NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

ERO Reliability Risk Priorities

RISC Recommendations to the NERC Board of Trustees

October 2014

RELIABILITY | ACCOUNTABILITY




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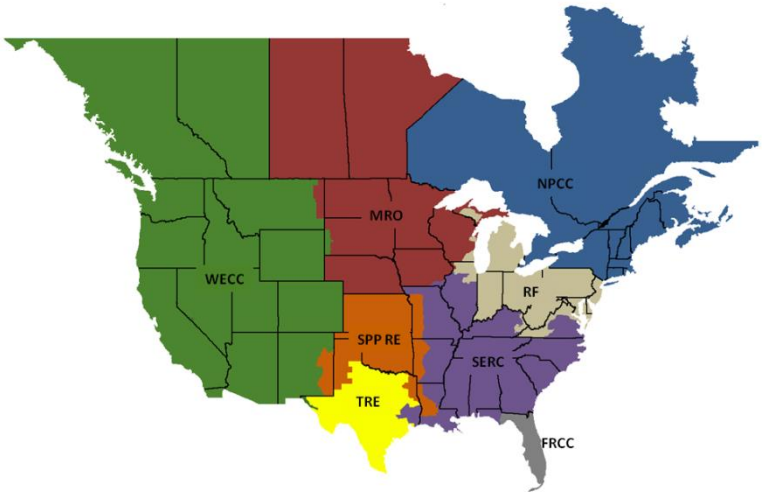
Preface

The North American Electric Reliability Corporation (NERC) is a not-for-profit international regulatory authority whose mission is to ensure the reliability of the bulk power system (BPS) in North America. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the BPS through system awareness; and educates, trains, and certifies industry personnel. NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC is the electric reliability organization (ERO) for North America, subject to oversight by the Federal Energy Regulatory Commission (FERC) and governmental authorities in Canada. NERC's jurisdiction includes users, owners, and operators of the BPS, which serves more than 334 million people.

The North American BPS is divided into several assessment areas within the eight Regional Entity (RE) boundaries, as shown in the map and corresponding table below.



FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
SPP-RE	Southwest Power Pool Regional Entity
TRE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

The Reliability Issues Steering Committee (RISC) is an advisory committee that triages and provides front-end, high-level leadership for issues of strategic importance to BPS reliability and offers stakeholder leadership engagement and input on those issues. The RISC advises the NERC Board of Trustees (Board), NERC standing committees, NERC staff, regulators, Regional Entities, and industry stakeholders to establish a common understanding of the scope, priority, and goals for the development of solutions to address these issues, including the use of solutions other than the development of new or revised Reliability Standards. In doing so, the RISC provides a framework for steering, developing, formalizing, and organizing recommendations to help NERC and the industry effectively focus their resources on the critical issues needed to best improve the reliability of the BPS.

This report documents the results of the RISC's continued work to define risks to the reliable operation of the BPS and provides guidance to the Board regarding activities NERC should take to manage those risks.

Executive Summary

The purpose of this report is to document the work performed by the RISC in 2014 to define and assess risks to reliability. The RISC's 2014 efforts built on its prior work that defined and prioritized risks and is intended to advise interested entities on activities that can be taken to reduce those risks. After developing the 14 risk profiles in the appendix, the RISC graphically mapped the current state of each risk relative to other risks. The risk map shows how the RISC believes each risk will change after risk management activities are performed, and it depicts the directional trends of each risk. Finally, the RISC also worked with NERC to host a Reliability Leadership Summit to finalize current reliability perspectives and to gather further information about existing and emerging risk trends.

From the 2014 activities, the RISC found key reliability-related themes that NERC should focus on. These themes are the complex interdependences between the electric industry and other industries; resiliency; regulatory and structural uncertainty; resource adequacy; resource commitment confidence and visibility; and situational awareness. In response to these themes, the RISC is recommending that NERC and industry take the following actions:

- Identify and report on gaps between interdependent business models and among electric industry companies to understand barriers to sustained reliability.
- Increase long-term reliability assessment efforts.
- Identify a framework to conclude the identification of essential reliability services (ERSs).
- Ensure the maturation of the ES-ISAC by defining key measures for success and facilitating deployment of Cyber Security Risk Information Sharing Program (CRISP) technology.
- Complete the implementation of the Reliability Assurance Initiative (RAI) across Regional Entities.
- Take action to ensure generation and transmission resource and planning data consistency and sharing for long-term, robust regional operational planning and real-time situational awareness.
- Continue to leverage NATF, NAGF, EPRI, and other industry-based best practice sharing forums to ensure resilience.

These actions are presented to the NERC Board and interested industry stakeholders for inclusion in business planning and budgeting. It may be necessary for the ERO to prioritize existing activities and stop work on low-priority activities to initiate the recommended actions.

Introduction

This report documents the results of the RISC's continued work to define risks to the reliable operation of the BPS and provide input to the Board on activities that NERC should take to manage those risks. The RISC reviewed and assembled information from stakeholder input and various committee reports to develop a set of risk profiles and a map of those risks based on the probability of occurrence and expected impact to reliability. The RISC also worked with NERC to host a Reliability Leadership Summit. This report includes the collection and assembly of industry expert opinions on risks and impact, so the analysis is qualitative in nature.

The RISC's goal for this report is to provide general and strategic perspectives on risks to reliability and to offer specific recommendations to support NERC as it develops metrics benchmarking each of these risks. As data is assembled to measure and track progress on addressing the risks, the quantification of a particular risk becomes easier to assess.

Chapter 1 – Method of Analysis

To carry out its responsibility to assess and prioritize the most critical reliability risks, the RISC completed an initial assessment of all ongoing efforts at NERC and made a set of recommendations to the Board in February 2013.[1] In the recommendations, the RISC identified four high-priority areas and five medium-priority areas for further study.

After review and discussion of the initial RISC report, the Board adopted the following resolutions:

> *RESOLVED, that the Board hereby accepts the report of the Reliability Issues Steering Committee (RISC), expresses its appreciation to the RISC for the excellent report, and endorses continued work by the RISC on a gap analysis on the high-priority and then the medium-priority issues and requests continued reports to the Board.*
>
> *FURTHER RESOLVED, that the Board hereby directs NERC management to continue to work with the RISC to consider how the priority rankings should be reflected in the development of the ERO's business plan and in the work plans of NERC committees.*
>
> *FURTHER RESOLVED, the Board hereby directs NERC management to work with the RISC and, as appropriate, NERC committee leadership to consider how NERC should utilize a data-driven reliability strategy development process that integrates with budget development and overall ERO planning (e.g., Standing Committee planning, department, and employee goal-setting).*

Following its February 2013 report to the Board, the RISC developed a list of ERO priorities[2] and presented it to the Board in August 2013. This report presented a gap analysis of the high- and medium-priority risks and issues identified in the February 2013 report, provided a process for incorporating RISC input into overall ERO planning activities, and produced a method to facilitate ongoing coordination with the technical committees to ensure alignment of activities with the priorities recommended by the RISC. Based on this report, NERC staff undertook further review and analysis to identify any additional reliability risk areas of strategic importance for the ERO. Following this analysis, recommendations were developed based on previous committee discussions, industry dialogue at the Reliability Leadership Summit, and past committee work products, such as the *Long-Term Reliability Assessment*, the *State of Reliability* report, and special reports and assessments. The result of this analysis[3] was presented to the Board in February 2014 and used in the development of the 2014–2017 ERO Enterprise Strategic Plan.

Based on these reports, the RISC further refined the risk profiles. The RISC also examined specific NERC reports, including the *2013 Long-Term Reliability Assessment,*[4] the *State of Reliability 2014,*[5] and the *2014 Summer Assessment.*[6] RISC and NERC staff also facilitated the annual Reliability Leadership Summit on September 11, 2014, in Washington, D.C. to obtain input from industry leaders on reliability risks. Based on the Board's acceptance of the recommendations in this report, the RISC expects NERC staff to include the recommended activities in its upcoming business planning and budget cycle through the development of corporate goals and standing committee work plans. Tactical and strategic items will be incorporated into the ERO top-priority reliability risks. Three-year strategic plans are developed using the input from the tactical and strategic items. In

[1] http://www.nerc.com/comm/RISC/Related Files DL/12-RISC Recommendation_Final_20130118_1213.pdf
[2] http://www.nerc.com/comm/RISC/Related Files DL/RISC_Priority_Recommendations-Jul_26_2013.pdf
[3] http://www.nerc.com/comm/RISC/Related Files DL/ERO Top Priority Reliability Risks 2014.pdf
[4] http://www.nerc.com/pa/RAPA/ra/Reliability Assessments DL/2013_LTRA_FINAL.pdf
[5] http://www.nerc.com/pa/RAPA/PA/Performance Analysis DL/2014_SOR_Final.pdf
[6] http://www.nerc.com/pa/RAPA/ra/Reliability Assessments DL/2014SRA.pdf

the strategic plan, NERC staff assigns work in conjunction with the committee chairs. The standing committees develop plans that are coordinated with and complementary to those of the Regions and NERC staff. Appropriate metrics for each work plan are developed. These metrics can then be used to assess the goals at the regional and NERC staff levels.

For future years, the RISC plans to use the set of risk profiles and the risk map included later in this report as a baseline for the evaluation of risks to the BPS. On an annual basis, the RISC will use the input mentioned above (e.g., NERC assessments, leadership summits), along with the progress on mitigation efforts underway, to re-evaluate individual risks to the BPS and make strategic recommendations to NERC staff and the Board.

Chapter 2 – Results

The current ERO reliability risk profiles developed by the RISC in 2014 are provided in the appendix. Each risk profile has a detailed problem description, which provides a summary of the risk to reliability and the potential impact of not reacting to the risk. Following the problem description is a list of risk management activities that are currently being employed to manage the risk. These activities may be undertaken by NERC, industry participants, governmental agencies, or other responsible groups. Following this are recommended activities that the RISC believes NERC and others could employ to further manage the risk. Finally, the RISC provided measures of success that can be used to determine whether the recommended activities are an effective way of managing these identified risks. The RISC acknowledges recognizable overlaps in some reliability risk profiles; however, the committee feels that highlighting separate risks to support a more granular focus outweighs any redundancy.

