day studies and freely share with each other and the RC, the status of planned outages of generation and transmission, expected transactions, and study results?

ERCOT ISO updates next-day studies to reflect planned outages of generation and transmission. ERCOT ISO, as a TOP and the only RC and BA for the ERCOT Interconnection, is the sole entity with complete visibility of the entire Interconnection. ERCOT ISO is also the only recipient of generation Current Operating Plan (COP) data. Since ERCOT acts as the single BA for the region, there are no inter-BA transactions other than through Direct Current ties. As such, ERCOT ISO is the only entity that can conduct next-day studies of the entire Region. The ERCOT Interconnection has local rules in place that reinforce the responsibilities associated with next-day planning and support the requirements in the TOP CFR.

All LCCs have the entire Network Model Management System (NMMS) Common Information Model (CIM)/XML Network Model [[1]](#footnote-1) of the ERCOT transmission system available to them through the Market Information System (“MIS”); however, having the CIM/XML model available for downloading is different from having the model file available to be used in study applications. Currently, only ERCOT ISO uses the CIM/XML model as direct input for its Energy Management System used in Real-time and Day-Ahead activities. Due to the technical aspects of the ERCOT CIM/XML model structure considerable time and cost would be necessary for other entities to use the ERCOT CIM/XML model in their own study applications.

Transmission and generation outage information for next-day studies is available to all LCCs from the ERCOT outage scheduling tools and processes; however, the format provided is not directly importable into the LCCs applications. Generator Current-Operating-Plans (COPs) for the next seven days are not available to LCCs for next-day planning, but ERCOT ISO has this information for conducting next-day security analysis. Single contingencies are developed through internal ERCOT ISO (RC, BA, TOP and PC (Planning Coordinator)) processes based on data provided by LCCs. Special contingencies, such as double-circuit contingencies, are developed by ERCOT ISO or can be suggested by LCCs to ERCOT ISO for inclusion in models. The sharing of study results is primarily accomplished with ERCOT ISO receiving transmission (including sub-100 kV equipment) and generation outages requests and performing multi-day-ahead and day-ahead operational review of those outages and the setting of system limits. Some neighboring LCCs model portions of each other’s systems to a certain extent that may reflect contingency-based issues within their neighbor’s borders; however, none of these limited models have the complete information to fully analyze the effect of contingencies. ERCOT ISO processes are the key in coordinating contingency implications among neighboring LCCs. Some LCCs also pre-screen outage requests prior to submitting to ERCOT ISO. ERCOT ISO conducts next-day contingency analysis through the Day-Ahead Reliability Unit Commitment (DRUC) process for the entire Interconnection.

The LCCs could benefit from having visibility into planned generation dispatch, for instance through the sharing of the COPs. This visibility would not impose an obligation on the LCCs to run studies in parallel with ERCOT ISO. A significant amount of additional data (i.e. generator ramp rates and limitations, explicit EMS modeling of Remedial Action Schemes, significant amounts of additional external SCADA points, LCC EMS modifications, external modeling enhancements, etc.) and resources would be required by LCCs to perform extensive studies for next-day planning purposes that are currently the responsibility and obligation of the ERCOT ISO. The studies that are run by the Local Control Centers support the ERCOT ISO obligations but would not replace those obligations.

Texas RE will continue to monitor developments on the following:

* LCC to LCC and ERCOT to LCC sharing of next-day study information, especially Provision of additional information (i.e. COPs, SPSs, Mitigation Plans, etc.) to the LCCs by ERCOT ISO.
* ERCOT ISO possible enhancements to the System Operations Test Environment (SOTE) currently accessible by LCCs.

1. Which TOPs have completed studies identifying the sub-100 kV facilities that can have significant impacts on BPS reliability and model those facilities in their next-day studies? How often are studies performed to evaluate the effect on sub-100 kV facilities when new transmission or generation facilities are added to the system?

ERCOT ISO updates next-day studies to reflect planned outages of generation and transmission equipment including sub-100 kV facilities. ERCOT ISO and LCCs include the sub-100kV networks in their models and next-day studies for the Region; therefore, effects of system changes on these facilities are included in the studies. Facility owners submit model data for all facilities 60 kV and above to ERCOT ISO prior to the facilities being placed in service and as facility configuration changes occur. Studies are performed that include all transmission facilities regardless of voltage level. ERCOT ISO includes all 69 kV contingencies in all EMS studies (real-time, outage coordination, day-ahead SOL studies, etc.). ERCOT ISO includes select 69 kV contingencies for inclusion in Market Management System studies which includes Reliability Unit Commitment (RUC) studies. ERCOT ISO incorporates the study results into its security constrained economic dispatch of generation and its direction to the Local Control Centers.

