NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

ERO Reliability Risk Priorities

RISC Recommendations to the NERC Board of Trustees

October 2015

RELIABILITY | ACCOUNTABILITY




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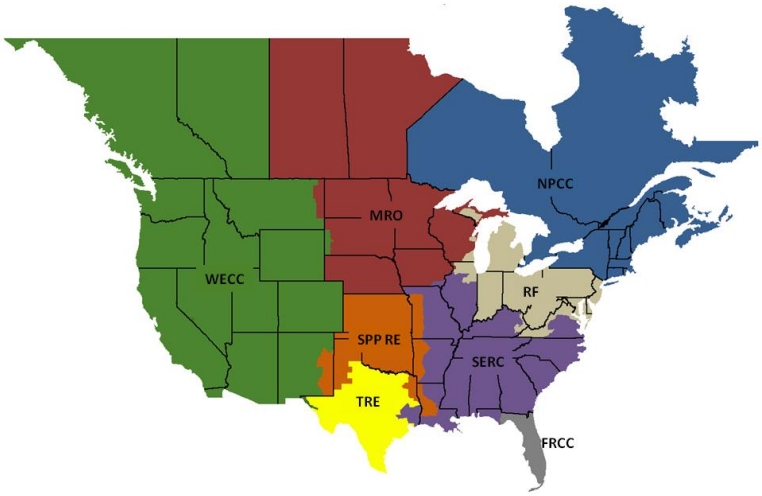
Preface

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 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 to the NERC Board of Trustees (Board). The RISC provides key insights, priorities, and high-level leadership for issues of strategic importance to BPS reliability. The RISC advises the Board, NERC standing committees, NERC staff, regulators, REs, and industry stakeholders in an effort to establish a common understanding of the scope, priority, and goals for the development of solutions to address reliability issues. The RISC provides a framework for steering, developing, formalizing, and organizing recommendations to provide guidance to the ERO Enterprise and the industry to effectively focus resources on the critical issues to best improve the reliability of the BPS.

This 2015 report presents the results of the RISC's continued work to define and prioritize risks to the reliable operation of the BPS and thereby provide recommendations to the Board regarding the strategic approach that NERC should take to enhance reliability and manage those risks.

Executive Summary

The purpose of this report is to document the work performed by the RISC in 2015 to identify, define, and prioritize reliability risks to the BPS. The RISC's 2015 efforts build on the prior work of the committee and are intended to provide continued guidance on efforts that enhance reliability and mitigate identified risks. This report continues to refine the presentation of reliability issues, in part by focusing on evolving reliability risks, while recognizing that certain risks are well known and are being actively managed. The full range of risk profiles, recommendations, and associated management statuses of each are provided in a supplemental report.

The RISC graphically mapped the current state and trajectory over a three-year period, showing individual risks relative to other risks. This mapping illustrates the RISC evaluation of the risk, the changes realized, and the expected result, reflecting the implementation of current risk management activities. In August 2015, NERC and the RISC hosted a reliability leadership summit to identify emerging reliability risks, finalize current reliability perspectives, identify potential gaps or refinements in understanding these risks, and gather insights about existing and emerging risk trends. In this report, the RISC highlights evolving risks that warrant monitoring or other action, as well as risks that materially changed or instances where existing action initiatives should be reinforced. Accordingly, well-understood risks that are effectively being mitigated are described in a separate category, and an updated status is provided in the supplemental report.

The overarching reliability risk themes recognized by the RISC focus on the increasing changes in the production, transmission, and use of electric energy by consumers. These fundamental changes involve movement away from centralized dispatch of large synchronous generation and transmission for all customer electric energy needs. This is transitioning to, in some cases, a more distributed model that reflects that customers are increasingly electing to self-generate some of their energy at the same time that significant changes are taking place in the overall resource mix and its geographic dispersion. As this transition unfolds over the coming years, the need for a reliable and resilient BPS remains paramount. The challenges for system planners and operators will be to develop analyses and tools to maintain a reliable BPS by ensuring essential reliability services (ERSs) are provided while customers continue to depend on the BPS.

Strategic Perspective

The RISC also provides suggested input on the top five strategic areas for ERO focus and attention during the development of the Strategic Plan. These are linked to addressing reliability risks and priorities during the development of the 2016-2019 ERO Strategic Plan and the subsequent 2017 Business Plan and Budget. These top five areas for strategic focus are:

1. address regulatory uncertainty,
2. enhance reliability assessments,
3. address changing resource adequacy,
4. create an effective resiliency approach, and
5. enhance cyber security posture.

Evolving Risks

With these strategic areas of focus, the RISC determined ranges of evolving reliability risks as a framework to recognize priorities and focus risk control measures. The "high" evolving reliability risks denote risks with high likelihoods to occur and high potential impacts to the BPS. These warrant the greatest level of focus and attention for risk control and mitigation efforts to decrease their likelihood and potential impacts. While both "moderate" and "low" evolving risks were recognized, the RISC urges the greatest focus and priority on the high categories described below:

- **Regulatory Uncertainty: markets, states, and federal/provincial**
  - These risks arise where the impacts from regulatory initiatives are uncertain in their extent, timing, and potential reliability considerations. These uncertainties are accentuated by the interplay among these three arenas, each of which reflects policy, regulatory, and legislative dimensions which may not include sufficient reliability coordination.
- **Resources**
  - Changing resource mix
  - Inadequate planning coordination
  - Ineffective resource planning

  This set of evolving risks reflects interdependent aspects from the continued and accelerated rapid transformation of the resource mix. As part of the increased and accelerated integration of new types of variable, renewable, and distributed energy resources, planners must ensure that sufficient ERSs and operator flexibility are available to maintain reliability.
- **Resiliency**
  - Cyber security

  These risks reflect aspects of resilience related to potential cyber disruptions of the BPS. As cyber aspects evolve, they require more assertive and flexible approaches to provide adequate assurances of reliability.

Reliability Leadership Summit

The Reliability Leadership Summit affirmed the unprecedented change in resource mix and technology integration is being accelerated. At the same time, the reliability of the interconnected BPS must be maintained as the grid transitions through these changes. As dispersed energy resources increasingly integrate within the distribution system, their characteristics affect and alter BPS reliability behavior and do not necessarily contribute the same level of reliability as resources that they replace. ERSs will need to be replenished, and operator reliability activities, such as the ability to control, observe and dispatch these resources, will need to be secured to ensure the continued reliability of the BPS. Notably, three categories of risks were identified:

1. Current risks identified and measurable through the ERO's existing processes and procedures
2. Risks that are evolving and accelerating due, in part, to regulation and shifting economics, and can result from the integration of new technology
3. Risks with a large potential impact on reliability from extreme events and intentional acts such as cyber and physical attacks, geomagnetic disturbances (GMD), electromagnetic pulses (EMP), and severe or extreme weather

Recommendations

The specific areas identified in 2015 focus on the complex interdependencies and multiple jurisdictions between the electric industry and other industries; resource management amidst changing resource mix; resiliency; regulatory uncertainty; system assets management and maintenance; the role of human performance; and event response and recovery. The RISC identified actions that should be taken to continue to address key risks, as well as actions or interventions that are underway and are being effectively monitored. The review of the reliability risks also integrates a temporal component or method used to underscore the pace or timing needed to put a range of actions into place. Accordingly, the RISC is recommending that NERC and industry take the following actions:

