NERC
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Panel I: 2015 State of Reliability Report

Remarks of Thomas Burgess, Vice President and Director of Reliability Assessment and Performance Analysis
North American Electric Reliability Corporation
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Introduction

Chairman Bay and Commissioners, members of the respective Commissions, staff and guests. My name is Tom Burgess and I am the Vice President and Director, Reliability Assessments and Performance Analysis at the North American Electric Reliability Corporation (NERC). Section 215 of the Federal Power Act, enacted by the Energy Policy Act of 2005, provides among other functions that NERC conduct periodic assessments of the reliability and adequacy of the bulk power system (BPS) in North America. NERC independently assesses and reports on both the actual performance of the BPS as well as the reliability and adequacy across the planning horizon. In this manner, effective efforts by NERC and the industry can address adverse reliability trends as well as develop recommendations to enhance reliability, while formulating feedback loops that assure measured progress across the reliability behavior spectrum. It is my privilege to update you today on the results and key findings of the *State of Reliability* report, which is among the premier evaluations of BPS performance.

Overview of the State Of Reliability

NERC's *State of Reliability 2015* report represents NERC's independent view of ongoing BPS trends to objectively analyze its state of reliability and provide an integrated view of reliability performance. The key findings and recommendations serve as technical input to NERC's risk assessment, reliability standards project prioritization, compliance process improvement, event analysis, reliability assessment, and critical infrastructure protection. These integrated views rest on comprehensive evaluation and analyses of historical and reliability performance, aligned with forecasted projections of anticipated long term aspects. These form a foundation for expanding risk management approaches, provide focus on reducing reliability risks, create options for enhancing reliability performance, and over the long term toward greater sustained reliability.

The analysis of BPS performance provides an industry reference of historical reliability, offers analytical insights toward industry action, and enables the identification and prioritization of specific steps that can be taken to manage risks to reliability. This year's report presents the coordinated activities across NERC departments to address risks to reliability that have been identified in prior *State of Reliability* reports. In this way actions identified in earlier efforts are reviewed to ascertain their effectiveness in achieving the intended reliability objectives. The following overview presents the key findings and recommendations intended to address identified risks.

Key Findings

Sustained High Performance for BPS Reliability

The analysis of the severity of composite generation, transmission and distribution aspects of BPS reliability remained high, demonstrating continued positive performance results. The severity risk index [SRI] value is derived for each day for the years 2008 through 2014 and reflects a daily, blended index comprised of transmission loss, generation loss, and load loss events aggregated into a single system performance value. These daily performance measurements are used to evaluate the year-on-year performance of the system.

These analyses demonstrate that BPS reliability remained within the performance objectives described in the Adequate Level of Reliability [ALR] measures. In 2014, generation and to lesser extent transmission represented the primary drivers of load-loss events on high incidence days. Review of 2014 and prior results, increasingly indicated that weather aspects are associated with the most severe events, and in 2014 all of the top-10 events were initiated or exacerbated by weather, mostly during the extreme cold January. The analysis describes high-stress days for the BPS as those with an SRI greater than 5.0, and there were only three high-stress days in 2014. Two of the days were associated with the polar vortex; the remaining high-stress day was associated with an extreme weather event in California. Overall, the calculated SRI for all but two of the 10 highest days was driven by generation performance and, to a lesser extent, transmission outage performance, and did not involve a significant degree of load loss.

While the BPS is expected to perform at a high level during weather events, weather continues to be a significant stress factor on BPS reliability performance, which suggests further review and examination. By considering the weather impacts on day-to-day and extreme-day performance, more differentiated metrics could potentially be developed to provide greater insight on controllable BPS reliability (specifically load-loss events) and potentially prudent steps that begin to lessen specific aspects of extreme weather impacts. Differentiating the impact of weather on these extreme days enables greater focus on BPS performance for events that can be controlled by industry action. The overall reliability was consistently above the ALR performance objectives when primary weather effects were excluded, demonstrating that the reliability risk of non-weather events is manageable.

No Load Loss Due to Cyber or Physical Security Events

An important advance in the *State of Reliability* development work is addressing the overall security posture condition reflecting both cyber and physical security instances. For the first time, new measures were developed to begin to provide insight about these aspects of reliability. Overall, no Reportable Cyber Security Incidents or physical security reportable events resulted in loss of load on the BPS in 2014. NERC, in concert with relevant subject matter experts and technical advisory groups, developed these security performance metrics, as recommended in the *State of Reliability* 2014 report.