ERCOT stakeholders are discussing possible additional modeling needs for Private Use Networks (non-utility industrial facilities typically with self-generation), some of which are below 100kV, in proposed revisions to the Nodal Protocols, NPRR190, NPRR425 and related Protocol revisions. Texas RE will monitor the progress of this work. These efforts are supplemental to previously established modeling and data requirements for such facilities and underscore the Region’s regular examination of which facilities need to be studied.

1. When and how are TOPs alerted to contingencies on neighboring systems that could impact their internal system and the need to plan for such contingencies? When do TOPs include contingencies in next-day studies on neighboring systems that could impact their internal system?

As noted in the response to Question #1, ERCOT ISO has complete visibility across the Region’s entire transmission system, including 69 kV, and provides notifications through outage coordination and operational communications. ERCOT ISO develops contingency plans based on system conditions. ERCOT ISO communicates these contingency plans in several different ways, including procedural output documents, operational notices, telephone calls, and emails.

ERCOT ISO alerts Local Control Centers of contingencies on neighboring LCC systems that could impact another LCC’s internal system and the need to plan for such contingencies. Some neighboring LCCs have chosen to model portions of each other’s systems due to system topology that may indicate contingency based issues within their neighbors’ borders; however, ERCOT ISO processes are the key in coordinating contingency implications among neighboring LCCs.

Texas RE will continue to seek feedback and monitor progress on the standardization of ERCOT ISO procedures regarding all contingency plan types, including possible posting of contingency plans on the ERCOT Market Information System (MIS).

**Group B: Longer-Term and Seasonal Planning Issues**

Seasonal Planning (Recommendations 5 – 8) address the responsibilities of TOPs/TPs for seasonal planning, especially in terms expanding the scope of their seasonal planning studies to include external facilities and the impact of sub-100 kV facilities, both internal and external to the TOP/TP’s system, on bulk power system reliability. The recommendations also stress the importance of sharing information with neighboring TOPs and the RC regarding overload relay trip settings that fall below or near the emergency ratings of their facilities.

**Response to Recommendations 5-8**

1. How are TOP operators alerted to and prepared to respond to first contingency conditions on their own and their neighbors’ systems?

ERCOT ISO, as the RC and PC for the ERCOT Interconnection, has total visibility of the entire ERCOT footprint and performs the seasonal analysis of the entire ERCOT Interconnection. During the current seasonal planning process, a full contingency analysis of the entire ERCOT Interconnection is conducted. ERCOT ISO alerts LCCs of contingencies on neighboring LCC systems that could impact another LCC’s internal system and the need to plan for such contingencies. Several neighboring LCCs model each other’s systems to a certain extent that may indicate contingency based issues within their neighbors’ borders, but ERCOT ISO processes, such as those involved in seasonal assessments and the Five Year Plan studies, are the key in coordinating contingency implications among neighboring LCCs in long-term and seasonal horizons.

1. How do seasonal studies evaluate the entire region whereby TOPs can see the effect on one area from a contingency occurring in another area? How does the seasonal planning process ensure there are no study gaps/seams between parts of the region?

ERCOT ISO and the LCCs act as a single Region with ERCOT ISO in the lead for the operational seasonal studies. ERCOT ISO uses its 90-day Outage study process as the basis for seasonal studies. The process provides a continuously updated look ahead that establishes that the temporal model (representing the expected physical system) with known outages is adequate to reliably serve the expected load. The study is a steady-state analysis that uses a full contingency set including sub-100 kV elements. If transient, stability, dynamic, or voltage issues are revealed in the analysis, the steady-state analyses are supplemented with appropriate additional specific studies.

1. In the seasonal study process, which elements, including those below 100 kV that can affect the reliability of the BPS, are deemed appropriate for study in contingency analysis (i.e. included as contingencies and the impacts of contingencies)?

ERCOT ISO has total visibility of the entire ERCOT Interconnection footprint and performs the seasonal analysis of the entire ERCOT Interconnection which includes the entire transmission network above 60 kV. During the seasonal planning process, a full contingency analysis of the entire ERCOT Interconnection is conducted.

As noted earlier, Texas RE will continue to monitor current consideration of Private Use Networks requirement under NPRR190 and related proposals which will help refine needs for these systems, a few of which may be under 100kV.

1. Under what conditions are seasonal studies performed by TOPs for shoulder periods such as Spring and Fall when load can still be high but transmission elements and generators may be scheduled out of service for maintenance? What load levels are considered?