- Identify and report on interdependent and evolving utility business models across electric industry companies, Regional Transmission Organizations (RTOs)/Independent System Operators (ISOs) and Balancing Authorities (BAs) to understand potential barriers to sustained reliability.
- Continue to expand long-term reliability assessments to measure the impacts on reliability from the changing resource mix.
- Build on the ERS framework to include the assessment of regional/area-specific requirements.
- Continue the maturation and effectiveness of the Electricity Information Sharing and Analysis Center (E-ISAC), the deployment of Cyber Security Risk Information Sharing Program (CRISP) technology, and the adoption of effective measures of industry posture for both physical and cyber security.
- Ensure planning data and modeling consistency efforts for both generation resources and transmission additions, as well as addressing reliability characteristics of dispersed generation (DG) and load, effectively and accurately reflect reliability behavior and model fidelity.
- Promote effective sharing mechanisms for long-term, robust regional operational planning and real-time situational awareness among entities, including across RTO/ISO markets, bilateral regions, and nonmarket seams.
- Continue to leverage the North American Generator Forum (NAGF), North American Transmission Forum (NATF), Electric Power Research Institute (EPRI), and other industry-practice-sharing forums to enhance resilience and improve reliability.
- Develop clarity for differentiating the meaning and character of resilience for reliability as well as effective ways to measure resilience.

Introduction

This 2015 annual report documents the results of the RISC's continued work to identify key risks to the reliable operation of the BPS, determine relative priority and pace of management efforts, and provide input to the Board on recommended actions to manage those risks. In this year's review, the report focuses on key evolving reliability risks and priorities for further action and risk mitigation efforts. The report also identifies risks that are evolving relative to managed actions. The RISC reviewed and assembled information from stakeholder input and various committee reports along with focused executive leadership interviews to develop a composite set of risk profiles and a graphic depiction of the key risks. The depiction is based on the likelihood of occurrence and expected impact on reliability, and it provides an indication of the evolution of the net reliability risks. The RISC also worked with NERC to host a Reliability Leadership Summit and conducted a number of focused interviews with key industry leaders to ensure that the perspectives and conclusions were comprehensive. This report includes qualitative analysis of the collection of industry expert opinions on risks and impact.

The RISC further emphasizes that there are important linkages between the risk priorities, findings, and observations identified in this report with the recommendations identified for NERC and industry action. Further, the RISC acknowledges the increasing adoption of these report observations for consideration by the NERC Board as input for the ERO's multiyear Strategic Plan and its Business Plan and Budget to align actions and resources with important metrics. The RISC participants include representatives from the technical and standards standing committees, which have been adopting specific interlinked observations, findings, and guidance presented in Chapter 1 of this report, and in further detail in the Supplemental Technical Report. These activities support the ERO's activities, as well as incorporating actions from NATF, NAGF, EPRI, and other industry groups.

Chapter 1 – Observations, Findings, and Guidance

The production, transmission, and use of electric energy by consumers are undergoing increasing and dramatic changes. The centralized dispatch of large synchronous generation and then transmitting that power to meet customer need is moving towards a more distributed model with a changing resource mix, inclusive of customers electing to self-generate some of their needs, and represents fundamental change. The potential impact from changes must be considered to ensure a reliable and resilient BPS. The RISC has identified and prioritized potential risks and made recommendations to maintain a reliable and resilient BPS.

The RISC undertook a comprehensive review of existing and evolving reliability risks, respective priorities, and evolving character of industry dynamics. It also gathered wide and diverse input from industry leaders, associated stakeholder groups, and the regulatory arena. The RISC explicitly conducted a Reliability Leadership Summit (August, 2015) and a wide-ranging series of focused executive interviews to provide further confidence that key existing and evolving risks to the BPS reliability have been identified and captured with no significant issues overlooked. This approach is essential in formulating a sound foundation for providing reliability risk advice to the Board for consideration in development of its Strategic Plan and Business Plan and budget. After a thorough review of these key inputs, the RISC offers the following observations, findings, and guidance for the NERC and industry to consider when addressing the most pressing risks to system reliability:

Strategic Perspectives

From an overall strategic perspective, the RISC determined some high-level observations that can guide the prioritization efforts for NERC, industry, and regulators. The first are current risks identifiable and measurable through the ERO's existing processes and procedures. These are a range of reliability risks that are reasonably well defined and understood, with a corresponding wide range of NERC and industry efforts in place to largely address reliability risks. These established and understood risks are recognized areas wherein continuous improvement efforts would serve to enhance reliability and lessen the oversight compliance burden. The second group of risks are evolving and accelerating due, in part, to regulation and shifting economics, and can result from the integration of new technology. These reliability risks are emerging; in many cases the reliability ramifications are beginning to be better understood, but a great deal of work remains. These areas are arising from the fundamental shifts in the resource mix and geographic dispersion, changing fuel concentrations, and expansion of distributed energy resources. This is coupled with ensuring essential reliability parameters are provided to sustain BPS reliability. The risks can be addressed by formulating predictive models, enhanced reliability guidance, and setting appropriate expectations for integrating and utilizing the grid. Finally, the third group of risks represents a large potential impact on reliability from extreme events and intentional acts such as cyber and physical attacks, GMD, EMP, and severe or extreme weather. These reliability risks are increasingly recognized with potentially serious reliability impacts arising from low-likelihood incidents in which there is little BPS experience in mitigating reliability risks, enhancing resilience, providing efficient recovery, or determining prudent measures to lessen impacts. Overall, this suggests enhancing predictive efforts to broadly enhance a widely-viewed perspective of situational awareness, working directly as the ERO as well as with vendors, forums, industry, and regulators to find appropriate strategies.

The RISC developed the overall findings, observations, and guidance reflecting the priorities and extent of the various risks as well as mitigation or risk control efforts. These are intended to serve as a roadmap to guide the ERO and industry as they undertake the range of risk control tools to better manage higher focus areas, representing risk areas with the greatest likelihood and most serious potential impact. This report is further intended to serve as a source of input on reliability risks and priorities during the development of the ERO Strategic Plan and the subsequent Business Plan and Budget for the 2016-2019 period. As a result, The RISC considered the range of risk focus areas, the risk profiles, and wide-ranging input to formulate the following top strategic priorities as inputs for the ERO.

1. Expand technical reliability guidance and outreach to lessen regulatory uncertainty
2. Improve reliability assessments to reflect changing resources and composite loads reliability behaviors
3. Address the changing resource adequacy impacts and regulatory aspects
4. Formulate an effective approach for resiliency
5. Expand range of efforts to address cyber vulnerabilities

By providing a concentrated reflection of these top priority focus areas within the ERO Strategic Plan and the associated Business Plan and Budget, significant progress can be realized by enhancing BPS reliability. The subsequent observations, findings, and guidance provide much greater granularity of identified risk areas and priorities for ERO and industry collaborative efforts, focus, and attention to support overall BPS reliability.