These advances reflect NERC's commitment to analyzing and advising industry on cybersecurity incidents that could lead to impacts on reliability and providing insights that support enhanced security posture

across the industry. A wide range of significant efforts undertaken include the Federal Energy Regulatory Commission (FERC) approved Version 5 in late 2013 the critical infrastructure protection cybersecurity standards (CIP Version 5), representing significant progress in mitigating cyber risks. A comprehensive program to support effective industry transition to the requirements in CIP Version 5 is designed to ensure overall conformance by improving industry's understanding of the technical security requirements, as well as the expectations for compliance and enforcement.

While these newly developed metrics advance the insights in the security position, further efforts in this area are considered important, in part reflecting the performance of the Electricity Sector Information Sharing and Analysis Center (ES-ISAC).. NERC is leading efforts to work with industry and forums, such as the North American Transmission Forum (NATF), to analyze more detailed information emerging from these developed security metrics and to develop additional metrics regarding overall security aspects of BPS reliability.

Decline of Average Transmission Outage Severity

A continuing positive trend in system performance indicates that the average transmission outage severity decreased further in 2014. The analysis of year-over-year changes in calculated transmission outage severity using comprehensive TADS events data revealed a significant decrease from 2012 to 2013, and a further reduction in 2014. This continuing positive performance in the average transmission outage severity encompasses the full range of outage causes. Those outage events initiated by Misoperations and Failed AC Substation Equipment remained high in total transmission outage severity and were the greatest contributors to transmission outage severity relative risk.

In 2014, NERC investigation of reliability issues related to AC substation equipment failures, led to recommendations on bus configuration evaluations, breaker lubrication practices, service advisory tracking, and proactive equipment replacement. These recommended practices were developed in consultation with industry experts and are considered practical elements that can lead to improvements in BPS reliability. The efforts to address the protection system misoperations aspects are considered of key importance and are described in a later section.

Significant Decrease in Unplanned Transmission Outages Resulting in Loss of Load

The unplanned transmission outages that result in loss of load are a key measure of the effectiveness in both operating and planning the BPS, and there was a significant decrease reported. These measures represent an aspect of reliability that both NERC and the industry have devoted a significant amount of effort to address root causes for outages resulting in loss of load, thereby enhancing overall reliability. Analysis of unplanned transmission outage data shows that the number of transmission-related events resulting in loss of firm load from 2002 to 2011 was relatively constant (average of 10 events per year), then dropped significantly over the last three years to an average of less than four per year. Of further

importance, the severity or extent of the outages were lessened over these same reporting periods, reflecting positive reliability performance.

NERC's continued focus on this measure resulting from past *State of Reliability* report analyses resulted in a range of actions. Key factors that contributed to these positive trends include adoption of Reliability Standard *TOP-003-1 – Planned Outage Coordination,* requiring that scheduled generator and transmission outages potentially affecting the reliability of interconnected operations must be planned and coordinated among Balancing Authorities, Transmission Operators, and Reliability Coordinators. Also, Reliability Standard *FAC-014-2 – Establish and Communicate System Operating Limits* requires that System Operating Limits (SOLs) and Interconnection Reliability Operating Limits (IROLs) are established and consistent with documented methodology. These standards help ensure that the impact on the BPS from unplanned transmission outages is effectively managed. Finally, those transmission outage events that are more impactful are evaluated in a rigorous Event Analysis process for root causes to derive potential actions and lessons learned that can be shared with industry. These efforts support continued positive trends, which is the desired strategy for identifying the relevant connections between reliability behavior, determining the appropriate set of tailored response actions, and measuring reliability results to assure effective consequences.

Stable Frequency Response Trend

Stable frequency is essential to supporting the BPS, representing a key measure of the balance among resources and reserves relative to anticipated loads, to respond to fluctuations, forced outages, and contingencies. Overall the frequency response of the BPS remains stable over the 2012 through 2014 period. NERC annually applies statistical tests to interconnection frequency response datasets, including additional analyses on time of year, load levels, and other attributes. The Eastern, Western, ERCOT, and Québec Interconnections have shown steady frequency response performance, trending above the recommended Interconnection Frequency Response Obligation (IFRO) at all times during the time period studied. The Eastern Interconnection frequency response has shown a statistically significant positive increase. The Western Interconnection and the ERCOT Interconnection are statistically stable. Although the Québec Interconnection frequency response experienced a statistically significant decline, the response remains well above the calculated IFRO for the Interconnection. It is important to continue to monitor these trends to determine whether any events approach or drop below the IFRO for any Interconnection and to identify any underlying causes and corrective courses of action, especially as the resource mix continues to evolve.