The forecasted peak demands are produced by the ERCOT ISO for the entire ERCOT Interconnection, which is a single Balancing Authority area, based on the Interconnection-wide actual demands. While the forecasted peak demands produced using the average weather profile are used for resource assessments, alternative weather scenarios are used to develop extreme weather load forecasts to assess the impact of weather variability on the peak demand for the ERCOT Interconnection. One scenario is the one-in-ten-year occurrence of a weather event. This scenario is calculated using the 90th percentile of the temperatures in the database spanning the last fifteen years. These extreme temperatures are input into the load-shape and energy models to obtain the forecasts. The extreme temperature assumptions consistently produce demand forecasts that are approximately 2 to 5 percent higher than the forecasts based on the average weather profile (50/50) for the summer season. Together, the forecasts from these temperature scenarios are usually referred to as 90/10 scenario forecasts. The continuously rolling 90-day outage study is performed and loads in the cases are continually changing to match the expected seasonal conditions. ERCOT ISO will also study off-peak loads and additional load variations when required. The study of multiple load levels has been and continues to be a discussion point for ERCOT ISO and the LCCs. The planning forecast methodology used by ERCOT ISO has changed to include the extreme weather events of 2011 (both in the winter and summer). Internally, LCCs study several different load levels. Load variation is somewhat LCC dependent as geography has to be considered (e.g. Dallas load variation versus western Texas load variation are quite different). ERCOT ISO uses several load forecast variations and system scenarios in developing the internal ERCOT Seasonal Assessment of Resource Adequacy provided for each season. Working Groups in the ERCOT Interconnection, like the Steady State Working Group, have processes in place to provide models to study load variations within the system. ERCOT ISO can recall or refuse to grant outages if studies or system conditions are indicative of a serious reliability concern in any time period (i.e. seasonal, short term, long term, real time, etc.) or voltage level being studied. If a refusal or recall of an outage occurs, there is significant dialogue between ERCOT ISO and the affected parties.

1. What is the process to share overload trip settings on transformers and transmission lines between neighboring TOPs, the RC, neighboring TPs, and the PC to ensure that the settings are incorporated into the next-day and seasonal planning process?

Processes in place to share data from the LCCs to ERCOT ISO (RC and PC for the ERCOT Interconnection) are meant to generally result in equipment characteristics being reflected in published planning data and results. Settings should also reflect the coordination of all new protective systems and changes as required per PRC-001. However, Texas RE has been made aware that overload trip settings specifically are not directly shared or modeled in planning cases, except perhaps in ratings for some equipment types (where relay settings may constitute the most limiting element when calculating the ratings). The Steady State Working Group, the group producing seasonal and future load-flow base cases used in the planning process, has the following statements in its procedure manual: “Facility ratings shall not exceed the most limiting applicable equipment rating of the individual equipment that comprises the facility. If the continuous or two (2) hour ratings of any series elements at the station terminals is less than the associated transmission line’s continuous or two (2) hour rating, then the most limiting elements’ rating data will be used as the Rate A and/or Rate B rating for the transmission line. The scope of equipment addressed shall include, but not be limited to, conductors, transformers, relay protective devices, terminal equipment, and series and shunt compensation devices.” Registered Entities in the ERCOT Interconnection have access to the seasonal and future load-flow base cases.

Overload trip settings are primarily shared among neighboring entities to verify protective relay coordination (e.g. PRC-001 requirements) on local points of interconnection. PRC-023 is used as the basis in evaluating relay loadability settings for any system elements subject to the requirements of PRC-023 including sub-200 kV elements designated by the PC (ERCOT ISO) for inclusion. There are several criteria available for Transmission Owners (TOs), Generator Owners (GOs) and Distribution Providers (DPs) to use in preventing protective relay settings from limiting transmission system loadability while maintaining reliable protection of the BES for all fault conditions. Certain PRC-023 criterion, if used, requires the agreement of the PC, TOP, and RC with the calculated circuit capability.

Texas RE will continue to seek feedback and monitor any progress on the following:

* Processes used to notify identified most limiting elements, with emphasis on relays, in a facility rating and the value of such notification.
* Processes for recognition of relay overload settings that exceed or are equal to ratings in operational tools (such as Real Time Contingency Analysis, RTCA) within ERCOT ISO systems.

1. How does the ERCOT Interconnection ensure that seasonal planning studies address the interaction of various Protection Systems, especially Special Protection Systems and UVLS systems that are designed to operate post-contingency?

Coordination of protective systems with SPS, UVLS, and post-contingent mitigation plans undergo a thorough review and analysis of impacts. In general, there is significant effort regarding coordination of protections systems but there may be isolated cases indicative of a need for further process review.

Near- and Long-Term Planning (Recommendations 9 – 10) focus on the importance of addressing gaps in the planning processes of TPs, and PCs, especially where these gaps result in a lack of consideration for critical system conditions, impact of sub-100 kV facilities, interaction of Protection Systems, and failure to benchmark models against actual system conditions that occur during unusual system events.

**Response to Recommendations 9-10**

1. How do the near- and long-term planning studies conducted by TPs and PCs evaluate the impacts of major transmission outages under heavy transfer conditions?