Observations/Findings

1. Virtually all of the observations here reflect reliability impacts associated with a changing resource mix, the provision of ERSs, and changing load characteristics and visibility/line of sight, presenting tremendous challenges to the traditional means of developing planning, resource, and load models.
2. The convergence of technology along with consumers' desire for options, alternatives, choices, and control is fundamentally changing how the BPS will be planned, operated, and used going forward.
3. Society continues to demand increased "greening" of the electric power industry, yet there is an increasing expectation for reliable provision of electricity.
4. Evolving regulatory and public policies will accelerate the pace of change of the resource mix and places an enormous pressure on the industry's ability to effectively plan and operate a reliable and affordable power system during a potentially extended transition period.
5. Technology advances continue to increase the penetration of distributed energy resources.
6. Distributed energy resources are expected to be more variable, intermittent, less dispatchable, and geographically dispersed; all of which presents additional challenges regarding planning and operations to sustain a high level of overall BPS reliability.
7. Increasingly, more distribution-centric resources are being interconnected into the bulk power system, reducing system operator awareness and control of resources needed to maintain reliability.
8. In the near term, natural gas will continue to be the fuel of choice, and the pace of switching over to natural gas will increase due to economics and environmental regulations
9. The reliability of the electric sector is increasingly dependent on other sectors such as natural gas and telecommunications, introducing potential common mode constraints and related reliability risks.
10. Cyber and physical threats to electric industry infrastructure will only increase in frequency and potential impact, especially as the extent and sophistication of these threats escalates.
11. Markets will influence the changing nature of the reliability behavior of the power system as well as the full complement of services required for a reliable BPS.

Guidance

1. Continue to focus assessment and analytic efforts on enhanced integration of interdependent natural gas and electric sector business models. These assessments should also include electric industry companies to understand barriers to sustained reliability as the resource mix continues to shift, introducing a different range of reliability risk considerations.

a. Develop a forward planning approach with the natural gas industries to adopt effective cross-sector reliability risk analyses as well with other key sectors critical to fuel delivery.

b. Identify market and other mechanisms needed to maintain long-term reliability (e.g., adequate resource capacity, adequate gas pipeline capacity to support future generation, and resource diversity) and to determine the adequate value of base resources (e.g., nuclear) to support long term reliability.

c. Expand NERC's assessment and outreach efforts to provide insights and recommendations and thereby form a foundation for ensuring accountability for reliability and resource adequacy, in part by engaging with industry, RTO/ISO, and state regulatory entities.

d. Expand resource adequacy evaluation mechanisms to incorporate greater consideration of probabilistic reliability characteristics, variability of resources, fuel delivery, energy aspects, resource/load models, and ERSs.

2. Expand long-term reliability and special assessment efforts to include the ERSs needed to maintain reliability, to reflect within the assessment criteria the reliability characteristics of resources and loads, and to bolster the credible and timely perspectives about BPS performance.

   a. Ensure that critical long term reliability assessments and special assessment focus areas include comprehensive reserve margins, probabilistic analysis (performance, variability, and uncertainty), expanded short term reliability assessments, external electric sector upstream/downstream analyses, and the level of ERSs.

   b. Encourage detailed performance of regional pipeline studies to assess electric system vulnerabilities to a common-mode failure of a natural gas supply pipeline.

   c. Continue reliability assessments of the Environmental Protection Agency (EPA) proposed rule 111(d) Clean Power Plan on resource generation, transmission adequacy, and reliability. This should also include support for a reliability assurance mechanism, and occur during implementation plan development.

   d. Expand the assessment of the increased reliance on distributed resources, demand response and reliability behavior changes in load composition and dynamic behavior to determine the effect on the BPS performance.

3. Formulate a comprehensive assessment strategy to analyze area or regional reliability behavior with regard to ERSs and provide relevant recommendations. This work represents a continuation of the ERS plan with milestones, with increasingly specific focus on the impacts and visibility of variable energy resources (VERs), energy-dominated resource composition, distributed generation resources, demand response, and demand-side resources.

4. Formulate an effective plan to implement the results of comprehensive Electricity Subsector Coordinating Council (ESCC) strategy recommendations of the ES-ISAC functions, including expansion of the CRISP implementation. Continue to expand initial efforts to develop measures depicting the security posture of the industry and the effectiveness of relevant Reliability Standards. Continue the maturation of the E-ISAC and facilitate deployment of CRISP technology to enhance security awareness and responsive 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. Continue to expand the effectiveness of risk mitigation efforts linked to the priorities and pacing presented within this report, with a design to enhance reliability and minimize identified risks while focusing on those areas with the greatest priority, devoting less attention to known effectively managed risks. Those priorities would reflect continued efforts to enhance reliability and lessen the compliance

burden for recognized risks, focus on directionally defining emerging changes to begin setting expectations and benchmarks, and better define approaches to predict or reduce impact of low-likelihood but potentially severe disruption risks.

6. Increase focus on system model accuracy and fidelity for interconnections through effective development and validation efforts that also incorporate meaningful feedback mechanisms that reflect actual system reliability behavior. Develop recommendations to ensure generation and transmission resource and planning data consistency and sharing for long-term, robust regional operational planning and real-time situational awareness that includes operator and planning tool development, technical conferences, and standard requirements.
7. Continue to leverage NATF, NAGF, EPRI, and other industry-based best-practice-sharing forums, where substantive and timely contributions can be delivered to ensure resilience through a prioritized approach. Further, leverage the expertise in these forums to analyze and make recommendations on highly technical potential risks to reliability (i.e., GMD and EMP).

Summary

The effort to distill and extract the key insights regarding important reliability risks, relevant priorities, and appropriate pacing obtained through the Reliability Leadership Summit and focused interviews have ratified and validated the scale, scope, and pace of reliability risk understanding across the ERO. Attention on the strategic focus areas and the high-priority evolving risk aspects 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. In this report, a group of existing risks have been identified that are well-understood and are being effectively managed through ongoing risk control measures that support consideration of maintaining or lessening the level of effort consistent with managed risks. This is particularly relevant considering the continued adoption of risk informed compliance monitoring and enforcement program deployment.

The RISC appreciates the NERC Board's support for the opportunity to provide these findings, observations, and guidance. The objective is to reflect corresponding detailed entity actions in the risk profiles in the supplemental technical report and to provide templates for the respective technical committee action plans. Finally, this report provides an overall linkage with the Strategic Plan elements, the Business Plan and Budget, and the risk-relevant ERO metrics.

Chapter 2 – Evolving Reliability Risks and Priorities

In order for the RISC to assess and prioritize the evolving reliability risks, it periodically undertakes a review of the status of existing risks. This activity is intended to take place every two to four years and build on the comprehensive initial assessment of ongoing efforts and corresponding recommendations to the Board made in February 2013, which were subsequently updated and refined in August 2014.[1] In the 2014 recommendations, the RISC identified high-priority areas and medium-priority areas.