Some key efforts initiated to sustain frequency performance include Reliability Standard BAL-003-1, approved by FERC on January 16, 2014 with phased-in effective dates of April 1, 2015, and April 1, 2016. The standard requires an annual data collection for determining Frequency Bias and for evaluating compliance with the Frequency Response Obligation (FRO). These requirements are essential to effectively

manage the frequency performance as the resource mix changes, the reliability behavior of the loads changes, and the management of the balance becomes more complex.

A related frequency performance aspect reviewed, determined that there were no reported system events in 2014 where frequency response performance was cited as a causal factor for initiating or sustaining an event. NERC will examine incidents in 2014 where frequency response was below the IFRO to determine any root causes and trends, such that actions necessary to improve the frequency response performance can be initiated.

As a result of continued monitoring of the frequency response performance subsequent to system contingencies, NERC issued an Industry Advisory on generator governor frequency response in early 2015. The analysis NERC undertook determined that a significant portion of the Eastern Interconnection generator dead bands or governor control settings could inhibit or prevent frequency response. With the exception of nuclear generators, entities with generators greater than 75 MVA were advised to review generator governor and Distributed Control System (DCS) settings to conform to specifications mentioned in the Advisory.

Although overall frequency response performance is generally stable, NERC is recommending four actions designed to improve these results. First, monitor the effectiveness of the Industry Advisory on generator governor frequency response on the Eastern Interconnection. Next, assess the impact of BAL-003-1 on frequency response for all Interconnections subsequent to the Reliability Standard's effective dates. In addition, identify root causes and underlying trends for incidents in 2014 where frequency response was less than the IFRO, so that necessary actions can be initiated. Finally, determine whether additional actions, beyond those currently being pursued in NERC Reliability Standards, are required to maintain and improve frequency response performance.

Protection System Misoperations Trending Lower, but Continue to Escalate Risk in Qualified Events

Overall protection system misoperations are beginning to trend lower, however they continue to escalate risk in those events analyzed within the Events Analysis process. The analysis of data showed that the protection system misoperation rate began to decline in 2014 resulting from increasing attention to protection system performance. The majority of protection system misoperations do not lead to significant events, however a small portion can cause or exacerbate the severity of reportable system disturbances. At the same time, those protection system misoperations that do occur can increase risk to reliability. Nearly 70 percent of transmission-related reportable events have associated protection system misoperations that either initiated the event or caused it to be more severe.

A focused series of actions include completing revisions to several Reliability Standards that involve protection systems to improve overall BPS performance. These standards are designed to improve

reliability by obligating entities to implement a corrective action program to mitigate specific root causes of misoperations. To increase awareness, a series of industry webinars on protection systems were conducted and Lessons Learned issued on how Generator Owners (GOs) and Transmission Owners (TOs) are achieving high levels of protection system performance. In addition, the top-three contributors to protection system misoperations reported by entities have been determined and represent the focus of further actions designed to steadily improve protection system misoperation performance.

From an event analysis perspective, reviews of the protection system misoperations within key events have identified two main causes of incorrectly set ground instantaneous overcurrent elements. The first is an increase in the maximum value of ground fault short circuit current available over time, rendering the ground settings too sensitive. The second is setting the ground instantaneous overcurrent element without enough margin to accommodate short circuit modeling tolerances and other component anomalies.

An early 2015 Lessons Learned advised entities to consider reviewing the maximum value of ground fault short circuit current that was used to develop the protection system settings and ensure that the short circuit current available is appropriate. It further advised entities to review their protection scheme practices for setting ground instantaneous overcurrent elements and determine the appropriate percentage of line length to protect with the instantaneous setting.

The overall analysis and insights by NERC about key aspects affecting continued trends of misoperation performance led to a series of additional recommendations. In order to provide greater awareness, NERC plans to develop reference materials and training on the importance of standard design templates to address design, logic settings, and peer review. Further work with the industry protection system experts, NERC and Regions is warranted to develop a guideline on quality control to improve protective relay settings. A partnership with protection system equipment manufacturers and NERC would facilitate an enhanced industry outreach program that targets specific entities with the greatest impact on protection system misoperation reduction. This includes work with microprocessor relay manufacturers to determine appropriate technical bulletins or industry alerts to address protection system equipment failures. Finally, expand the current efforts with the NATF, in coordination with NERC, to engage its membership on key topical areas of improvement and develop targeted improvement plans.