Short term planning studies take major transmission outages into effect. There is a wide variety of longer term planning studies some of which, like the Five Year Plan set of studies, evaluate impacts of major transmission outages under heavy transfer conditions. Cases are prepared for varied system conditions and special studies also accompany planned outage requests. During the planning process, a full contingency analysis of the entire ERCOT Interconnection is conducted. Impacts are reviewed by TPs and the PC as a case of normal business. The planning process dictates evaluation criteria used to determine the need for new facilities. The Regional Planning Group provides a primary forum for discussion, input and comment on issues related to planning the ERCOT system for reliable and efficient operation. The Planning Working Group identifies any needed improvements to planning criteria, processes, and data provision requirements as well as assisting in the review and analysis of unusual or emergency type events having a significant impact on the ERCOT Interconnection transmission system.

1. How do these studies evaluate the impact of such outages on sub-100 kV facilities, especially those operated in parallel with the BES, to determine whether any potential exists for system cascading?

ERCOT ISO has total visibility of the entire ERCOT Interconnection footprint and performs the planning analysis of the ERCOT Interconnection which includes the entire transmission network above 60 kV. During the planning process, a full contingency analysis of the entire ERCOT Interconnection is conducted. The impact evaluation is completed at all voltage levels above 60 kV and there has been no differentiation noted in actions based on the voltage levels.

1. How does the ERCOT Interconnection ensure that near- and long-term planning studies address the interaction of various Protection Systems, especially Special Protection Systems and UVLS systems that are designed to operate post-contingency?

Coordination of protective systems with SPS, UVLS, and post contingent mitigation plans undergo a thorough review and analysis of impacts. In general, there is significant effort regarding coordination of protections systems but there may be isolated cases indicative of a need for further process review.

1. What does the Region do to benchmark its planning models against real system conditions, especially severe and unusual system conditions? When does the Region benchmark its planning models?

ERCOT ISO has processes in place to ensure consistency between operations and planning models based on local rules (ERCOT Protocols). These processes, which involve Registered Entities, are unique in the industry to review planning and operational model data. Model data is submitted by Registered Entities to ERCOT ISO, which is responsible for maintaining an accurate computer model for the ERCOT Interconnection utilized for analyzing and planning system operations. The data is incorporated directly into a time-based modeling system that serves as the base platform used in real-time and in future planning models (referred to as the Network Model Management System in the Region). ERCOT ISO manages the modeling process which includes several data validation and feedback milestones with the Registered Entities. Topology processing is coordinated and approved with the ERCOT LCCs. ERCOT’s Operations & Planning Synchronization Task Force was created in the Spring of 2012 to help address enhancements to the planning and operations processes regarding the utilization of models and modeling data within the ERCOT Interconnection.

The planning forecast methodology used by ERCOT ISO has changed to include the extreme weather events of 2011 (both in the winter and summer). ERCOT ISO specifically publishes two seasonal assessments each year in Summer and Winter that aim to include impacts of more severe conditions. Models are updated to correct discrepancies discovered during operational studies and conditions, faults, and disturbances. There is a local requirement where the ERCOT ISO will direct a dynamic simulation and a review of the automatic firm load shedding programs whenever warranted by conditions.

Additionally, ERCOT ISO has compared PMU data with telemetry data in its analysis of certain events to validate the modeled expectations of the event and tune PMU-related parameters.

1. How do system dynamic studies take into account protective relay (PRC-023), UVLS, and UFLS schemes?

ERCOT ISO adds existing UVLS and UFLS relay data to dynamic studies where appropriate. Load Resources relay data that trigger at 59.7 Hz are also added to studies where appropriate. The Dynamics Working Group will simulate an actual disturbance event for the purpose of assessing the fidelity of the ERCOT dynamics models and data with actual system performance during the event. The process of coordination and evaluating impact of transmission line overload relaying (at all voltage levels), in particular, in dynamic analyses may need review and

Texas RE will continue to seek feedback on this in dynamics case building with appropriate working groups. A similar situation regarding operational studies such as those associated with mitigation plans is noted under operational issues.

Group A: Next-Day Planning and Real-Time Operating Issues

Situational Awareness (Recommendations 11 – 16) cover a broad range of situational awareness issues, including: real-time visibility of external systems; adequacy of real-time tools; reliance on post-contingency mitigation measures; communicating the need for backup when RTCA capabilities are lost or impaired; and inconsistencies between real-time and planning models.

**Response to Recommendations 11-16**

1. Which TOPs in the ERCOT Interconnection have RTCA or State Estimator (SE) tools and visibility of external systems, and what potential gaps are left? How many TOPs have real-time tools versus having other entities that perform real time analysis for them?

ERCOT ISO as a TOP and the only RC in the Interconnection has total visibility of the entire ERCOT Interconnection with backup capability and performs real-time analysis of the entire ERCOT Interconnection. ERCOT ISO implements reliable real-time tools that provide situational awareness to identify and plan for contingencies operated on redundant platforms. ERCOT ISO uses a significant amount of tools and applications in addition to the RTCA and SE functions including its voltage stability analysis tool (VSAT), transient stability analysis tool, and Transmission Constrain Manager management (TCM), as well as offline study tools, to manage the ERCOT Interconnection system. ERCOT ISO maintains the real-time tools and off-line study tools necessary to provide “n-1” visibility for the entire ERCOT Interconnection. LCCs have access to a System Operations Test Environment (SOTE) through which ERCOT ISO provides SE (state estimator) case results every five minutes. The SOTE does not provide real time visibility to the LCCs. Some LCCs may use the SOTE studies and data to validate internal models and telemetry.