Figure 1 provides an illustrated view of the 14 risk profiles. The x axis represents the probability of an event occurring that would impact the entire BPS, and the y axis represents the expected impact on the BPS if the risk were to occur. Each risk placement is based on defined threats to reliability, current mitigation activities, and recommended actions. A solid circle designates the current risk with existing mitigation measures in place, and an outlined circle designates the risk once current and recommended mitigation measures are in place. A shaded gradient connects each current risk to the mitigated risk. A risk designated as red means it needs action. A risk designated as yellow indicates that the RISC identified the risk as one to monitor, but no additional action is needed at this time. Finally, a risk designated as green indicates one where no further action is needed at this time. Where appropriate, a bold arrow represents the risk trend, defined as the projected change in risk based on known or expected external pressures.

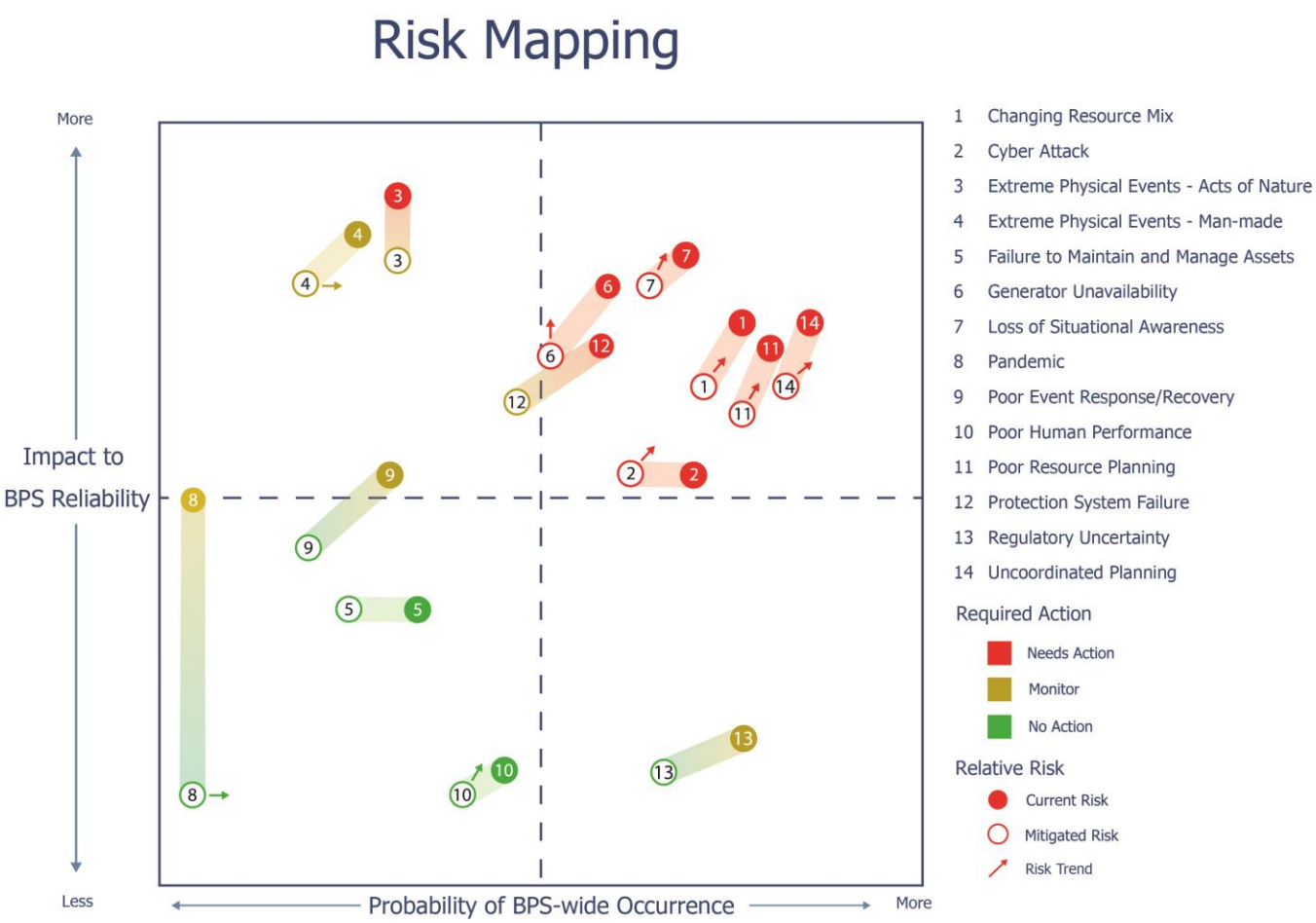


Figure 1: Risk Map of ERO Risk Profiles

The RISC chose to quantify each risk by measuring two factors: probability of occurrence, and expected impact on the BPS if the risk were to occur. Table 1 provides the result of this analysis. For each identified risk, the probability of occurrence and the expected impact on the BPS if the risk were to occur is quantified. The current risk is the risk to reliability with existing measures in place. The mitigated risk is the anticipated state with implementation of current and suggested recommendations identified in the appendix. Finally, the risk trend is the projected change in risk based on known or expected external pressures.

Table 1: Grid Mapping/Placement of Risk Profile						
Risk (In Alphabetical Order)		Probability of Occurrence (BPS wide)		Impact to BPS Reliability		
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	Risk Trend
1	Changing Resource Mix	High; types of new resources such as variable generation and volume of resource change	Slight decrease; still have unknown operating conditions	High; widespread change in types of resources	Slight decrease; unknown conditions	Ongoing pressures on traditional generation and transmission facilities
2	Cyber Attack	High; Critical Infrastructure Protection (CIP) v3 standards are in place but v5 yet to be implemented	Slight decrease; improved coordination among entities	High; need to remain in monitor mode to gauge performance of all CIP standards	Additional recommendations reduce probability but not impact	Constantly evolving threats
3	Extreme Physical Events – Acts of Nature	Low probability of interconnection-wide event	No way to change probability of occurrence	High; interconnection-wide event could cause high volume of damage	Mutual assist., staging, sparing, etc. decrease impact	Unknown
4	Extreme Physical Events – Man-made	Low probability of interconnection-wide event	Slight decrease due to improved communication and focus	High due to potential impact of interconnection-wide event	Decrease due to hardened facilities	Increasing due to evolving terrorist threats
5	Failure to Maintain and Manage BPS Assets	Low	Decrease due to focus on supply chain and sparing	Low	No change	Unknown
6	Generator Unavailability	A moderate-to-high probability is projected due to the combination of more frequent extreme weather events and fuel availability	A decrease is anticipated with improved coordination, impact studies, and winter preparedness recommendations	High due to interconnection-wide potential of forced outages, de-ratings, and failure to start	Decrease with implementation of recommendations	Multiple variables – dependency/ availability of natural gas and unknown impacts of Environmental Protection Agency (EPA) 111(d)

Table 1: Grid Mapping/Placement of Risk Profile						
Risk (In Alphabetical Order)		Probability of Occurrence (BPS wide)		Impact to BPS Reliability		
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	Risk Trend
7	Loss of Situational Awareness	High; factors include the frequency of outages and limited operational visibility	Decrease; guidelines and preparedness improve awareness but cannot mitigate full/partial Energy Management System (EMS) outages	High; a full EMS outage or prolonged restoration can have widespread implications	Decrease but impact remains high	Inherent complexity of maintaining or upgrading decision support tools adds upward pressure to probability and impact to reliability
8	Pandemic	Low	No change probability of occurrence	Current mitigation activities have moved this from high impact to moderate	Decrease with focused monitoring efforts	Increase due to globalization, travel
9	Poor Event Response / Recovery	Moderate; unique event characteristics, several variables	Decrease due to improved coordination	Moderate; existing coordination processes are solid	Decrease due to improved coordination	Unknown
10	Poor Human Performance	Low probability based on criteria such as operator experience and regular training.	Slight decrease; training and processes	Low impact to reliability	Decrease due to improved awareness	Replacing experienced operators; more complex operating environment
11	Poor Resource Planning	High	Slight decrease with improved ability to plan across seams	High	Slight decrease; impact remains high	Long lead time required to address resource adequacy
12	Protection System Failures	Moderate; numerous components, settings, coordination	Decrease; look to overall state of reliability, not singular, high-profile events	High; numerous components, settings, coordination	Shift to moderate; various system protection initiatives underway	Unknown

Table 1: Grid Mapping/Placement of Risk Profile						
Risk (In Alphabetical Order)		Probability of Occurrence (BPS wide)		Impact to BPS Reliability		
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	Risk Trend
13	Regulatory Uncertainty	High; impact of EPA 111(d) is not certain; Reliability Assurance Initiative (RAI) is being developed	Decrease due to level of engagement on issues	Low (until impacts of proposed EPA rules are assessed and RAI is further developed)	Decrease due to proposed reduction of compliance burden	Unknown
14	Uncoordinated Planning	High due to complexity of changing resources mix and new technologies	Slight decrease with improved ability to plan across seams	High (until impacts of proposed EPA rules are assessed)	Slight decrease; due to proposed new models and planning studies	Multiple variables – dependency/ availability of natural gas and unknown impacts of EPA 111(d)

Chapter 3 – Discussion

As the RISC began its examination of the detailed ERO risk profiles in the appendix, six key themes that warrant priority attention emerged. These themes were reinforced by electric industry leaders as well as top state and federal officials during the Reliability Leadership Summit held in Washington, D.C. on September 11, 2014.

The first theme that emerged is the complex **interdependences** between the electric industry and other industries.[7] Historically, electric generation in North America has heavily relied on coal as its main source of fuel. More economic fuel prices for natural gas and a changing environmental landscape have caused electricity producers to build new and replace existing capacity with plants fueled by natural gas, which has become a prominent fuel source in North America. Recent events, including the 2014 polar vortex,[8] have shown that electricity production is now highly dependent on the availability of a reliable gas infrastructure with sufficient capacity to deliver supplies where and when they are needed. In addition, as new technology is developed to enhance bulk electric system (BES) performance, reliance on a dependable and secure telecommunications infrastructure is important. Further, it is essential that key cyber and physical assets are protected from both physical and electronic attacks. Constant communication and strong collaboration with the natural gas and telecommunications industries will be essential to the success of the ERO. In addition to the activities that various groups are taking to address interdependency issues, the RISC recommends that the NERC Planning Committee (PC) perform regional pipeline studies to assess electric system vulnerabilities to a common-mode failure of a natural gas supply pipeline.