The Board adopted the following resolutions based on the initial 2013 recommendations:

> *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).*

The RISC developed a list of ERO priorities[2] that was presented to the Board in August 2013, provided a gap analysis of the high and medium-priority risks and issues, delivered a proposed process for incorporating the RISC input into overall ERO planning activities, and discussed a method to enhance alignment and coordination with the technical committees. The recommended actions and refinements have been partially integrated within multiyear work plans developed by the Technical Committees and otherwise managed by NERC staff. These elements, consistent with the Board resolution, were further refined and implemented in 2014 to enhance the integration of risks and priorities into the ERO Strategic Plan and Business Plan and Budget development efforts. This report reflects further refinements regarding the integration between the risks identified by the RISC, priorities, and recommendations, as well as the timing of the material results in order to provide more integrated input into these ERO processes.

This report and recommendations reflect discussions with representatives from technical and standards committees, industry dialogue at the Reliability Leadership Summit, a series of focused executive leadership interviews, and comprehensive reports and assessments. In particular, these reports include the *Long-Term Reliability Assessment,*[3] the *State of Reliability,*[4] the *Winter and Summer Assessment,*[5] *and the Framework Report of the ERSs and the Phase I Reliability Review of the Clean Power Plan.* The RISC and NERC staff also facilitated the annual Reliability Leadership Summit on August 25, 2015, in Washington, DC, to obtain input from industry executive leaders on evolving reliability risks.[6] These results are intended for presentation to the ERO executive management group in September 2015 for integration in the development of the 2016–2019 ERO Enterprise Strategic Plan. The final report will be presented to the Board in November 2015.

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

The RISC efforts focused on further refinement of the risk profiles and alignment with standing committee work efforts, while acknowledging the enhanced integration of recommendations in the ERO strategic planning efforts. The baseline of ERO reliability risk profiles were updated and are provided in the supplemental report. These enhanced risk profiles are intended to provide an overall compendium of reliability risks. These risk profiles include an update on the evolving status, mitigation and management efforts, and a general update on progress and the effectiveness of mitigation measures underway. They are presented in composite groupings that further refine the groupings of reliability risks, supported by a diagrammatic representation of the general areas of interdependence. These risk profiles describe reliability risks, a summary of the risks, and the potential impact of the risks. The list of risk management activities have also been refreshed for those completed and currently being employed to manage the risk. Where appropriate, an indication is provided for the primary entities undertaking these activities, including NERC, industry participants, governmental agencies, forums, or other responsible groups. These also provide further recommended activities that could be employed to further manage the risk, as well as overall measures of success that can be used to determine their basic effectiveness.

The ERO Enterprise and industry can then use the composite risk profiles and the risk map as a baseline evaluation of reliability risks for periodic re-evaluation of the respective reliability risks. The RISC can also direct its efforts toward identifying key focus areas, evolving BPS reliability risks, and strategic recommendations to NERC staff and the Board.

The primary objective of this report, as noted above, is to focus on identifying evolving or highlighting existing reliability risks, including those which merit a continued level of attention, and determine recommendations aligned with the multidimensional aspects of the risk. Accordingly, risks that are well understood and have effective measures in place for risk mitigation are noted in the supplemental report.

The RISC also evaluated risk trajectories surrounding the pace of an evolving or emerging risk as well as a view of the extent and effectiveness of the respective measures and overall efforts in addressing the risks. In this manner, the level of effort and mechanisms for lessening the risk or improving reliability can be enhanced and calibrated, gauging the effectiveness of the current risk control and management efforts. Overall, risk trajectory assessment supports well-established risk priorities and emphasizes both 1) the greatest and near-term risks, with the greatest upward trend in risk, and 2) risks that warrant expanded efforts. Further, this has enabled the determination of risk areas where currently known attributes and effective measures underway can represent areas where the focus and extent of management efforts can be considered lessened.

Figure 1 provides an illustrated view of the six enhanced groupings of risk profiles. The x-axis represents the likelihood of an event or condition impacting the overall BPS, and the y-axis represents the expected consequence on the BPS. Each risk placement is based on the RISC assessment perspective, which includes the 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. Generally, risks occupying the upper right quadrant represent risks warranting continued action to address and mitigate the reliability impacts. Where appropriate, a bold arrow represents the risk trend, defined as the projected change in risk based on known or expected external pressures.

The RISC chose to consider each risk by evaluating two factors: likelihood of occurrence and expected impact on the BPS if the risk were to occur. The information presented on Figure 1 is an illustrative, qualitative way to present both the relative likelihood and the potential impact of each risk area in a heat map configuration.

Legend Guide to Figure 1

As a guide to understanding the contents of the information, the solid numbered circles **[Current View of Risk]** are intended to denote the present view of the risk position for each risk area, mapped against likelihood and impact scales. The open numbered circles **[Mitigated Risk – After Recommended Actions]** are intended to convey the expected position of the risk as the various risk mitigation efforts by the ERO and industry are completed, with the shaded connection linking the two. The trend **[Overall Risk Trend]** of each risk area is reflected by a directional arrow indicating the evolving nature of most of the risk areas, and risks that are viewed as stable **[Stable Risk Trend]** are indicated by an asterisk. Overall, the objective is to convey both current and mitigated state of the risk with an indication of the direction and pace of the risk's evolution.