LCC capabilities for real-time visibility and situational awareness vary across the ERCOT Interconnection, with the larger LCCs equipped with SE and RTCA. Some Local Control Centers have real time tools, but these are operated for the benefit of the individual Local Control Center and not explicitly for ERCOT ISO purposes. Some LCCs model facilities operated by another LCC (total and partial- the practice varies) and have utilized options to retrieve some real-time data from ERCOT ISO. There is limited data sharing from LCCs to other LCCs via ICCP links. All LCCs have access to the ERCOT ISO model which includes all LCC facilities and have the option to retrieve real-time data from ERCOT ISO via ICCP links; however, as noted before, this data is sometimes not in a format that can be readily incorporated into LCC applications. LCCs work extensively with ERCOT ISO and neighboring LCCs on issues that cross boundaries.

ERCOT ISO determines System Operating Limits (SOLs) and Interconnection Reliability Operating Limits (IROLs). Multi-element SOLs and IROLs may not be necessarily modeled in ERCOT's Real-Time Contingency Analysis (RTCA) (i.e., each contingency analysis output shows results on individual element, not on the multi-element SOLs/IROLs as a whole). Multi-element SOLs and IROLs are modeled in other tools (e.g., VSAT, Real-Time Monitoring (RTMONI), and TSAT) used by ERCOT ISO to manage the ERCOT Interconnection system.

Texas RE will continue to seek feedback on the following:

* Procedure for each LCC’s communication efforts with other LCCs, other than ERCOT ISO, regarding their tools or the solutions from the tools.
* Study processes regarding SPS interactions within real-time applications.
* LCCs real time visibility outside of their system (and including Private Use Networks) for operator situational awareness.
* Discussions regarding ERCOT ISO possible enhancements to the System Operations Test Environment (SOTE) currently accessible by LCCs.
* LCC RTCA capabilities, internal RTCA processes, and process for sharing with ERCOT ISO and other LCCs.
* ERCOT ISO review of plans regarding loss of its SE/RTCA functionality, SE/RTCA application failure, RTCA contingencies failure to converge, and associated notification process for these conditions where applicable.

1. Post-contingency mitigation measures:
   1. To what extent do TOPs and the RC rely on post-contingency mitigation measures? If so, how are these measures evaluated to ensure they do not lead to cascading outages under severe or unusual system conditions?

Post-contingency mitigation measures are used in the ERCOT Interconnection. Their development is coordinated between ERCOT ISO and LCCs, with communication and impact of the measures representing a significant part of the effort. Upon request of ERCOT ISO, LCCs may provide additional information or assist in developing post-contingency mitigation plans. The development includes the study of conditions and outcomes, which may be based on temporary abnormal conditions such as equipment outages. ERCOT ISO has ultimate approval authority for all mitigation plans. The procedures for development of post-contingency mitigation plans are written by ERCOT ISO. Past ERCOT events provided examples of the use of post-contingency mitigation measures and how those measures are evaluated to avoid cascading outages under severe or unusual system conditions.

Texas RE will continue to seek feedback on the following:

* Further verification that the analysis leading to the mitigation plan adequately identifies the concerns raised by NERC, looking at recent system events here as well as the WECC event. Consideration of overload relay settings will play a part in developing any new processes associated with this recommendation.
* Further discussion of ERCOT ISO’s utilization of ratings provided by LCCs, particularly when common figures are provided for normal, two hour and fifteen minute ratings.
  1. How are affected neighboring TOPs notified of possible ramifications of these post-contingency measures?

The development of post-contingency mitigation measures is coordinated between ERCOT ISO and LCCs, including communication regarding impact of the measures. ERCOT ISO has ultimate approval authority for all mitigation plans, including those with post-contingency measures.

* 1. How do post-contingency mitigation measures take into consideration the effects of protective relay actions (e.g. PRC-023 settings, UVLS system response, etc.)?

Based on discussions with stakeholders, it is somewhat unclear how protection system settings are consistently considered by ERCOT ISO and LCCs during the development of post contingency mitigation plans. There may be cases indicative of a need for a process review when viability of post-contingency mitigation plans is impacted by protection system settings. Based on review of the WECC event, LCCs have proposed to ERCOT ISO a process to confirm protective relay overload settings when developing post-contingency mitigation measures.

Texas RE will continue to seek feedback and monitor any updates to the mitigation plan process regarding the consideration of relay settings.

* 1. How can the post-contingency mitigation plans be implemented by System Operators in a time-frame necessary to take the mitigating actions, considering the effects of these relay actions?