The second theme discussed by the RISC and repeated throughout the Reliability Leadership Summit is **resiliency.**[9] It is essential that planners and operators of the BES prepare for and respond appropriately to threats to reliability. A point stressed at the Reliability Leadership Summit was to avoid tunnel vision in risk mitigation in which focus is solely on preventing or mitigating a single threat. Thought needs to be given to the range of threats that could occur at a facility or portion of the system, and industry should apply solutions that can address multiple threats simultaneously. While NERC and the industry have taken many steps to address several of the mentioned threats, there is value in following a structured approach that applies all tools[10] available to the ERO to address both well-understood and evolving threats to the BPS.

The RISC recommends that NERC clearly define the measures for success for the Electric Sector Information Sharing and Analysis Center (ES-ISAC). NERC should also facilitate deployment of Cyber Security Risk Information Sharing Program (CRISP) technology to enhance communication among participants. The ES-ISAC should facilitate increased communication of security threat and vulnerability information from the government to the industry. The ES-ISAC should increase the use of the ES-ISAC Portal for two-way communication with industry members. NERC should also work with industry chief information officers (CIOs), the North American Transmission Forum (NATF), and the North American Generator Forum (NAGF) to identify best cyber practices and indicators. The NATF, NAGF, and NERC Operating Committee (OC) and PC should establish a strategic plan that includes the development of technologies that aid spare equipment sharing and recovery. Finally, NERC should engage the Electricity Sub-Sector Coordinating Council (ESCC) to identify interdependent and critical

[7] See Risk Profile #1: Changing Resource Mix; Risk Profile #2: Cyber Attack; Risk Profile #3: Extreme Physical Events – Acts of Nature, Risk Profile #4: Extreme Physical Events – Man-made; Risk Profile #5: Failure to Maintain and Manage BPS Assets; Risk Profile #6: Generator Unavailability; Risk Profile #8: Pandemic; and Risk Profile #13: Regulatory Uncertainty.

[8] http://www.nerc.com/pa/rrm/Pages/January-2014-Polar-Vortex-Review.aspx

[9] See Risk Profile #1: Changing Resource Mix; Risk Profile #2: Cyber Attack; Risk Profile #3: Extreme Physical Events – Acts of Nature; Risk Profile #4: Extreme Physical Events – Man-made; Risk Profile #5: Failure to Maintain and Manage BPS Assets; Risk Profile #6: Generator Unavailability; Risk Profile #7: Loss of Situational Awareness; Risk Profile #9: Poor Event Response/Recovery; Risk Profile #11: Poor Resource Planning; Risk Profile #12: Protection System Failures; and Risk Profile #14: Uncoordinated Planning.

[10] Tools available to NERC include Advisories, Alerts, Recommendations, Guides, Internal Controls, Initiatives, Criteria, Standards, Reliability Directives and Lessons Learned.

infrastructure sector communication protocols, and identify best practices on how to approach the public and public officials to understand restoration prioritization needs.

The third theme in the ERO risk profiles is **regulatory and structural uncertainty.**[11] In addition to existing activities that industry groups are taking, the RISC recommends that NERC complete the implementation of the RAI, focusing the ERO's compliance and enforcement activities on areas that impact reliability the most, including finalizing inherent risk assessments, internal control evaluation, and logging approaches that facilitate implementation of RAI. Further, NERC should clarify accountability for Reliability Coordinators and System Operators to maintain awareness and understanding beyond their local systems.

The fourth theme is the recognition that the growing BPS complexities are driving the need to ensure **resource adequacy of both transmission and generation**[12] within the BPS. The importance of coordinated planning, reliability assessments, the development of tools to facilitate planning assessments, and the evaluation of resources, market conditions, and infrastructure assessments of gas, electric, and water are important for determining future impacts and trends in reliability. Future studies need to incorporate the impacts of fuel deliverability and the dependencies on the telecommunications infrastructure, including data and voice. The RISC recommends that NERC undertake a detailed assessment of these emerging issues through the long-term reliability assessments (LTRAs) and planning activities as follows:

- Evaluate the increased reliance on demand response resources (i.e., what amount of demand response capacity is operationally available to support reliable operations); and
- Analyze changes in load composition and dynamic behavior.

Additionally, NERC should identify a framework to collaborate with the Independent System Operators and Regional Transmission Organizations (ISOs/RTOs) Council, other transmission providers, and FERC on ERS recommendations for effective placement once the report is completed. This includes establishing and executing a plan with milestones to define ERSs, with specific focus on the impacts of variable energy resources (VERs), demand response, and demand-side resources. Once defined and studied in the LTRA process, NERC should establish recommendations for operational integration of these resources. Third, NERC should complete its assessment of EPA proposed rule 111(d) on resource adequacy and reliability. Finally, NERC should analyze areas where market mechanisms are presenting risks to reliability by incenting activities that are not working efficiently to produce desired reliability outcomes. Some examples to investigate are adequate generation capacity, adequate gas pipeline capacity to support future generation, generation fleet diversity, and nuclear retirement due to inadequate cost recovery.

The fifth key theme described in the ERO risk profiles is that the growing BPS complexities are driving the need to ensure **resource commitment confidence and visibility.**[13] Uncertainty concerning the commitment of demand-side resources to meet load obligations and the lack of visibility of demand-side resources once committed presents a scheduling risk to operators in real time. At the same time, continuing improvements in smart grid technologies, energy efficiency, and other changes in load composition impact characteristics and behavior of load, reactive power needs, and how the system operates and behaves during disturbances. The RISC recommends that NERC consider the performance and monitoring requirements for all generation types (including demand-side resources) for transparency across the industry. Also, NERC should establish a guideline to consistently account for demand response and demand-side resources in operational calculations, thus

[11] See Risk Profile #1: Changing Resource Mix; Risk Profile #2: Cyber Attack; Risk Profile #6: Generator Unavailability; Risk Profile #11: Poor Resource Planning; and Risk Profile #13: Regulatory Uncertainty

[12] See Risk Profile #1: Changing Resource Mix; Risk Profile #6: Generator Unavailability; Risk Profile #11: Poor Resource Planning; Risk Profile #13: Regulatory Uncertainty; and Risk Profile #14: Uncoordinated Planning

[13] See Risk Profile #1: Changing Resource Mix; Risk Profile #6: Generator Unavailability; Risk Profile #7: Loss of Situational Awareness; Risk Profile #11: Poor Resource Planning; Risk Profile #13: Regulatory Uncertainty; and Risk Profile #14: Uncoordinated Planning

addressing visibility concerns about behind-the-meter resources. As a guideline is established, NERC should identify and work with stakeholders to mitigate any potential market barriers to implementation.

The sixth and final theme is **situational awareness,**[14] especially for System Operators, including dispatch flexibility and controllability issues. It is important that System Operators maintain visibility to all system conditions that may impact their operational decisions. Industry will become increasingly dependent on new technologies to facilitate situational awareness. NERC should coordinate with FERC and the Department of Energy (DOE) to drive consistency in the application of this technology. Additionally, NERC should take action to ensure necessary coordination is underway for data transparency to ensure that robust regional operational planning and situational awareness are maintained.

While there are many other actionable recommendations as well as valuable ongoing risk mitigation efforts detailed in the profiles, the preceding summary represents the high-priority areas where NERC should allocate resources to preserve reliability in 2015 and beyond.

[14] See Risk Profile #1: Changing Resource Mix; Risk Profile #2: Cyber Attack; Risk Profile #3: Extreme Physical Events – Acts of Nature; Risk Profile #4: Extreme Physical Events – Man-made; Risk Profile #6: Generator Unavailability; and Risk Profile #7: Loss of Situational Awareness.

Chapter 4 – Recommendations

After a thorough review of the ERO risk profiles and a consideration of the crosscutting themes considered at the Reliability Leadership Summit and discussed above, the RISC recommends (in no particular order) that NERC and industry take the following actions to address the most pressing risks to reliability.

1. Identify and report on gaps between interdependent business models and among electric industry companies to understand barriers to sustained reliability.
    a. Engage the natural gas and telecommunications industries, as well other sectors critical to fuel delivery.
    b. Identify market mechanisms that present potential long-term risks to reliability (e.g., adequate generation capacity, adequate gas pipeline capacity to support future generation, generation fleet diversity, and nuclear retirement due to inadequate cost recovery). Ensure accountability for reliability and resource adequacy is well understood in all locations for transparency and engagement.
2. Increase long-term reliability assessment efforts. NERC must review risk assessment criteria, scopes, and schedules for the LTRAs to ensure NERC remains the credible and timely voice on electric reliability. Critical LTRAs focus areas include:
    a. Performing regional pipeline studies to assess electric system vulnerabilities to a common-mode failure of a natural gas supply pipeline.
    b. Completing an assessment of EPA proposed rule 111(d) on resource generation and transmission adequacy and reliability.
    c. Assessing the risks to the BPS of the increased reliance on demand response resources and changes in load composition and dynamic behavior.
3. Identify a framework to conclude ERS identification efforts. This work must include establishing and executing a plan with milestones to define ERSs, with specific focus on the impacts and visibility of VERs, demand response, and demand-side resources.
4. Ensure the maturation of the ES-ISAC by defining key measures for success and facilitating deployment of Cybersecurity Risk Information Sharing Program (CRISP) technology to enhance communication among participants. NERC should also engage the ESCC to identify interdependent and critical infrastructure sector communication protocols to enhance communication among industry about emerging threats.
5. Complete the consistent implementation of RAI across Regional Entities.
6. Take action to ensure generation and transmission resource and planning data consistency and sharing for long-term, robust regional operational planning and real-time situational awareness. Develop plans for tool development, technical conferences, and standard requirements as needed.
7. Continue to leverage NATF, NAGF, EPRI, and other industry-based best practice sharing forums to ensure resilience through all-hazard, prioritized approaches. Further, leverage the expertise in these forums to analyze and make recommendations on highly technical potential risks to reliability (i.e., Geo-Magnetic Disturbance (GMD) and Electromagnetic Pulse (EMP)).

Focus on these high-priority efforts may entail redirecting NERC resources, reprioritizing existing activities, and even stopping work on low-priority activities. Finally, where it does not have specific authority to address a particular risk, NERC should formally raise the risk concerns and work collaboratively to educate and support appropriate entities.