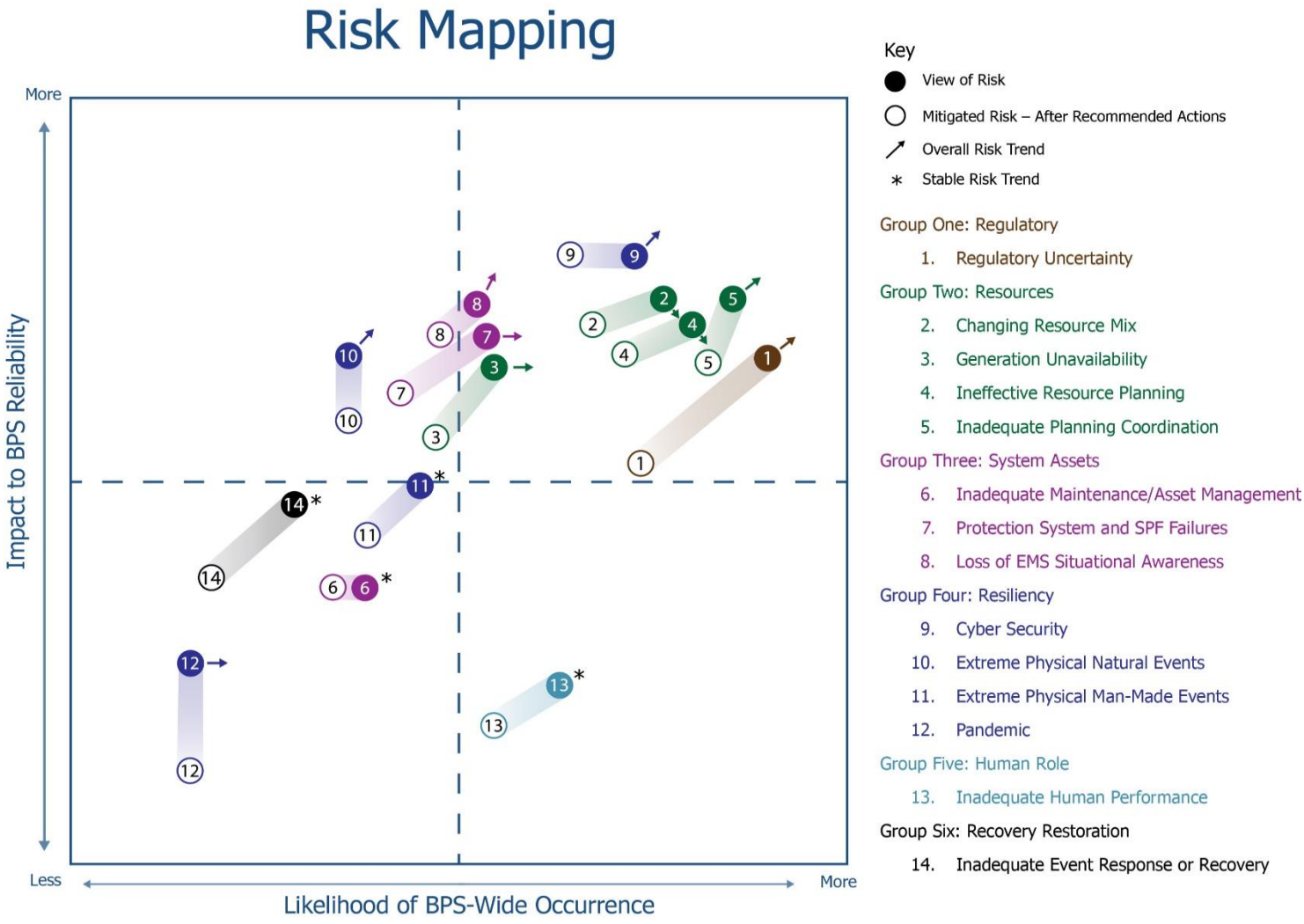

Figure 1: Risk Map of ERO Risk Profiles

Table 1 provides a perspective of individual risk's likelihood of occurrence and potential impact on the BPS. 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 Supplemental Technical Summary. Finally, the risk trend is the projected change in risk based on known or expected external pressures. The information in Table 1 aligns with the illustration provided in Figure 1.

Table 1: Grid Mapping/Placement of Risk Profile

Group #	Risk Area	Likelihood of Occurrence (BPS Wide)		Impact to BPS Reliability		Risk Trend
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	
1	**Regulatory Uncertainty: Markets, States, and Federal**	High; impact of EPA regulations, including 111(d), is not certain; resource mix and adequacy increasingly challenged	Stable or slight increase due to extent and pace of changes and uncertainty within regulatory domain as changes increasingly affect operational and planning aspects	High, recognizing that proposed EPA rules accentuate resource retirements/shifts, expansion of energy-resources and distributed generation, while there is potential for competing regulatory objectives	Stable or increasing with wide recognition of challenges	Increasing
	Resources	High	Stable or slight increase	High	Generally stable	
2	**A.** Changing Resource Mix	High; increasing expansion of new types of resources, such as variable generation and volume/geography of resource change, coupled with expansion of distributed resource concentrations	Slight decrease or stable; still have unknown reliability operating behavior of ERSs	High; widespread expansion in types and scope of resources, with local/regional concentrations	Slight decrease or stable; unknown reliability characteristics and operating conditions	Ongoing shifts from synchronous to asynchronous forms of generation and expansion of transmission facilities point to increased likelihood of occurrence with lower impact to reliability
	B: Inadequate Planning Coordination	High due to complexity of changing resources mix, emerging distributed resources, new technologies, expanded sector recognition, and overall changing reliability behavior	Stable or slight increase, improved ability to coordinate plans across market to nonmarket seams, offset by expanding resource mix	High	Stable or slight increase; reliability behavior requires development of new models and planning studies, as well as operational processes	Multiple variables – dependency/ availability of natural gas and accelerating resource and load-side changes complicating reliability behavior point to increasing trend

Table 1: Grid Mapping/Placement of Risk Profile

Group #	Risk Area	Likelihood of Occurrence (BPS Wide)		Impact to BPS Reliability		Risk Trend
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	
	C: Ineffective Resource Planning	High	Slight increase, moderated by some improved ability to plan across seams, offset by changing resource reliability behavior	High	Slight decrease; impact remains high	Moderate increase in likelihood of occurrence with lower impact to reliability , recognizing long lead times required for assets, and uncertain regulatory environment to address resource adequacy
	D: Generator Unavailability	A moderate-to-high likelihood is projected due to the combination of more frequent extreme weather events, fuel availability, and risk concentration	A decrease is anticipated with improved coordination, impact studies, and winter preparedness recommendations	High due to interconnection-wide potential of forced outages, deratings, and failures to start	Decrease with implementation of recommendations	Multiple variables – dependency/ availability of nature gas and unknown impacts of EPA 111(d) point to increased likely occurrence
	System Assets	Moderate	Stable or decreasing	Moderate	Stable or decreasing	
3	A. Inadequate Maintenance /Asset Management	Low	Decrease due to focus on supply chain, sparing, resilience, and recovery measures	Low	Stable	Stable
	B: Protection System and Single Points of Failure	Moderate; numerous components and settings, coordination, and increasing complexity	Stable or slightly declining; look to overall state of reliability–not singular, high-profile events	Moderate; numerous components and settings, coordination, and complexity, offset by protection system design and resilience measures	Stable moderate; various system protection initiatives and standards development efforts underway	Stable
	C: Loss of EMS-Situational Awareness	Moderate; factors include the frequency of outages and related effects on operational visibility, expanding operational tool complexity, and human performance	Decrease; guidelines and preparedness improve awareness but cannot mitigate full/partial energy management system (EMS) outages	Moderate; a full EMS outage or prolonged restoration can have widespread implications, offset by resilience measures, communications, coordination	Decrease but impact remains high	The inherent complexity of maintaining or upgrading decision support tools and the growing complexity of resources increases pressure to likelihood and impact to reliability