This requires careful analysis and planning in the development of the post-contingency mitigation plan, as the San Diego event shows that certain protection system actions will occur before System Operators are able to act. As part of the proposed LCC process to confirm protective relay settings effects when developing post-contingency mitigation measures, consideration of the time-frame necessary for System Operator actions needs to be reviewed in the mitigation plan development.

1. What steps are taken to ensure consistency between real-time and planning models?

ERCOT ISO has a process in place to ensure consistency between operations and planning models based on local rules (ERCOT Protocols) in place. The ERCOT ISO processes, which involve Registered Entities, are unique in the industry and help ensure consistency between planning and operational model data. Model data is submitted by Registered Entities to ERCOT ISO, which is responsible for maintaining an accurate computer model for the ERCOT Interconnection utilized for analyzing and planning system operations. The data is incorporated directly into a time-based modeling system that serves as the base platform for model data used in real-time and in future planning models (referred to as the Network Model Management System in the Region). ERCOT ISO manages the modeling process which includes several data validation and feedback milestones with the Registered Entities. Topology processing is coordinated and approved with the ERCOT LCCs. ERCOT’s Operations & Planning Synchronization Task Force was created in the Spring of 2012 to help address enhancements to the planning and operations processes regarding the utilization of models and modeling data within the ERCOT Interconnection. The ERCOT Interconnection had made considerable progress in this area even prior to the WECC event.

1. To what extent have the TOPs in your region incorporated the recommendations of the [NERC Real-Time Tools Best Practices Task Force](http://www.nerc.com/filez/rtbptf.html)?

ERCOT ISO is the RC for the ERCOT Interconnection and is also the only TOP required to operate the State Estimator and RTCA tools for the entire ERCOT Interconnection. ERCOT ISO was the only TOP operating in the ERCOT Interconnection at the time the referenced best practices were developed. ERCOT ISO provided experts to the Task Force for the development of the recommendations. Some LCCs have evaluated the report and enhanced their practices where applicable.

Consideration of BES Equipment (Recommendation 17) addresses the need for consideration, both in advanced studies and in real-time operations, of sub-100 kV facilities operated in parallel with the BES that can have an impact on bulk power system reliability.

**Response to Recommendation 17:**

1. What steps are taken to ensure that sub-100 kV facilities that could impact bulk power system reliability are considered in both real-time and advanced studies, especially during severe or unusual system conditions?

ERCOT ISO and LCCs include the sub-100kV networks in their models and studies for the Region; therefore, effects of system changes on these facilities are included in real-time and advanced studies. Facility owners submit model data for all facilities 60 kV and above to ERCOT ISO prior to the facilities being placed in service. Studies are performed that include all transmission facilities regardless of voltage level. ERCOT ISO includes all 69 kV contingencies in all EMS studies (real-time, outage coordination, day-ahead SOL studies, etc.). ERCOT ISO includes select 69 kV contingencies for inclusion in Market Management System studies which includes Reliability Unit Commitment (RUC) studies. ERCOT ISO incorporates the study results into its security constrained economic dispatch of generation and its direction to the Local Control Centers. ERCOT ISO can recall of refuse to grant outages if studies or system conditions are indicative of a serious reliability concern in any time period (i.e. seasonal, short term, long term, real time, etc.) or voltage level being studied. If a refusal or recall of an outage occurs, there is significant dialogue between ERCOT ISO and the affected parties.

Interconnection Reliability Operating Limits (Recommendation 18) refers to the identification and recognition of Interconnection Reliability Operating Limits (IROLs), both in day-ahead studies and in real-time operations.

**Response to Recommendation 18:**

1. What is the procedure for identifying IROLs within ERCOT and how are these limits shared and coordinated with TOPs within the Region?

ERCOT ISO is responsible for identifying IROLs as the RC and PA within the ERCOT Interconnection. ERCOT ISO maintains several procedures managing the identification, monitoring, publication, and coordination of IROLs and SOLs within the Region (e.g.,”ERCOT System Operating Limit Methodology for the Operations Horizon” procedure). ERCOT ISO reviews these processes regularly and incorporates necessary improvements considering comments from the LCCs with the ERCOT Interconnection. ERCOT ISO processes identify SOLs that are potential IROLs (not confirmed IROLs) and addresses the SOLs in real-time. The LCCs submit the necessary data, including facility ratings per ERCOT SOL Methodology, to ERCOT ISO to facilitate identification of IROLs and SOLs. Identified IROLs are posted daily for review by LCCs. Real-time IROL power flows and the associated IROL limit values are provided as ICCP points available to LCCs and some have incorporated the points into their own monitoring systems. ERCOT ISO has indicated that the procedures involving identification of SOLs and potential IROLs were under review by ERCOT ISO before this NERC request was provided.

Texas RE will continue to monitor progress on updates to ERCOT ISO procedure, including technical justification for IROLs and consideration of other SOL conditions that may result in similar consequences (such as potential loss of load not meeting the current threshold level for IROL classification).