The RISC appreciated the NERC Board for the opportunity to provide these recommendations. Detailed entity actions to implement the recommendations above may be found in the risk profiles in the appendix.

Appendix – Risk Profiles

Risk Profile #1: Changing Resource Mix

As the generation and load on the power system changes, driven by both individual consumer and company decisions, the dynamics of the system are, in some areas, significantly different than those considered when the system was originally planned and designed, exposing new operational vulnerabilities not previously considered. Without focused action to respond, this risk continues to increase.

Detailed Problem Description

The energy currently produced by large rotating generators is being replaced by energy produced in different locations by variable resources, demand response programs, and other new types of resources. These resources exhibit different characteristics with respect to some of the less-obvious fundamental components of reliable operation (e.g., inertia, frequency response, generator output maneuverability). Operationally, uncertainty concerning the commitment of demand-side resources to meet load obligations and the lack of visibility of demand-side resources once committed presents a scheduling risk to operators in real time. At the same time, continuing improvements in smart grid technologies, energy efficiency, and other changes in load composition impact characteristics and behavior of load, reactive power needs, and how the system operates and behaves during disturbances (e.g., fault-induced delayed voltage recovery). All of these changes move the system toward different behaviors, operating characteristics, and levels of reliability risk.

Risk Management Activities to Date

Ongoing problem evaluation – NERC's technical committees research and analyze specific issues related to this risk, such as the work being done by the Integrating Variable Generation Task Force and planned for the Essential Reliability Services Task Force.

Raising awareness – NERC annually publishes long-term reliability and seasonal assessments and NERC special assessments (such as *Maintaining Bulk Power System Reliability While Integrating Variable Energy Resources – CAISO Approach* (2013); and *Accommodating High Levels of Variable Generation* (2009)).

Essential Reliability Services Task Force (ERSTF) – The ERSTF has a multifaceted purpose that includes developing a technical foundation of ERSs; educating and informing industry, regulators, and the public about ERSs; developing an approach for tracking and trending ERSs; formulating recommendations to ensure the complete suite of ERSs are provided and available; and providing guidance necessary for operating a reliable grid.

Recommendations

- Execute the risk management activities identified in the above-mentioned assessments and reports.
- Develop a standardized model of variable generation for stability and power-flow studies for consistency, accuracy, and transparency across the industry.
- Consider the requirements to use in planning for VERs as well as performance and monitoring requirements for all generation types for transparency across the industry.
- Assess the risks to the BPS of the following through the long-term reliability assessments and planning activities:
  - Increased reliance on demand response resources (i.e., what amount of demand response capacity is operationally available to support reliable operations); and
  - Changes in load composition and characteristic behavior of load.
- Track specific unit retirements (due to the Mercury and Air Toxics Standards (MATS) Rule, Environmental Protection Agency (EPA) Section 111(d), etc.) and include those retirements in a separate table in the long-term reliability assessments.
- Track planned construction of variable resources with expected in-service dates.

- Perform an assessment of the EPA's proposed rule 111(d) on resource adequacy and reliability.
- NERC should identify a framework to collaborate with the ISO/RTO Council and FERC on ERS recommendations for effective placement once the report is complete. Include market structure and tariff barriers to effective implementation as well as the tools to be used.

The NERC OC and PC should perform these activities:

- Assess any standards modifications required to ensure appropriate applicability and alignment with reliability goals as defined in the LTRAs.
- Establish a plan/time frame, then execute the plan to define ERSs with specific focus on the impacts of VERs, demand response, and demand-side resources. Once defined and studied in the LTRA process, establish recommendations for operational integration of these resources.
- Establish a guideline to consistently account for demand response and demand-side resources in operational calculations, thus addressing visibility concerns about behind-the-meter resources.
- Identify market barriers to effective implementation.

Measures of Success

Near Term:

- An OC/PC-established timeline for defining ERSs.
- NERC-defined dates and process to complete an assessment of EPA proposed rule 111(d) on resource adequacy and reliability.

Midterm:

- OC/PC-established definition of ERSs with specific focus on the impacts of VERs, demand response, and demand-side resources.
- NERC completion of an LTRA addressing increased reliance on demand response resources (i.e., what amount of demand response capacity is operationally available to support reliable operations).
- NERC completion of specific unit retirement information included in the LTRA.
- NERC completion of an assessment of EPA final rule 111(d) on resource adequacy and reliability.

Long Term:

- OC/PC assessment of any standards modifications required to ensure appropriate applicability and alignment with reliability goals as defined in the LTRA.
- Standardization of the implementation of the model for variable generation for stability and power-flow studies—includes load composition modeling and simulation.
- System Operators' ability to simulate and consider fuel risk in reliability assessments and capacity impacts due to extreme cold weather, interstate pipeline failure, and other assumptions. Establish a guideline that describes best practices associated with capacity shortfalls to recommendations.
- OC/PC establishment of a guideline to consistently account for demand response and demand-side resources in operational calculations, thus addressing visibility concerns about behind-the-meter resources.

Risk Profile #2: Cyber Attack

Cyber Attack generally refers to malicious activities on the behalf of hackers, disgruntled employees, terrorists, unfriendly nation-states and non-governmental organizations, and other similar parties that occur through the use of computer-based attacks or exploits with the intention of damaging or destroying a computer network or system. Cyber Attack is an area of increased focus due to the potential for harm that it represents to utilities, telecommunications, and other industries.

Detailed Problem Description

While the implementation of mandatory CIP standards and the establishment of the ES-ISAC are substantial risk mitigation measures, Cyber Attack is a threat that is constantly evolving. A lack of partnership and information sharing among industry participants and with government agencies exposes the industry to these threats. Any communication gaps between the cyber experts and industry operators could result in vulnerabilities. Also, with the fast-paced change in technology, the addition of increased automation, remote control technology, and grid sensors enabling the close monitoring and operations of systems, more advanced tools are needed to counter ever-evolving threats.

Risk Management Activities to Date

Government-Industry Collaboration

- The Department of Homeland Security (DHS) revised the National Infrastructure Protection Plan (NIPP), providing a comprehensive risk management framework that includes electricity sector-specific plans to contribute to national critical infrastructure security and resilience.
- The Department of Energy (DOE) and industry developed the Electricity Subsector Cybersecurity Capability Maturity Model (ES-C2M2), providing a reference model for gauging the maturity of an overall security program.

NERC-Industry Collaboration

- The ES-ISAC improves information sharing and analytic capabilities.
- The CIP Reliability Standards ensure the security of cyber assets that are essential to the reliable operation of the electric grid.
- The biennial Grid Exercise (GridEx) events include a North American drill with national and local scenarios to exercise the detection and response capabilities to coordinated cyber and physical attacks.
- The Cyber Risk Preparedness Assessment (CRPA) provides on-site assessments performed by NERC staff to help owners evaluate their overall risk preparedness.

NERC Technical Committee – Critical Infrastructure Protection Committee (CIPC) Initiatives

- The BES Security Metrics Working Group is developing metrics to measure the state of BPS security and is providing periodic reports.
- The Electricity Sub-sector Information Sharing Task Force is developing a framework for the type of information to share that would be beneficial for both the ES-ISAC and the industry.
- The Cyber Attack Tree Task Force is developing information/profiles that will be helpful for use in identifying potential attack vectors.
- The Security Training Working Group is developing informational workshops and webinars on current cybersecurity-related issues.
- The CIPC is developing a business continuity working group.

Electricity Sub-sector Coordinating Council (ESCC)

- The ESCC develops strategic plans and actions that protect the electricity infrastructure from physical and cyber threats.

Recommendations

NERC should perform these additional activities:

- Establish effective communication between ES-ISAC and the Operations Reliability Sub-committee (ORS).
- Establish effective communication between ES-ISAC and the Bulk Power Situational Awareness (BPSA) group.
- Establish effective communication between ES-ISAC and the Information Sharing Task Force to ensure the appropriate information is shared and understood by the industry.
- NERC and stakeholders should define what success is for the ES-ISAC.
- Develop a comprehensive business and budget plan for implementing the CRISP program/technology into the ES-ISAC work scope that was approved by the Board in August.
- Facilitate deployment of CRISP technology, which will result in enhanced actionable communication among participants.
- Define a set of goals for target numbers of CRISP participants by specific dates.
- Ensure functional and physical separation of ES-ISAC staff and NERC staff with a strong code of conduct and restrictions on passing information to FERC, NERC and Regional Entity staff for compliance and enforcement purposes.
- Develop a plan to evaluate, monitor, and incorporate new technologies to keep up with evolving technologies and threats.
- Include cyber exercises in drills.
- Model various scenarios (contingency analysis) on systematic cyber attack and consider standard design basis.
- Work with CIOs, NATF, and NAGF to identify best practices on cyber practices and indicators.

Measures of Success

Near Term:

- NERC-developed ES-ISAC strategic plan including incorporation of the CRISP and other technology.
- Defined communication interface between the ES-ISAC and the Operations Reliability Sub-committee (ORS).
- Defined communication interface between the ES-ISAC and the Bulk Power Situational Awareness (BPSA) group.
- Defined communication interface between the ES-ISAC and the Information Sharing Task Force.
- Defined goal for target number of CRISP participants by specific dates.

Midterm:

- A CRISP technology deployment resulting in enhanced actionable communications among participants.
- An increase in the number of CRISP participants to predefined targets.
- Established plan to evaluate, monitor, and incorporate new technologies to keep up with evolving technologies and threats.
- Demonstrated functional separation of ES-ISAC and NERC Compliance and Enforcement staff through strong governance and accountability.
- Regular participation by ES-ISAC representatives in the ORS meetings to enhance operational and cyber knowledge transfer between the two groups.
- Effective output of the Electricity Sub-sector Information Sharing Task Force that includes established goals with specific timing parameters for sharing key information.

Risk Profile #3: Extreme Physical Events – Acts of Nature

While the probability of extreme physical events (such as severe weather) that can lead to extensive interconnection-wide damage is low, the potential consequences are high enough that additional risk mitigations warrant attention.