Table 1: Grid Mapping/Placement of Risk Profile

Group #	Risk Area	Likelihood of Occurrence (BPS Wide)		Impact to BPS Reliability		Risk Trend
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	
4	**Resiliency**	High: increasing expectations about resiliency as reliability	Stable; formation of responsive standards in cyber and physical, increased recognition of expectations	High; expansion of digital and network devices, greater BPS electric sector criticality, continuously evolving sophisticated threats	Stable as recognition and implementation of flexible mitigation	Complex digital and network expansion, evolving sophisticated threats trend increasing
	A: Cyber Attack	High; CIP v3 standards are in place and v5 are in process of implementation; increasing recognition of evolving impacts, and need for active mitigation through E-ISAC, CRISP, and ESCC	Slight increase or stable; improved coordination among entities; high level of awareness	High; need to accentuate effectiveness gauge of CIP standards performance while expanding means to address evolving security risks	Additional recommendations reduce likelihood and enhance resilience, but there is a potential for wide impact	Constantly evolving security threats increase the risk trend
	B: Extreme Physical Natural Events	Low likelihood of interconnection-wide event, but a larger likelihood of regional or area incidents	Potential mitigation through hardening techniques, enhancing resilience, recovery, and restoration, although likelihood of occurrence constant	Moderate; interconnection-wide event could cause extensive damage; regional or area impacts could have high impact volume	Hardening, expanding node resilience, operational recovery/preparation/ restoration enhancements through mutual assistance, staging, sparing, etc. to decrease impact	Potentially increasing through extreme weather effects
	C: Extreme Physical Man-Made Events	Low likelihood of interconnection-wide event; coordinated incidents potentially increase regional or area likelihood	Slight decrease due to improved communication and awareness as well as implementation of physical security standards	Moderate due to potential impact of interconnection-wide event	Stable or decreasing due to increased attention on developing hardening strategies for BPS facilities, expanding resources, and asset sharing	Stable, yet fluctuating due to evolving man-made or terrorist-based threats
	D: Pandemic	Low	Stable likelihood of occurrence, although there are varied elements of incidence	Current mitigation activities have moved this from high impact to moderate or low	Decrease with recognized range of adaptation strategies, enhanced coordination with CDC, and continuing monitoring efforts	Potential likelihood increase due to globalization, travel, evolving nature of incidence

Table 1: Grid Mapping/Placement of Risk Profile						
Group #	Risk Area	Likelihood of Occurrence (BPS Wide)		Impact to BPS Reliability		Risk Trend
		Current Risk	Mitigated Risk	Current Risk	Mitigated Risk	
5	**Human Role** Inadequate Human Performance	Moderate; unique event characteristics, regional or area impacts	Decrease due to improved coordination, partially offset by expanding resilience expectations	Low; existing coordination processes are solid, response and recovery generally effective	Decrease due to improved resilience measures	Stable
6	**Recovery - Restoration** Inadequate Event Response or Recovery	Low; unique event characteristics, regional or area impacts	Decrease due to improved coordination, partially offset by expanding resilience expectations	Low; existing coordination processes are solid, response and recovery generally effective	Decrease due to improved resilience measures	Stable

Chapter 3 — Discussion of Evolving Reliability Risks and Perspectives

The RISC evaluated a wide range of reliability risk information captured in the detailed ERO risk profiles in the supplemental report, resulting in six key reliability risk themes as well as the identified priority of each. These themes were reinforced by electric industry leaders as well as top state and federal officials during the 2015 FERC Technical Conference, focused industry leader interviews, and the Reliability Leadership Summit held in Washington, DC, on August 25, 2015.

Evolving Reliability Risk Considerations

The RISC established a series of six key reliability risk themes in terms of likelihood of incidence, the impact to BPS reliability, and trend characteristics of the risk. These groupings emerged from a comprehensive review of relevant assessment materials, various NERC reports, and perspectives from industry leadership on standing technical committees as well as focused conferences and interviews of executive leaders across industry. These provide a robust foundation for reaching the conclusion and observations reflected within this report.

The RISC's assessment is that certain key aspects impacting reliability have changed considerably over the last three years. New types of resources have been integrated, conventional synchronous resources are being retired, load reliability behavior is changing, and overall reliability behavior of the BPS has become more interdependent and increasingly diverse. Previously, it was sufficient to evaluate capacity adequacy on peak using capacity reserve margins to provide reliability assurance of adequate resources and operational bandwidth under any alternate system conditions. These assessments depended on the inherent capability of large synchronous generation resources to support voltage and frequency; however, integrating diverse types of resources on both the BPS and within the distribution system has resulted in increasingly large energy-dominated regions. This realization has led to increasing awareness that it will not be sufficient to simply depend on capacity reserve margins, thermal limits, voltage profiles, frequency response, and stable power flows to ensure a reliable BPS.

The mix of resources is transitioning to increased reliance on renewable resources, connected both to the BPS and spread within distribution or customer installations. In addition, there is an increase in the integration of energy dominant resources and demand response implementations. Therefore, the BPS is increasingly dependent on a complex interplay of these resources, coupled with a continued phase-out of conventional synchronous fossil and, in some cases, nuclear resources. This is further compounded by increasing use of natural gas resources to fuel a larger component of the bulk supply, raising common-mode dependency aspects from concentrating a significant amount of supply to a single fuel source.

As expectations among customers, the public, government, and regulators continues to expand in the face of extreme or low-likelihood incidents, the demand for increasing resilience is beginning to replace the conventional notions of bulk power reliability. Expanding reliability considerations includes many resilience aspects under preliminary development through adoption of risk-informed approaches, development of ERSs, integration of risk frameworks for resilience assessments, and probabilistic analytic approaches being expanded. However, these approaches do not completely address the full range of changes occurring within and affecting the BPS, the overall reliability behavior, or the appropriate level of response for extreme or rare incidents.

The RISC recognizes that, among the key objectives of the group, it is important to more effectively identify trends and evolving issues that have the potential to create risks to reliability so that proactive measures based on sound technical foundations can be developed. As the character and reliability behavior of the BPS during transition are better formulated, then the emerging trends point to a proactive approach to use the full range of the reliability or resilience toolkit resources to guide industry, regulators, policy makers, and the ERO in effectively managing these risks. The industry must improve the forward assessment of reliability and resilience parameters,

anticipating macro and regional changes. Further, risk management feedback loops and risk control measures should be effectively adopted to enable entities (i.e., industry, regulators, legislators, and the ERO) to formulate effective reliability plans during such transitions. By developing coordinated and collaborative approaches with these partners and recognizing the varied other factors relevant to each of these groups, a common reliability risk set of approaches can be implemented effectively to avoid disruptions to the BPS. The ERO recognizes that most of the preparation, work, and review of activities to improve restoration and recovery are in the purview of the various state commissions. Accordingly, NERC will continue to identify potential risks and seek out potential mitigations.

RISC Themes: Groupings of Evolving Risks

With these considerations in mind, the RISC concluded with three ranges (i.e., high, moderate, and low) of evolving risks and six groupings of reliability risks that provide a framework for extending their previous work to the entire range of risks. These represent, in most cases, refinements of the reliability risks presented in the 2014 Risk Priorities Report, as well as reconsideration of the interdependencies among the identified risks.

In this summary, the ranges are delineated as high, moderate, and low. **High Evolving Risks** denote continuously evolving reliability risks, with high likelihood and anticipated large potential impacts to the BPS. These warrant the greatest level of focus and attention for risk control and mitigation efforts to lessen the risks, decrease the likelihood, and improve overall reliability. **Moderate Evolving Risks** signify that, while there are some aspects of evolving risk, the expectation of likelihood and potential impacts to the BPS are more managed through existing measures and efforts. These represent areas for continued monitoring and attention to ensure that existing measures are effective in reducing risks and improving reliability. Risks in the **Low Evolving Risks** category are considered to be risks that are well recognized and understood, have limited potential impact or moderate likelihood of occurring, and have broad measures and reliability tools in place to manage the risk, mitigate the consequences, and improve reliability. These represent areas where the reliability risks are viewed as being under control and under comprehensive management. Still, continued implementation of risk control efforts and monitoring of their effectiveness would be warranted.