1. What is the process to consider whether any System Operating Limits (SOLs) constitute an IROL in real-time, day-ahead, and seasonal studies?

ERCOT ISO evaluates all IROLs on an annual basis. ERCOT ISO also reviews SOL exceedances to determine if they qualify as potential IROLs based on the following criteria defined in the document “ERCOT System Operating Limit Methodology For The Operations Horizon”:

* + 1. “Potential IROLs will be investigated when the Real-Time Contingency Analysis application indicates a thermal rating exceedance in excess of 125% of the SOL of the monitored facility rating (Emergency Rating).
    2. Potential IROLs will also be investigated for base case exceedance greater than 100% of the normal facility ratings.
    3. Potential IROLs will also be investigated when the Real-Time Contingency Analysis application indicates an under-voltage condition characterized by bus voltages of less than 90% across three or more related BES facilities or an over-voltage condition greater than 110% across three or more related BES facilities.
    4. An unsolved or divergent contingency is present in RTCA.”

1. What is the process to validate existing SOLs and ensure that they take into account all transmission and generation facilities that impact BPS reliability?

The LCCs submit model data to ERCOT ISO that includes the facility ratings as one of the components used by ERCOT ISO to identify IROLs and SOLs. The LCCs work extensively with ERCOT ISO on the provision of ratings that may constitute SOLs/IROLs and SOLs, in general, are well known because the basis for determining SOLs is the LCC’s ratings.

A review of the Facility Rating Methodology expectations, sharing of relay overload settings, and the general management of facilities based on the ratings provided will be topics for further discussion among Texas RE stakeholders, to ensure consistent understanding across the Region.

1. What are the limitations to tools necessary to identify and monitor all SOLs (including IROLs) in real-time, day-ahead, and seasonal studies? Examples may be multi-element SOL’s in RTCA or SPS modeling in RTCA.

Multi-element SOLs and IROLs may not be necessarily modeled in ERCOT's Real-Time Contingency Analysis (RTCA) (i.e. each contingency analysis output shows result on individual element, not on the multi-element SOLs/IROLs as a whole). Multi-element SOLs and IROLs are modeled in other tools (e.g. VSAT, RTMONI, and TSAT) which provide real-time monitoring but may lack real-time post-contingency analysis.

Texas RE will continue to seek feedback and monitor any updates to the study processes regarding SPS interactions within real-time applications.

Protection Systems (Recommendations 19 – 26) address multiple issues related to Protection Systems, including: regular review, analysis, and coordination of Special Protection Systems with and among interconnected systems, especially under adverse system conditions; sensitivity of turbine control systems during extreme events; communicating to neighboring systems and RCs equipment when overload relay settings are below or only marginally above applicable ratings; reflecting overload relay settings in the determination of System Operating Limits (SOLs) (including IROLs).

**Response to Recommendations 19-26:**

1. How do TOPs share with the RC and neighboring TOPs overload relay trip settings on transformers and transmission lines that could impact the reliability of the BPS?

Each LCC coordinates protective systems on major transmission lines and interconnections with other LCCs and Generator Operators that are impacted by the protection system. Each affected LCC coordinates protective systems on major transmission lines and interconnections that impact transmission facility capacity with ERCOT ISO. LCCs share all facility ratings with ERCOT ISO including those that are limited by relay trip settings. There has not been an explicit requirement for the LCC to share additional rating related data above and beyond the most limiting series element based rating set. However, based on the questions regarding the relay overload settings, LCCs and ERCOT ISO are reviewing possible changes to the procedures for the development of post-contingency mitigation plans used in the ERCOT Interconnection.

Texas RE will continue dialogue among Regional stakeholders on:

* Consideration of relay settings by LCCs in providing ratings to ERCOT ISO and in coordinating such information to other LCCs, particularly in consideration of post-contingency mitigation plan development.
* Recognition of overload settings exceeding ratings in operational tools (such as RTCA) within ERCOT ISO systems

1. How do TOPs share with neighboring TOPs, overload trip settings below 150% of the normal rating or below 115% of the highest emergency rating, whichever of these two values is greater? If these conditions exist, do TOPs share their operating procedures for mitigating the problem? Are these operating procedures pre- or post-contingency? For post-contingency procedures, how is it established that there is enough time for operators to initiate the procedures based on the time delays associated with the relay settings?

Each LCC coordinates protective systems on major transmission lines and interconnections with LCCs and Generator Operators that are impacted by the protection system. Each affected LCC coordinates protective systems on major transmission lines and interconnections that impact transmission facility capacity with ERCOT ISO indirectly through ratings, contingency plan review and other means. Other coordination includes sharing overload relay trip settings related to PRC-023’s relay loadability criteria cited in this question. If the applicable facility is rated above 200 kV or has been identified as operationally significant to BPS reliability by ERCOT ISO (as PC), then PRC-023 allows certain criteria options to the Registered Entity that owns the facility. Use of these criteria requires the agreement of the TOP and PC with the calculated circuit capability Documentation of the agreement may result in an operating procedure such as a mitigation plan, which would be developed and coordinated between the TOPs and ERCOT ISO. Such mitigation plan development would consider the adequacy of time for system operator action given factors such as the time delays associated with protective relay settings, for post-contingency mitigation plans.