Detailed Problem Description

Severe weather events (e.g., hurricanes, tornadoes, polar vortices, GMDs, etc.) are physical events that, at the extreme, can cause extensive interconnection-wide equipment damage, fuel limitations, and disruptions of telecommunications. Because of the long time involved in manufacturing and replacing some BPS assets, an extreme physical event that causes extensive damage to equipment could result in degraded reliability for an extended period of time. While isolated, local physical events have a high probability of occurrence, the likelihood of extensive interconnection-wide events is low. However, the potential consequences of such an event are high enough that additional focus is needed to properly address this risk. While additional facilities could be one mitigation measure, permitting, siting, and construction of additional facilities will require long lead times for implementation.

Risk Management Activities to Date

Ongoing problem evaluation. NERC's technical committees research and analyze specific issues related to this risk, such as the work being done by the Geomagnetic Disturbance Task Force, Severe Impact Resiliency Task Force, and the Critical Infrastructure Protection Committee.

Raising awareness. NERC publishes special assessments and reports as needed: *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System* (2009), *Geo-Magnetic Disturbances (GMD): Monitoring, Mitigation, and Next Steps* (2011), *Effects of Geomagnetic Disturbances on the Bulk Power System* (2012). Performing event analysis on cold weather events (such as the polar vortex), including collaboration with industry to secure detailed information on failures for subsequent analysis.

Mandatory Reliability Standards. Industry has developed requirements related to GMD (Standards Project 2013–03 GMD Mitigation).

Develop coordination programs. NERC established a Spare Equipment Database, which facilitates sharing of equipment in times of need. This is complementary to EEI's Spare Transformer Equipment Program and SpareConnect program.

Industry Initiatives.

- Industry has participated in Regional Entity drills.
- Edison Electric Institute (EEI) has established the National Response Event (NRE) Initiative, which includes tabletop exercises.
- Southeastern Electric Exchange (SEE) has facilitated coordinated communication.
- Entities have developed specific Business Assurance Programs, which include continuity planning and exercises.

Recommendations

NERC should perform these additional activities:

- Complete the GMD standards projects.
- Establish effective communication between ES-ISAC, the Telecommunications ISAC, and Natural Gas ISAC.
- Assess the risks to the BPS of the following through the long-term reliability assessments and planning activities:
  - Inadequate natural gas availability and pipeline capacity and their impacts on reliability.
  - Multiple simultaneous limitations on natural gas deliveries during extreme cold weather.
  - Vulnerability to GMD events.
- Consider state-level requirements and factor them into any NERC reports or recommendations. Consult with states as needed.

Industry should perform these additional activities:

- Emphasize the need for increased industry participation in coordination support programs, such as the NERC Spare Equipment Database, EEI's Spare Transformer Equipment Program, and EEI's SpareConnect program.

- Evaluate inventories of critical spare transmission equipment and increase as required.

The NATF, the NAGF, the NERC OC, and the NERC PC should perform these additional activities:

- Identify and promote specific resiliency best practices with regard to planning for extreme events.
- Develop an event guideline outlining event response protocols and recovery strategy elements.

NERC and industry should leverage the Severity Risk Index (SRI) as a measure of system resilience and restoration performance for loss of generation, transmission, and load.

Measures of Success

Midterm:

- Performance and reporting on joint ES-ISAC and Telecommunications ISAC assessments of potential disruptions.
- NERC completion of the LTRA that addresses the following:
  - Natural gas availability and pipeline capacity impacts on reliability
  - Multiple simultaneous limitations on natural gas deliveries during extreme cold weather
- An increase in participation in the Spare Equipment Database and Spare Transformer Equipment Program numbers.
- FERC-approved GMD standards.
- Event guideline outlining prevention strategies and event response protocols.
- Documented GMD vulnerability assessment
- Trend SRI

Long Term:

- Leverage the SRI as a measure of system resilience and restoration performance for loss of generation, transmission, and load.

Risk Profile #4: Extreme Physical Events – Man-made

While the probability of extreme physical events (such as a coordinated or localized physical attack) that lead to extensive interconnection-wide damage is low, the potential consequences are high enough that additional risk mitigations warrant attention.

Detailed Problem Description

Coordinated sabotage attacks such as localized physical attacks of significance or EMP are physical events that, at the extreme, can cause extensive interconnection-wide equipment damage and disruptions of telecommunications. Because of the long time involved in manufacturing and replacing some BPS assets, an extreme physical event that causes extensive damage to equipment could result in degraded reliability for an extended period of time. While isolated, local physical events have a higher probability of occurrence, the likelihood of extensive, interconnection-wide events is low. However, the potential consequences of such an event are high enough that additional focus is needed to properly address this risk.

Risk Management Activities to Date

Ongoing problem evaluation – NERC's technical committees research and analyze specific issues related to this risk, such as the work being done by the Severe Impact Resiliency Task Force and the Critical Infrastructure Protection Committee.
Simulation and training – NERC hosts the biennial GridEx, which identifies strengths and weaknesses by providing entities the opportunity to respond to simulated malicious attacks against the electricity subsector.
Raising awareness – NERC publishes special assessments and reports as needed: *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System* (2009).
Develop coordination programs – NERC established a Spare Equipment Database, which facilitates sharing of equipment in times of need. This is complementary to EEI's Spare Transformer Equipment Program.
Mandatory Reliability Standards – Industry has developed Reliability Standard CIP-014-1 – Physical Security.
Partnering with governmental agencies – The risks related to an intentional coordinated attack and electromagnetic pulse can be mitigated in some measure as an act of national defense. In partnership with the ESCC, acting under the Critical Infrastructure Partnership Advisory Council (CIPAC) framework to protect sensitive information, industry (including NERC) leadership engages in dialogue with governmental agencies to explore potential mitigation strategies for such intentional acts. Reports with recommendations are provided to membership. See http://www.dhs.gov/critical-infrastructure-partnership-advisory-council for more information on how the ESCC works under security clearance with DHS and other agencies to better understand threats and associated recommendations. The CIPAC framework allows confidential topics to be discussed without triggering Freedom of Information Act (FOIA) requirements for disclosure.

Recommendations

NERC should perform these additional activities:

- Complete the Physical Security Standard project (CIP-014-1).
- Establish effective communication between ES-ISAC and the Telecommunications ISAC.
- Assess the risks, natural gas availability, and pipeline capacity impacts on reliability to the BPS in the long-term reliability assessments and planning activities.

Industry should perform these additional activities:

- Emphasize the need for increased industry participation in coordination support programs, such as the NERC Spare Equipment Database, EEI's Spare Transformer Equipment Program, and EEI's SpareConnect program.
- Evaluate inventories of critical spare transmission equipment and increase as required.

NERC and industry should leverage the SRI as a measure of system resilience and restoration performance for loss of generation, transmission, and load.

The NATF, the NAGF, the NERC OC, and the NERC PC should perform these additional activities:

- Identify and promote specific resiliency and vulnerability assessment best practices with regard to planning for extreme events.
- Develop an event guideline outlining prevention strategies and event response and recovery protocols.

Measures of Success

Midterm:

- Performance and reporting on joint ES-ISAC and Telecommunications ISAC assessments of potential disruptions.
- NERC completion of an LTRA that addresses the following:
  - Natural gas availability and pipeline capacity impacts on reliability
  - Multiple simultaneous limitations on natural gas deliveries during extreme cold weather
- An increase in participation in the Spare Equipment Database and Spare Transformer Equipment Program numbers.
- FERC-approved Physical Security standard (CIP-014-1).
- Event guideline outlining prevention strategies and event response protocols.
- National Association of Regulatory Utility Commissioners resolution supporting cost recovery for implementing specific resiliency strategies by the industry.

Long Term:

- Leverage the SRI as a measure of system resilience and restoration performance for loss of generation, transmission, and load.

Risk Profile #5: Failure to Maintain and Manage BPS Assets

The failure to maintain and manage BPS equipment and transmission rights of way is a latent risk to BPS reliability. Such a risk may manifest either as a direct or indirect contributor to a Disturbance (defined as an unplanned event that produces an abnormal system condition).

Detailed Problem Description

The failure to maintain equipment is a reliability risk exacerbated when an entity either does not have replacement components available or cannot procure needed parts in a timely fashion. Deficiencies in maintenance strategies create additional pressure on sparing programs and the ability to replace aging infrastructure. Also, the failure to maintain transmission rights of way contributes to vegetation-related outages. Another latent reliability risk, highlighted by the 2010 Facility Ratings Alert to industry, involved the misalignment between the design and actual construction of BPS facilities. Risks are also present in the vendor supply chain, where manufacturing quality control or product failures come to light (e.g., 345 kV Breaker Failure Industry Advisory). Additionally, emerging threats may impact product delivery systems such as cargo carriers or downstream service providers.

Risk Management Activities to Date

Raise awareness. In general, the use of Industry Advisory alerts provides valuable information on a variety of risks, including manufacturer defects and supply chain concerns. Regarding the transmission right-of-way clearance discrepancies, two alert recommendations on October 7, 2010, and November 30, 2010 were issued.
Information Requests. Data collection and analysis regarding field conditions and alignment with design assumptions for transmission facilities is ongoing. An example of this type of data collection and analysis would be the 345 kV breaker failure. NERC requested the North American Transmission Forum, the North American Generator Forum, and other trade associations to work with their members to collect and report aggregate information related to this concern.
Vegetation Management. The *Vegetation-Related Transmission Outages Report* is produced by NERC on a quarterly basis and highlights trends and circumstances of FAC-003 violations.
Technical Task Force. The NERC PC has established the AC Substation Equipment Task Force to look at substation equipment failures and make recommendations.

Recommendations

NERC should perform these additional activities:

- Evaluate and enhance the Alert program to address how it will prospectively address scoping for information requests with industry input and potential follow-up activities involving maintenance and management of assets.
- Timely closeout of the Facility Ratings Alert.
- Establish effective communication interfaces between ES-ISAC and the Supply Chain ISAC.
- NATF, NAGF, OC, and PC collaborate to establish a strategic plan to identify technologies that may aid spare sharing and recovery.

Measures of Success

Near Term:

- Where existing criteria or bandwidth have been defined, assign the appropriate group to monitor, track and trend standard violations.
- Track number of successful activities, success stories, maintenance, and reliability issues.
- Timely closeout of the Facility Ratings Alert recommendation.
- An initial plan to ensure joint coordination of ISAC efforts on potential supply chain disruptions.

Midterm:

- An evaluation of the NERC Alert program with an emphasis on defining the scope of an information request initiated by an Alert.
- Performance and reporting on joint ES-ISAC and Supply Chain ISAC assessments of potential supply chain disruptions.