High Evolving Risks:

Regulatory Uncertainty: Markets, States, and Federal

1. These evolving risks arise in areas where regulatory initiatives are uncertain as to the extent, timing, and impact. These aspects are compounded by uncertainty in the interplay among these three arenas, each of which comprise policy, regulatory, and legislative initiatives. These aspects are accentuated to the extent these are insufficiently coordinated among these arenas and inadequately consider reliability perspectives.

Resources:

1. High – Changing Resource Mix
2. High – Uncoordinated Planning
3. High – Ineffective Resource Planning
4. Moderate – Generation Unavailability

Resiliency

1. High – Cyber Security
2. Moderate – Extreme Physical Natural Events
3. Moderate – Extreme Physical Man-Made Events

4. Low – Pandemic

Moderate Evolving Risks:

Inadequate Human Performance

1. Moderate -- This range of risks is associated with human performance in conduct of reliability functions, notably those associated with system operations and sustaining situational awareness. While the resource mix continues evolving, expectations for performance increase, and the range of information presented is increasingly complex, reflecting the wide range of resources, reliability behavior, and variability.

Low Evolving Risks:

Inadequate Maintenance/Asset Management

1. Moderate – Protection System Failures
2. Moderate – Loss of Situational Awareness

Inadequate event response or recovery

Pulse Point Interviews

In order to expand the consideration of potential reliability risks from a strategic perspective, the RISC conducted an open-ended range of one-on-one interviews with key industry executives and leaders to gain their perspectives. The goal was to focus on key reliability risks from different vantage points among regulators and utilities and to ensure that key areas of reliability concern and relevant priorities were adequately identified for consideration by the RISC. In large measure, the overall reliability risk and priorities sentiment of these leaders reinforced themes from the 2014 RISC Report and risk profiles. There were a series of notable aspects of identified focus and reliability concerns that emerged from the industry leaders interviewed in 2015, noting that some suggested there should be greater focus on addressing these risks by translating into proactive concrete steps rather than continuing to "admire the problem." A summary of these aspects are described here.

Planning/Resource Adequacy

The shifting nature of the BPS has greatly expanded the complexity of reliability behavior and planning as the resource mix evolves to asynchronous and energy-only forms. The traditional calculation of reserve margins may not account for variability of certain renewable resources and the loss of ERSs or other asynchronous inputs such as solar rooftop installation that equals as much as 3,000 MW of distributed generation in certain areas. The increase in renewables/variable generation, impending regulations, and the associated investment costs will all greatly impact how utilities plan to support reliability and provide adequate resources in the future. Further, the increasing dependence on gas and the addition of micro-grids adds a layer of complexity with regard to visibility and controllability of resources. The rapidly evolving resource mix, particularly in significant changes in different regions across North America and regions in which significant resource shifts have been accommodated, point to the need to carefully anticipate resource changes, the potential loss of ERSs, and the need to measure impacts in the ERO's reliability assessments. Focus should be on ensuring greatly enhanced models and tools to understand these reliability characteristics. There should be focus on beginning to address the reserve margin questions with the regulatory perspective to ensure long-term reliability. Overall, the BPS elements are increasingly complex, with changing technology/behavior, and the impact of asynchronous generator behavior and distributed generation should be noted.

Cyber Security and Physical Security

The cost of preventing security breaches is very expensive, and the quickly changing nature of the threats/intrusions does not allow for organizations to adopt a simple cost/benefit analysis for evaluating potential solutions. If possible, it would be greatly beneficial to share and leverage the best practices of peer groups to

address cyber security threats. Executives also discussed potential solutions, such as conversion to a closed intranet as a possible solution to cyber threats to EMSs. With regard to physical security, it was discussed that over generation and the isolation of the EMS from the rest of the system may be proactive approaches worth adopting. In terms of providing overall oversight and assurances of security, the ERO should recognize that measures should go beyond reliability rules may be required. From a physical security perspective, the best strategic approach may be to consider ways to desensitize the network to coordinated forms of attack.

Regulatory and Market Concerns

The industry should ensure the right policies are in place to address reliability expectations given events like the polar vortex and Hurricane Sandy. Further, market rules may introduce barriers to long-term reliability assurance and represent reliability management challenges in vertically integrated states. Market rules may also exacerbate resource constraints in certain areas, which can in part be addressed by developing stress testing approaches. Some experts suggested that, as understanding of ERSs mature, total costs to consumers/utilities should be reflected in the markets. If the gas industry does not adopt any changes for reliability, the electric market organizations should evaluate what steps are necessary to ensure reliable operations. Among the many government entities/regulators (e.g., Congress, FERC, NERC, the administration, states, etc.), clear accountability for different aspects of reliability should be established, in particular assuring resource adequacy. Industry expressed a desire that NERC and the REs advocate for reliability with regulators and address reliability aspects from market issues. Finally, the uncertainty created by pending and adopted environmental policy provisions has the unintended effect of stalling infrastructure decisions, resulting in short-term approaches that further concentrate or create reliability risks.

Interdependencies

The evolving resource mix has introduced an increasing dependency and fuel source constraint, especially with natural gas, which highlights the risks of electric generation concentrating supply sources. While these risks have been addressed previously in NERC assessments, greater effort is needed to understand and assure acceptable levels of reliability risk. Further interdependencies emerge when considering extreme events and conditions that reveal linkages with communications, networks, and transportation facilities.

Recommendations

The industry leaders also made several recommendations for NERC. These recommendations include developing a stress test for the BPS. This would help identify critical scenarios or areas of opportunity to enhance reliability. Stress testing should also focus on testing and improving contingency plans and understanding which entities are modeling evolving risks. Also, in order to prevent the loss of inverter based asynchronous generation, some thought that a manufacturing design standard could be created and integrated within smart inverter designs.

Further, some believed that, in addition to considering whether N-1 planning is adequate, communication networks and communication with gas pipelines should be explored in order to improve resiliency. When evaluating ERSs, the industry should evaluate whether utilities have the right tools to sufficiently model current activity on the system.

FERC Technical Conference

The FERC Technical Conference was conducted on June 4, 2015 in Washington, DC, and focused on three key areas: 1) the overall state of reliability as highlighted by the NERC issued report, 2) emerging reliability issues, and 3) ERO performance and initiatives. The first session focused on the overall effectiveness of the ERO's and industry's reliability activities, in particular the progress with respect to previous recommendations, potential obstacles, or added resources needed to support particular risk areas. The discussion focused on protection misoperations, ac substation equipment failures, improvements in non-weather-related load loss events, and planning and operation analysis requirements needed over the next five years.

The second session addressed emerging reliability issues and considerations for various assessment studies for the ERO and industry. The discussion focused on the development of the ERS approach for reliability building blocks needed for reliability as the resource mix changes. The discussion also dealt with actions and recommendations needed to address declining reserve margins in certain areas, specific considerations for lessening the potential impact from the increasing gas-electric interdependencies, and practical approaches to continue to ensure reliability during finalization and implementation of the EPA Clean Power Plan rule.