As noted above, Texas RE will continue dialogue among Regional stakeholders on the following:

* Consideration of relay settings by LCCs in providing ratings to ERCOT ISO and in coordinating such information to other LCCs, particularly regarding post-contingency mitigation plan development.
* Recognition of overload settings exceeding ratings in operational tools (such as RTCA) within ERCOT ISO systems.

1. How frequently do the TOPs review Special Protection Systems for their continued necessity and their coordination with other similar systems and within the Interconnection?

As indicated in ERCOT Nodal Operating Guide 6.2.2 (14)(a), ERCOT ISO and the affected LCC each conduct a review of each existing SPS at least every five years as required by changes in system conditions. The SPS review includes demonstration of performance requirements for inadvertent operation of an SPS.

Texas RE will continue to seek discussion of coordination between different SPSs as well as the interaction between SPSs and other Protection Systems within the ERCOT Interconnection, including treatment in the planning process.

1. What efforts are underway to evaluate the performance of generators under severe or unusual system conditions, especially with regard to the behavior of turbine control systems and underfrequency relay coordination?

There has been limited review of coordination of turbine frequency response with underfrequency relays, including some discussion of the damage curves for machines (for instance ERCOT Operating Guides Section 2.6.2 which describes trip delay settings for generator underfrequency relays and operating restrictions above 60 Hz.) Technical working group experts within the ERCOT Interconnection regularly evaluate the performance of generators under disturbances, including severe or unusual system conditions. They discussed the situation encountered by the SONGS units in the WECC event and the general matter of sensitivity of turbine control systems during extreme events. Speed sensors are an existing part of the plant distributed control system (DCS) and could trigger an overspeed trip, but these are in place to protect generator equipment. Control coordination is typically done during commissioning, and subsequently on an as-needed basis. If a separation scheme were developed in the ERCOT Interconnection, extensive analysis would be conducted with participation among facility owners.

Angular Separation (Recommendation 27) addresses the need for tools to determine, in advance of contingencies, the angular separation following line trips under a wide range of system conditions, as well as the need for plans for reclosing lines with large phase angle differences.

**Response to Recommendation 27:**

1. Which TOPs or the RC have identified or can identify, from seasonal and operational planning studies and in real time, the standing angles that would result following major transmission line outages?

The ERCOT ISO State Estimator shows the calculated phase angle for every bus in the system. ERCOT ISO knows phase angle differences between busses at all times. SOTE information contains phase angle information and is available to LCCs in the ERCOT Interconnection; however, SOTE does not provide real time visibility to the LCCs. Some LCCs may use the SOTE data to validate internal models and telemetry.

No issues were identified in discussion with stakeholders; however, Texas RE will continue to seek feedback that indicates concerns with the standing angles that would result from major transmission line outages, or the ability to predict post-contingency angles.

1. Where are there PMUs or PMU-capable digital relays located and streaming data such that post-contingency angles can be seen directly in SCADA/EMS systems of the TOPs or RC?

ERCOT ISO and Registered Entities have participated in discussion of PMU applications in the ERCOT Interconnection; this is a long term effort in the ERCOT Region as well as elsewhere.

Some LCC’s have pilot usage of PMUs currently. ERCOT ISO’s June 2012 report at the North American Synchro Phasor Initiative meeting describes the PMU’s in service now in the Region and recent utilization for other analysis (<https://www.naspi.org/File.aspx?fileID=987>).

1. Where does the RC have predetermined plans for reducing angles to within synchro-check relay settings to allow prompt reclosing of lines?

Any post-contingency voltage angle limit impacts would be addressed as part of a post-contingency mitigation plan, similar to thermal limits exceeded post-contingency. No plans were identified during discussions with ERCOT ISO and the LCCs but the same general process would be used to develop them as other mitigation plans.

1. The Common Information Model (“CIM”) is defined as follows: A standard way to communicate information about a transmission system.  The CIM is used to describe the ERCOT transmission system topology consisting of Transmission Elements, including all the parameters needed to describe the Transmission Elements and how they interrelate to one another.  The CIM that ERCOT uses must conform to the Electric Power Research Institute (EPRI) standards for CIMs.

   The Network Operations Model is defined as follows: A representation of the ERCOT System providing the complete physical network definition, characteristics, ratings, and operational limits of all elements of the ERCOT Transmission Grid and other information from Transmission Service Providers, Resource Entities, and Qualified Scheduling Entities.

   [↑](#footnote-ref-1)