Risk Profile #6: Generator Unavailability

Extreme weather conditions over extended periods can lead to very high demands for electricity and contribute to the simultaneous loss of large amounts of generation in a Region or sub-Region. This combination of generation unavailability and high electricity demand can lead to the need for emergency operation actions (including shedding load or triggering emergency resources) needed to maintain reliability and avoid cascading/uncontrolled separation of the overall BPS.

Detailed Problem Description

Extreme weather conditions, severe cold, heat, and drought create significant stress on maintaining overall bulk system reliability and present unique challenges for electric system planners and operators. These conditions can significantly increase residential and commercial electricity demand and consumption, at the same time imposing adverse regional generation impacts as well as fuel availability issues. The combination of increased consumption of large amounts of electricity can significantly increase the use of fuels commonly used by many power plants to produce electricity. Further, the extreme weather can stress key power plant components needed to generate electricity and can result in decreased fuel deliveries due to limited transport capability (e.g., on key gas pipelines, compressor stations, or rail service used for coal deliveries). Extreme weather conditions can also vary the amount of wind and clouds (fuel for VER resources) that impact the expected amount of available renewable generation in some areas.

When combined, the heightened electricity demand, increased potential for failure of power plant components, limitations on fuel supply availability, and competing use of certain fuels can lead to increased risks of adverse reliability impacts, including simultaneous forced outages, de-ratings, and failures to start of multiple generating units. When these severe conditions are present over large geographic areas, the combined impacts on the fuel supply, power plant operations, generation unavailability, and heightened electricity demand can lead to severe reliability impacts.

Although these conditions are anticipated to occur at low frequency, planners and operators responsible for managing a reliable BPS can be extremely challenged by these combined impacts. These extreme conditions occur beyond the extent of planned stress conditions, anticipated severe operation conditions, or fuel supply availability expectations. Further, the conditions can lead to imprecise forecasts of residential and commercial electricity demand, which is the baseline for planning the BPS and operators determining the amount of electric generation needed during critical periods. When the combination of some, or all, of these conditions occur during these extreme incidents, the end result can be operations under severe unanticipated scenarios or a shortage of generation, prompting operators to implement curtailments or shed load in local areas to maintain reliability in the overall grid.

Risk Management Activities to Date

Promote Best Practices and Guidelines. The NERC OC has developed a guideline for generator unit winter weather readiness. NERC will continue sharing lessons learned and best practices for managing equipment during extreme weather.

Raise awareness. NERC issues annual notifications reminding entities to prepare for extreme events. *Accommodating an Increased Dependence on Natural Gas for Electric Power* (2013) and *A Primer of the Natural Gas and Electric Power Interdependency in the United States* (2011).

Recommendations

NERC should perform these additional activities:

- Coordinate with The American National Gas Association to develop natural gas availability and pipeline capacity impacts on reliability. Specifically, develop a pipeline performance metric for operations and emergency conditions. Perform an assessment of the EPA's proposed rule 111(d) on resource adequacy and reliability.
- Coordinate with the current EIPC Gas-Electric Interface Study.

The NATF, the NAGF, the NERC OC, and the NERC PC should perform these additional activities:

- Identify and promote specific resiliency best practices with regard to planning for extreme events.
- Develop an event guideline outlining prevention strategies and event response protocols.
- NERC should ensure the polar vortex event analysis effort yields executable results and a strategic plan for addressing implementation of any recommendations.
- NERC OC should define and develop a process for inter-regional coordination of critical resources.

The NERC PC should perform these additional activities:

- Evaluate opportunities to develop more accurate short-term load forecast models through collaboration with the Balancing Authorities and Regional Entities.
- Conduct an inter-regional pipeline study to assess pipeline failure risks and to identify a wide-area profile of potential impacts.
- Develop a wide-area profile of potential generator/natural gas vulnerabilities and communicate the information to regional Reliability Coordinators to improve coordination of critical resources.

Measures of Success

Near Term:

- NERC completion of assessments on the following:
  - EPA proposed rule 111(d) on resource adequacy and reliability
  - Natural gas availability and pipeline capacity impacts on reliability
- Improved generator performance during cold weather events as indicated by decreasing values in the following:
  - Frequency of unexpected loss of generation
  - Percentage of generation de-rates
  - Frequency of generator failures
  - Equivalent Forced Outage Rate (EFOR)
  - Frequency and magnitude of load shedding
  - Trend error in short-term load forecast per Balancing Authority

Midterm:

- Event guideline outlining prevention strategies and event response protocols.

Long Term:

- Gas pipeline performance metrics
- Development of system modelling incorporating both electric generating and natural gas deliverability capabilities
- Refined models based on actual performance of forecast wide-area stress points during extreme cold weather events

Risk Profile #7: Loss of Situational Awareness

Not having decision-support tools available (coupled with a lack of alternate procedures), and not having operational visibility of local and neighboring entities' operations to manage reliability in real time is a latent risk that could lead to interconnection-wide reliability issues.

Detailed Problem Description

NERC has analyzed data and identified that outages of tools and monitoring systems are fairly common occurrences. Functional capabilities impacted by this risk include perceiving and comprehending the information provided by decision-support tools, information sharing, coordination of models, and planning across seams. Less-than-adequate situational awareness has the potential for significant negative reliability consequences and is often a precursor event or contributor to events. Additionally, insufficient communication and data regarding neighboring entities' operations is also a latent risk that could result in invalid assumptions of another system's behavior or system state.

Risk Management Activities to Date

Ongoing problem evaluation. NERC's technical committees research and analyze specific issues related to this risk, such as the work being done by the Real-time Tools Best Practices Task Force and EMS Working Group (EMSWG).
Raising awareness. NERC continues an ongoing practice of issuing Alerts, publishing Lessons Learned, presenting data and case studies to appropriate technical committees, and hosting a Monitoring and Situational Awareness Technical Conference, which provided a forum for vendors and users to share information and exchange knowledge about increasing EMS availability.

Recommendations

NERC should perform these additional activities:

- Complete Reliability Standards that mandate minimum real-time monitoring and analysis capabilities (Standards Project 2009-02 Real-Time Reliability Monitoring and Analysis Capabilities). The current Transmission Operations/ Interconnection Reliability Operations and Coordination (TOP/IRO) drafting team may address the Project 2009-02 tool issues, thus eliminating the need for Project 2009-02.

The NERC OC should perform these additional activities:

- Continue emphasis on work currently underway by the EMSWG, including analyzing and addressing unplanned full and partial EMS outages.
- Develop a guideline describing approaches for continued reliable operation following the loss of critical tools such as reliable Real-Time Contingency Analysis (RTCA) and Automatic Generation Control (AGC).
- Develop a guideline to improve operational visibility of a neighboring entity's operation and planning across seams.
- Collaborate with industry and vendors to develop best practices for system design and maintenance that minimize the probability of downtime.
- Develop a guideline to improve preparedness following loss of situational awareness through effective mitigation techniques such as manned substations and adopting a conservative system operations posture when returning facilities to service.

The NERC PC should perform these additional activities:

- Review communications and data protocols between Balancing Authorities to ensure appropriate data modeling and communication needs are in place.

Industry should perform these additional actions:

- Improve preparedness following the loss of situational awareness by training personnel on effective mitigation techniques (such as manned substations) and adopting a conservative system operations posture when returning facilities to service.

- Clarify accountability for Reliability Coordinators and System Operators to maintain awareness and understanding beyond their local systems.

Measures of Success

Near Term:

- An initial baseline measure of the frequency and duration of unplanned full and partial EMS outages.
- A mechanism or process for analyzing outage trends and providing solutions to industry.

Midterm:

- A guideline emphasizing best practices and approaches for continued reliable operations following loss of critical tools.
- A guideline addressing operational visibility of a neighboring entity's operation and planning across seams.
- A review of communications and data protocols between planning entities to ensure that appropriate data modeling and communication needs are in place.
- Training guideline on effective mitigation techniques (such as manned substations) and adopting a conservative system operations posture when returning facilities to service.
- FERC-approved standards addressing real-time monitoring and analysis capabilities.

Risk Profile #8: Pandemic

Pandemic risk is unique when compared to other risk areas. This risk area may impact a large number of people who become infected with a disease that can be transmitted from human to human. When a pandemic occurs, severe loss of uniquely trained staff will be experienced across the ERO and the industry.

Detailed Problem Description

Pandemic generally refers to an event occurring over a wide geographical area and affecting an exceptionally high proportion of the population. Industry has in the past prepared plans for responding to a pandemic. While a pandemic has a low probability of occurring, the impact could be high (i.e., Ebola pandemic and swine flu pandemic.). Consideration should be given regarding what to do to prevent the pandemic as well as how to recover and maintain reliability during one.

Risk Management Activities to Date

- EEI provides the Threat Scenario Project.
- NERC and DOE developed the *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System* report (2010).
- Entity-specific business continuity programs include continuity planning and exercises.
- Utilities and other appropriate entities participate in state, local and federal exercises.

Recommendations

NERC should perform these additional activities:

- Monitor and act as needed. Refresh pandemic plans as needed, for NERC and delegated Regional Entities.
- Include pandemic response in regular business continuity table-top exercises designed to reveal any gaps between the roles and expectations of government and industry.
- Monitor pandemic or infectious disease likelihood through interfaces with the Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), and state and federal government entities.
- Communicate pandemic or infectious disease likelihood to industry as warranted.

Measures of Success

Pandemic is currently considered a low-likelihood, albeit high-impact, probability event. As such, NERC activities should primarily be categorized as monitoring in nature, and not classified as near term, midterm, or long term in nature. Rather, on an ongoing basis, NERC should:

- Maintain communication with the CDC, WHO, and appropriate government entities as appropriate regarding developing pandemic threats and issues.
- Plan to include pandemic response in regular business continuity table-top exercises designed to reveal any gaps between the roles and expectations of government and industry.
- Ensure that a strategic plan for establishing parameters for the pandemic model, objectives, and coordination of facilitators and participants utilizing the universal risk assessment methodology is available.
- Provide periodic communications on pandemic or infectious disease likelihood to industry.
- Dissemination of the exercise outcomes and reports on lessons learned. Outcomes will inform future risk assessment methodologies as well as any needed threat/vulnerability studies.