Use of Energy Emergency Alert Level 3 Continues to Decline

The use of Energy Emergency Alert Level 3 continues to decline reflecting the results of efforts by NERC and industry to better manage these BPS conditions. The issuance of an EEA3 indicates an issue with the real-time adequacy of the electric supply system. It may be due to a lack of fuel or dependence on transmission for imports into a constrained area, not simply a lack of available generation resources. In 2014 there were four Energy Emergency Alert Level 3 (EEA3) events declared, which is fewer than any other year for which data was reported, and only one resulted in load shed. This event was due to conditions during the polar vortex that resulted in record-low temperatures and high demand. The other three reported EEA3 alerts

did not result in loss of load and were generally caused by transmission limitations resulting in a localized area's inability to make use of the reserves that existed within the region. The primary factors contributing to these results include additional transmission infrastructure and changes to market and dispatch approaches that lessen the potential for congestion and constraints in areas formerly using EEA 3 strategies.

NERC continues to evaluate each reported EEA3 event to determine the potential impact to reliability, and determine trends to provide a relative indication of performance measured at a Regional Entity or interconnection level. Finally, the Event Analysis process is used to evaluate for root causes, determine appropriate actions, and derive potential lessons learned that can be shared with industry.

State of Reliability Summary

The overarching objective of the *State of Reliability 2015* report is to quantify risk and performance, highlight areas for improvement, and reinforce and measure success in controlling risks to reliability. There are multiple aspects of reliability performance that lead to a wide range of efforts and actions to control risks and improve reliability, each of which requires a solid technical foundation of information and data to support appropriate recommendations, actions and industry decisions.

The State of Reliability Report outlines the key areas for which reliability findings are warranted, regarding critical BPS reliability attributes. The underlying data and comprehensive analyses are quite broad and evaluate many aspects of reliability, each of which is important to identify key trends, and develop insights emerging from changes anticipated in the 5-10 year horizon that could affect reliability. As the resource mix changes and the reliability characteristics of both resources and loads continue to evolve, these approaches used with the *State of Reliability* report can anticipate those challenges, including changes needed in planning and operating arenas.

NERC continues to examine the reliability impacts related to the changing resource mix, notably focusing on the essential reliability services aspects. Reliably integrating high levels of variable resources (wind, solar, and some forms of hydro) will require significant adjustments and modifications to traditional methods used for system planning and operation. The amount of variable renewable generation is expected to grow considerably as policy and regulations are being developed and implemented by federal authorities and individual states and provinces throughout North America. Further changes resulting from the retirement of conventional generation, increasing demand response, and the introduction of distributed resources are changing the reliability behavior of the BPS. As some areas develop experience in managing these issues, these analyses offer the opportunity to provide insight and relevant perspectives for other areas, shaped by their particular resource mix and reliability behavior. Power system asset managers, planners, and operators must consider the impacts of variable generation in power system planning and design and develop the necessary practices, tools, training, and methods to maintain long-term BPS reliability. Where warranted, potential enhancements to NERC reliability standards or guidelines to maintain BPS reliability will be considered.

The overarching objective is to provide a roadmap for the transition to a generation mix with a high penetration of renewables and reduced conventional and synchronous generation. Conventional generation (steam, hydro, and combustion turbine technologies) inherently provides essential reliability services needed for reliable operations – which includes voltage support, ramping capability and frequency support.

Conclusion

The ability to extract key insights, trends, and performance behavior, and anticipate emerging trends and changes affecting the BPS, depends in large part on sophisticated analysis of extensive databases of reliability information. A key part of that is integrating Event Analysis data, with performance analysis databases, and align with short and long term reliability assessments to affirm insights and identify proactive steps to avoid reliability problems. NERC is accentuating its focus on the statistical analysis and cross-correlations among the various databases (Transmission Availability Data System, Distribution Availability Data System, and Generation Availability Data System) as well as with insights and observations from the Events Analysis program.

The overall continued focus on advance identification of potential threats to reliability and proactive key actions will help ensure that the BPS maintains its high sustained performance and supports the ERO in fulfilling its mission. This concludes my presentation and discussion of the recently approved *State of Reliability 201*5 report. Thank you for your attention to this information.