Risk Profile #9: Poor Event Response/Recovery

Poor event response/recovery is defined by the failure to safely and efficiently restore transmission service to critical load in a timely manner. Failure is indicated when insufficient methods or resources are deployed following an event and such methods contribute to prolonged transmission outage durations, thereby increasing the duration of BPS unreliability.

Detailed Problem Description

The effect of poor event response and recovery is far-reaching. For example, during restoration activities, owners and operators of BPS facilities are exposed to safety, operational, or equipment-related risks. The concerns could be amplified in a hastily performed restoration where procedures are rushed or discarded. From the customer's perspective, a prolonged transmission outage or frequent intermittent disruptions because of poor response or recovery could impact critical health services such as fire and rescue operations.

Poor event response and recovery occurs when an entity cannot effectively mobilize or utilize available resources to restore transmission service in the most timely, safe, and cost-effective manner. While each event is unique, an effective recovery includes some attributes that are (1) within an entity's control, and (2) can be measured against realistic expectations. Attributes may include adequate material stores, specialized fleet/equipment, skilled workforce, and established safety procedures/protocols.

Risk Management Activities to Date

The following entity-specific efforts minimize poor event response and recovery:

- Spare equipment initiatives provide focus on maintaining sufficient stores of materials in times of emergency.
- Fleet maintenance programs ensure that specialized fleet and equipment is available and ready to assist in recovery.
- A skilled workforce is better prepared through professional development, drills/exercises, and planning. Together, these efforts allow engineers and operators to understand an entity's system operating characteristics and flexibility.
- Safety procedures and protocols are reinforced through business continuity plans and incident response teams.

Various entities provide leadership and assistance:

- EEI provides a Voluntary Mutual Assistance Program, the Spare Transformer Equipment Program (STEP), the SpareConnect program, and executive support of business continuity initiatives.
- The NATF maintains a peer review program and several practice groups focused on improving electric transmission system performance.
- The ESCC provides direction and sponsorship of high-level industry and government emergency plans and playbooks.
- NERC's Reliability Risk Management program area includes the Event Analysis and Lessons Learned programs, which provide integral functions for improving performance.

Recommendations

NERC and the NERC OC should perform these additional activities:

- Develop metrics and drill element recommendations to improve the overall industry posture on post-event preparedness. An entity's performance against expectations can be fairly assessed and used as a learning experience for preparation with future events.
- Explore opportunities to engage Regional Entities, trade associations, and industry forums (e.g., EEI and NATF) on specific and cost-effective solutions to improve response times.
- Promote the alignment of event analysis and lessons learned with system hardening and resiliency measures such that entities can better plan, budget, and implement lasting, robust solutions after major events (e.g., Higher

Design and Construction Standards discussed in EEI's *Before and After the Storm* publication (March 2014)).

Industry:

- Identify interdependent and critical infrastructure sector communication protocols.
- Identify best practices on how to approach public and public officials to understand restoration prioritization needs.

Measures of Success

Near Term:

- An established communications plan to inform industry on best use of reliability metrics and indices.
- Initial outreach to trade associations and industry forums to ensure consistent understanding of the risk of poor event response and recovery.

Midterm:

- A strategic plan for highlighting restoration best practices and indices for gauging improvement.
- A preliminary assessment highlighting risk areas and collaborative solutions as recommended by Industry, NERC, ESCC, and other stakeholders.

Risk Profile #10: Poor Human Performance

Poor Human Performance (HP) generally refers to those situations in which a human being makes a decision that contributes to operational errors.

Detailed Problem Description

NERC's Event Analysis program has identified a key problem that spans a number of potential issues: the contribution of organizational culture and management to operational error. Specifically, stronger management and organizational support for enhanced robustness of entity event evaluation would be expected not only to reduce operational error (and the elements that influence decision making), but also to ensure such errors are not repeated. Reliability Standards continue to contribute to improved human performance (i.e., Reliability Standard COM-002-4 for three-part communication).

Risk Management Activities to Date

- NERC staff is aggressively working to improve industry performance in this area through training and communication initiatives within the Event Analysis program and Lessons Learned.
- NATF has established an HP Practices Group.

Recommendations

NERC should perform these additional activities:

- Assist and inform the industry regarding best practices for event analysis, cause coding, and lessons learned.
- Develop and distribute lessons learned in a timely fashion.
- Continue to host the Annual NERC HP Conference and Workshop and encourage industry participation.
- Collaborate with the NATF HP Practices Group to share best practices.
- Focus on HP education and training.

Measures of Success

Midterm

- Trend occurrence of event cause codes associated with:
  - A4B1C05 (assessment did not determine cause of previous event or known problem)
  - A4B1C08 (corrective action responses to a known or repetitive problem were untimely)
  - A4B1C04 (follow-up did not identify problems)
- Trend the annual percentage of events coded as "AZ" – "Information to determine cause less than adequate" or "A4" – "Management/Organization."

Risk Profile #11: Poor Resource Planning

Plant retirements are leading to cases where resources may be inadequate to ensure firm demand is served at all times.

Detailed Problem Description

Environmental regulations, increased uncertainty in future resources due to other potential environmental regulations, low natural gas prices, load forecasting uncertainty, and economic factors all contribute to an increased rate of plant retirements and a lack of construction of new plants. Specifically, continued expansion of environmental regulations—including CO_2 regulations and other regulations targeting water usage by generators—greatly increases this risk. While demand response and energy efficiency may offset some of these losses, performance of those technologies can be uncertain, and each brings unique challenges. Long-term outages of multiple units to apply environmental retrofits also may have impacts. This all contributes to a lack of certainty regarding resource adequacy in North America over the next several years. Forecasts show potential deficiencies in reserve margins as early as 2014 and 2015 in the Electric Reliability Council of Texas (ERCOT) and Midwest Independent Transmission System Operator, Inc. (MISO). While entities are aware of this issue and are taking action, the amount of time required to implement solutions may be too long to provide relief in the near term, and taking a reactive approach would be inadequate.

Risk Management Activities to Date

Ongoing problem evaluation. NERC's technical committees research and analyze specific issues related to this risk, such as the work being done by the Reliability Assessments Subcommittee.
Raising awareness. NERC continues an ongoing practice of publishing LTRAs and special assessments: *Potential Impacts of Future Environmental Regulations* (2011); *Resource Adequacy Impacts of Potential U.S. Environmental Regulations* (2010).

Recommendations

NERC should perform these additional activities:
Continue emphasis on sharing information through assessments. Host technical conferences and encourage meetings with regulators to discuss the issue and explain the potential consequences.

- Collaborate with entities to develop best practices and guidelines for effective management of reserve margins.
- Enhance coordination efforts for long-term planning across operational seams.
- Promote better unit retirement forecast models to generate scenarios for planning studies.

The NERC PC should perform these additional activities:

- Consider whether the current body of Reliability Standards is sufficient to ensure this risk is appropriately managed.
- Develop interconnection-wide models more commensurate with expected dispatches to help perform long-term planning.

Measures of Success

Near Term:

- A NERC/technical committee strategic plan to engage entities, disseminate information, and provide a framework for technical conferences as needed.

Long Term:

- Resource adequacy and transmission capacity in all North American Regions should reverse declining trends and approach target reserve margin levels by the end of the 2014–2017 period. Reserve margin forecasts should not fall below targets within the future three-year horizon.
- No significant uptick in Energy Emergency Alerts.
- Long-term dispatch models that generate credible scenarios for planning studies.
- Transmission Load Relief (TLR) trends resulting from dispatches significantly different from planning models.

Risk Profile #12: Protection System Failures

A fault accompanied by a failure of any Protection System component could result in instability, violations of applicable thermal or voltage ratings, unplanned or uncontrolled loss of demand or curtailment of firm transfers, or cascading outages. In addition, a lack of Protection System coordination potentially increases the size and magnitude of events due to unnecessary trips. Protection System Misoperations are considered a significant threat to BPS reliability.

Detailed Problem Description

Protection Systems serve a vital role in defense against system disturbance events. When Protection System components fail, or when they are not coordinated properly, the order of execution can result in either incorrect elements being removed from service, or more elements being removed than necessary. Failures to trip and slow trips can result in damaged equipment, which may result in degraded reliability for an extended period of time. NERC's annual state of reliability reports have consistently concluded that Protection System Misoperations are a significant contributor to disturbance events and increase the severity of automatic transmission outages.

Risk Management Activities to Date

Information Requests. NERC has an ongoing data request and analysis to determine the risks to the BPS posed by potential single-point-of-failure events, in response to FERC Order 754. Data collection and analysis regarding Protection System Misoperations is facilitated by revised Reliability Standard PRC-004-2 – Protection System Misoperations.

Promote Best Practices and Guidelines. The NERC System Protection and Control Subcommittee (SPCS) published a document explaining the need for and design of redundancy in protection systems. The SPCS's also published a document explaining the need for power plant and transmission system protection coordination, as well as associated training materials and webinars. The Protection System Misoperations Task Force developed a set of suggestions for addressing commonly seen problems and improving Protection System performance through the development of guidelines.

Mandatory Standards. Project 2007-06 System Protection Coordination addresses information sharing and Protection System coordination studies driven by changes in system conditions. Project 2010-05.1 Phase 1 of Protection Systems involves analysis and corrective action plans for all Protection System Misoperations. Project 2007-11 Disturbance Monitoring requires the use of appropriate disturbance monitoring equipment.

NATF Protection System Misoperation Reduction Initiative. The NATF presented information on this initiative at the August 14, 2014, NERC Board of Trustees Meeting.

Recommendations

NERC should perform these additional activities:

- Continue the ongoing data request and associated analysis to determine the risks to the BPS posed by potential single-point-of-failure events. NERC and industry's (SPCS, NATF, and NAGF) analysis of Protection System Misoperations should continue. However, the analysis must inform entities on direct causes of misoperations, their magnitude or impact to BPS reliability, and which proven best practices could be deployed.
- Upon the completion of the data request described above and dependent on the associated findings from that analysis, NERC should develop a standard that requires entities to identify and address, on an ongoing basis, those cases in which a fault accompanied by a failure of any single Protection System component could result in instability, violations of applicable thermal or voltage ratings, unplanned or uncontrolled loss of demand or curtailment of firm transfers, or cascading outages.
- Develop technical guidance that supports the proper application and setting of relay elements and associated firmware in order to minimize the chance of a misoperation occurring.
- Ensure that NERC and the Regions develop metrics to facilitate consistent reporting of Protection System Misoperations.

Measures of Success

Near Term:

- Meaningful information about direct causes and best practices.

Midterm:

- Report on findings from the analysis of misoperations data provided by industry.
- Technical guidance supporting the proper application and setting of relay elements and associated firmware in order to minimize the chance of a misoperation occurring.
- Improvements in the following:
  - Instances in which a single point of failure on a Protection System causes or contributes to an event on the BPS.
  - The frequency of unnecessary Protection System trips caused by incorrectly applied Protection System schemes/settings.
  - Variability of Regional Entity and registered entity misoperation performance (i.e., the ratio of misoperations to total correct operations).

Long Term:

- Overall mean (average) misoperation performance rate improves.

Risk Profile #13: Regulatory Uncertainty

Regulatory uncertainty is defined as any unknown future federal, state, or provincial statute that could result in risk to the BPS and compliance risks in an increasingly complex operating environment.

Detailed Problem Description

Regulatory uncertainty includes two key risk areas. First, future federal, state, or provincial statutes (including congressional or parliamentary action, EPA regulations, FERC/NERC and Regional Entity directives, and individual state or provincial action) could pose a risk to the BPS. While singular statutes could individually pose risk, additional risk is added through the complex and compounding effects of uncoordinated public policy decisions made at various levels of the government or by multiple government agencies. Specific examples include ERO regulations, restricted bandwidth in cellular space, safety restrictions on fuel delivery, renewable portfolio standards, and continued expansion of environmental regulations—including CO_2 regulations and other regulations targeting water usage by generators.

Second, complex, competing, and diverse rules cause entities to take actions based on compliance rules rather than considering reliability objectives, which can impact an operator's flexibility to reliably operate the grid.

Compliance risks in an increasingly complex operating environment include areas of the overall NERC process that detract from the mission of increasing the reliability of the BPS by introducing or perpetuating requirements or business practices with conflicting results. Examples of these areas include:

- Maintaining a focus on compliance rather than operations.
- Introduction of system complexity (e.g., complex tools to manage compliance in the areas of CIP, protection and controls, and environmental) with no correlating increase in system reliability.
- Inconsistent interpretations, which are extremely evident to entities registered in multiple Regions. Ever-changing interpretations makes drafting and implementing compliance programs a moving target.

Risk Management Activities to Date

Reliability Assurance Initiative: The RAI program is an ERO strategic initiative for improving the efficiency and effectiveness of compliance monitoring and enforcement of the NERC Reliability Standards. RAI allows for appropriately scoped oversight of registered entities' compliance through risk assessments and evaluation of internal controls. This should minimize audit and compliance fatigue for registered entities while allowing NERC and the Regions to focus resources on the higher risk areas.

Risk-Based Registration (RBR) Initiative: This NERC initiative is designed to ensure that the right entities are subject to the right set of applicable Reliability Standards using a consistent approach to risk assessment and registration across the ERO.

Results-Based Standards Initiative: This initiative provides clear objectives for Standard Drafting Teams (SDTs) to ensure that standards are developed that comply with the quality objectives defined by NERC and contribute the greatest positive impact to BPS reliability. This is accomplished by making sure each requirement targets a specific reliability risk and identifies a clear and measurable expected outcome.

Compliance Exceptions: This initiative builds on Find Fix and Track (FFT), which was the first step in implementing a risk-based strategy that recognizes that not all instances of noncompliance require the same type of enforcement process. The evolution of FFT is to get to the point where an instance of noncompliance that poses a lesser risk to the reliability of the BPS does not have to trigger an enforcement action but allows NERC and the Regional Entity (RE) the ability to exercise discretion on whether or not to initiate an enforcement action.

Recommendations

NERC should perform these additional activities:

- Given its formal role under Section 215 of the Federal Power Act, NERC should, when appropriate, perform

independent, technical assessments of proposed regulatory statutes to determine any impacts to reliability.
- Perform an assessment of EPA proposed rule 111(d) on resource adequacy and reliability.
- Complete development and implementation of the Reliability Assurance Initiative (RAI) including components such as the Multi-Region Registered Entity (MRRE) Process with continued emphasis on transitioning the initiative through conceptual models, demonstrations (pilots), and final implementation.
- Complete and implement the RBR Initiative.
- Develop and enforce consistent compliance monitoring and enforcement practices across NERC and the Regional Entities beyond entity audits through broad multi-regional peer reviews made up of diverse audit teams.
- Leverage industry associations and forums (e.g., North American Transmission Forum (NATF)) to ensure that registered entity perspectives are included in consistency efforts.
- Address cohesiveness between audit practices and requirements of the Reliability Standards concurrently through collaborative models such as the newly formed Transition Stakeholder Group for the Critical Infrastructure Protection standards and continued industry engagement on Reliability Standard Audit Worksheets (RSAWs).
- Revisit the Paragraph 81 initiative to identify and remove Reliability Standards and/or Requirements that distract from reliability objectives.
- Continue support of Standards Committee initiatives to streamline the Reliability Standards Development Process. Any efficiency gained must not be misdirected to overly aggressive standard development timelines or other distractions, because unintended consequences and wasted resources are a likely outcome.
- Engage in high-level collaboration (NERC/FERC/DOE) to establish long-term strategy for consolidated national energy policy.

Measures of Success

Near Term:
- Complete RAI and ensure ERO remains focused on compliance and enforcement in areas that matter most to reliability. Finalize risk assessment and logging approach to facilitate implementation of RAI.
- NERC completion of an assessment of EPA proposed rule 111(d) on resource adequacy and reliability.
- Audit scopes correlating with an entity's risk assessment.
- Transparent communications between NERC, Regions, and the entity explaining the basis for changes when the current audit scope deviates from the prior audit scope.
- Completion of the RBR methodology.
- Examples of consistent interpretations and compliance monitoring and enforcement practices from Regional Entities.
- Draft RSAW revisions that clearly demonstrate adherence to the Reliability Standards without overly burdensome administrative items that distract from reliability objectives.
- Occurrence of high-level collaboration (NERC/FERC/DOE) to establish long-term strategy for consolidated national energy policy.

Midterm:
- NERC completion of an assessment of EPA final rule 111(d) on resource adequacy and reliability.
- Percentage of self-logged instances of compliance exceptions versus possible violations.
- A successful CIP v5 transition including other prioritized standard revisions. Success indicators are flat trends in noncompliance.
- A mature RBR methodology capable of including the appropriate NERC registered entities.
- Results-based standards that either eliminate or modify current versions.
- Completion of the RAI implementation strategy.

Long Term:
- Industry feedback (through assessments/surveys) indicating improved ERO and Regional Entity performance.
- A mature RAI with a fully implemented risk-based program for compliance monitoring and enforcement of Reliability Standards.

Risk Profile #14: Uncoordinated Planning

Increasing complexities (changing resource mix, deployment of new technologies, etc.) can increase risk to reliability if not properly considered in local planning cases and if planning is not properly coordinated at operational seams. Uncoordinated planning at the seams can lead to cases where generation or transmission resources, or information concerning those resources, may be inadequate to ensure firm demand is served.

Detailed Problem Description

An increased rate of plant retirements, a lack of traditional generation and transmission construction, reliance on demand response and energy efficiency, uncertain performance of new technologies, dynamic system operating characteristics, and long-term outages of multiple units to employ environmental retrofits all contribute to a lack of certainty regarding resource adequacy in North America over the next several years. Forecasts show potential deficiencies in reserve margins as early as 2014 and 2015 in ERCOT. Additionally, uncertainty in resource adequacy is attributed to differences in long-term planning practices, use of different models, a lack of information sharing, and uncoordinated planning. Another concern for planning is lack of awareness about when generators will be retired. Solutions require long lead times, and a reactive planning approach is inadequate.

Risk Management Activities to Date

Ongoing problem evaluation – NERC's technical committees and subcommittees research and analyze specific issues related to this risk, including the Reliability Assessment Committee (RAS), Integration of Variable Generation Task Force (IVGTF), Smart Grid Task Force (SGTF), Geomagnetic Disturbance Task Force (GMDTF), System Analysis and Modeling Subcommittee (SAMS), Modeling Working Group (MWG), and the ERSTF.
Raising awareness – NERC continues an ongoing practice of publishing long-term reliability assessments and special assessments: *Potential Impacts of Future Environmental Regulations* (2011); *Resource Adequacy Impacts of Potential U.S. Environmental Regulations* (2010).
Reliability Standards – Industry implementation of new Transmission Operator (TOP) and Transmission Planning (TPL) standards.

Recommendations

Promote better unit retirement forecast models to generate scenarios for planning studies.

NERC and the Regions should perform these additional activities:

- Continue emphasis on sharing information through assessments. Host technical conferences and encourage meeting with regulators to discuss the issue and explain the potential consequences.
- Collaborate with entities to develop best practices and guidelines for effective management of reserve margins.
- Enhance coordination efforts for long-term planning by (1) developing models of market operations, and (2) assisting in performing regional studies to quantify reliability impacts due to market operations across operational seams.
- Continuously evaluate efficacy of planning models suitable to coordinate long-term planning across Regions and North America.

The NERC PC should perform these additional activities:

- Consider whether the current body of Reliability Standards is sufficient to ensure this risk is appropriately managed.
- Develop interconnection-wide models more commensurate with expected dispatches to help perform long-term planning.

NERC should assess the risks to the BPS of the following through LRRAs and planning activities:

- Challenges associated with adding transmission capacity.
- Difficulties with transmission siting.
- The need for transmission to maintain reliable operation of the system.

Measures of Success

Near Term:

- A NERC/technical committee strategic plan to engage entities, disseminate information, and provide a framework for technical conferences as needed.

Midterm:

- NERC completion of an LTRA that addresses the following:
  - Challenges associated with adding transmission capacity.
  - Difficulties with transmission siting.

Long Term:

- Resource adequacy and transmission capacity in all North American Regions should reverse declining trends and approach target reserve margin levels by the end of the 2014–2017 period. Reserve margin forecasts should not fall below targets within the future three-year horizon.
- No significant uptick in Energy Emergency Alerts.
- Long-term dispatch models that generate credible scenarios for planning studies.
- Downward Transmission Load Relief (TLR) trends.