The final session focused on ERO performance and initiatives, in particular the risk-based Compliance Monitoring and Enforcement Program and linkages with improvements to reliability performance, reduced risks, and increased compliance efficiencies. The session also accounted for the effectiveness of ESCC and ES-ISAC in enhancing security. Finally, the panel considered progress on addressing GMDs and the implementation of CIP version 5 and the physical security standard. A consistent theme was that these issues were being identified as key areas of focus and ERO/industry attention, and the results of the technical conference would support the considerations needed to determine appropriate actions and priorities. In addition, the enhanced ways to collaborate in developing proactive approaches to address reliability risks and enhance reliability of the BPS were examined. Solid oversight of the effectiveness of the various efforts, not only in realizing the respective goals but also in achieving actual measurable reliability beneficial results, must be demonstrated.

Reliability Leadership Summit

The 2015 Reliability Leadership Summit was focused on four panel sessions designed to address key reliability areas and identify efforts to prioritize risks while determining scaled approaches to enhance reliability and lessen the potential risks. The panel sessions addressed the following areas:

- **Panel 1 – The Changing Nature of Reliability**

  Along with the current set of reliability responsibilities, more and more emphasis is being placed on the resilience of an organization to respond to extreme events. Due to the changing nature of reliability and the increased focus to both expanded expectations and resiliency to extreme events, resiliency is becoming the new yardstick to measure reliability.

- **Panel 2 – The Changing Nature of the Grid**

  Planning for and operating to the changing resource mix confronting the industry involves using different strategies for modeling, integration of large amounts of relative new technologies, and implementing new tools and practices. With the addition of distributed generation, demand response, and microgrids, the basic grid paradigm is shifting. As this transition occurs, the grid's ERSs are impacted. As the trusted leader for reliability, what is NERC's role to ensure continued reliable operation of the BPS? To assure resource adequacy and operational reliability, addressing this transition is essential.

- **Panel 3 – Cyber and Physical Security**

  NERC has seen a significant amount of its resources dedicated to security topics in recent years. On the physical side, NERC and industry are just beginning. On the cyber side, the enormity and speed of change requires continued and elevated NERC engagement to assure reliability. The public/private sector relationships in the US and Canada continue to grow. What are NERC's future needs as we facilitate this evolution with the ES-ISAC, CRISP, and the ESCC?

- **Panel 4 – Leadership Round Table**

  In this open-format discussion, industry leaders will share thoughts and ideas on the priority and significance of reliability risks. This panel is focused on distilling the observations and themes discussed

in the earlier panels, as well as other identifying potential blind spots and outlining strategic considerations for NERC and the Board to address key and emerging reliability risks.

On August 25, 2015, over a hundred executives from the industry came together for NERC and RISC's annual Reliability Leadership Summit. The overarching message from the summit was a reliable interconnected BPS is critical to support innovation and integration of new technologies into the grid. These technologies include integration of large amounts of variable resources, increased use of gas-fired generation, high-voltage and distribution technologies, and end-use applications (such as plug-in vehicles and distributed energy resources). Additionally, the grid will face a host of cross-jurisdictional interdependencies such as gas-electric interdependency and electric telecommunications.

The reliability of the interconnected BPS must be maintained as the grid evolves through these aforementioned changes and is a key enabler of this evolution. However, as dispersed energy resources increasingly transition to the distribution system, their reliability characteristic are not necessarily the same as those they replace. ERSs will need to be replenished and operator reliability activities such as controllability, observability, and dispatchability of resources will need to be secured for the continued reliable operation of the BPS. Notably, three categories of risks were identified:

1. The first category is risks that are easily identified and measurable. The ERO Enterprise has processes and standards in place to identify and understand these risks via Events Analysis, Availability Data Systems, System Analysis, and special operational reliability assessments. These risks should be continually identified and mitigated through existing processes and standards.
2. The second category is risks that are slowly emerging but accelerating due in part to regulation and shifting economics and result from the integration of new technology into the interconnected BPS. Not all of this technology contributes to reliability in the same way as the conventional technology. This risk category includes the increase of wind generation, solar generation, demand response, distributed resources, and retiring baseload coal generation. In aggregate, these attributes will have a large impact on the grid. The reliability of the interconnected grid must be sustained, so understanding the quantity and quality of ERSs (such as frequency response and voltage support) and operator reliability activities (such as resource observability, controllability and dispatchability) required to maintain reliability will be critical to support this technology integration. These risks should be identified and mitigated through the ERO Enterprise's longer term reliability assessments and monitoring system transformation through Events Analysis, Availability Data Systems, and System Analysis.
3. The third category is risks that could have large potential impacts on the reliability of the BPS. They include extreme events and intentional acts such as cyber and physical attacks, GMD, EMP, and severe or extreme weather. The security and resiliency of organizations are highlighted by extreme events because they are impossible to prevent as the threats can come in many forms. Risk mitigation and optimized prevention are key themes through identification of all critical assets, target devaluation, system resiliency, system recovery, and asset management. The industry cannot be certain when these events will occur, but the industry must be proactive with mitigations actions to ensure the grid is resilient to such vulnerabilities.

The summit participants agreed that these risks must be addressed during the transformation of the grid. It will be important that policy makers, regulators and the public are educated and informed towards supporting the continued reliability of the interconnected BPS and the necessity for providing the complete range of ERSs so its value as an engine for innovation and technology integration is maintained. In addition to these three categories of risk, several cross-cutting themes were identified at the summit:

- **Accurate Models:** It is imperative to have accurate models that can be used to simulate and predict the way the BPS reacts to system perturbations, the evolution of load characteristics, and the integration of new technologies. The addition of new resources and technologies (e.g., inverter-based technology)

makes it very difficult to maintain a deterministic approach to the BPS. Probabilistic and updated models are vital to maintaining a wide-area view of the system, and this may require new utility investments in new tools.

- **Interdependencies:** A common theme throughout the day was that the industry must balance a number of jurisdictions regulated outside of Section 215 of the Federal Power Act, which at the same time create potential risks to reliability:
  - Fuel Supply: Generation increasingly relies on natural gas supply. There is an increasing need to coordinate with the other industries, particularly gas, in order to maintain reliable operations. Fuel supply uncertainties include identifying entities to sign merchant generator contracts, constructing new pipelines, and combining spot and firm fuel supplies to ensure an increased availability of generating units.
  - Markets: The markets need to be robust enough to provide confidence in capacity and related to provide ERSs. Also, the markets may not be providing adequate incentives to build the proper infrastructure investment inside and outside of the electric industry.
  - The Clean Power Plan (CPP): The final rule from the EPA was recently released, and the impact of the resource mix changes are not fully identified. However, it is clear that the transformation of the interconnected grid and resources on the grid will be accelerated to comply with the final rule.
  - Telecommunications: The increased focus on cyber security has increased the scrutiny on telecommunications and the interdependency with reliable operations of the BPS. In order to mitigate cyber-attacks or plan for communications breaches, the telecommunications industry must be strategically engaged. Additionally, industry may desire to rebuild or acquire their own telecommunication networks in order to improve their ability to address cyber threats.
  - Other governmental agencies: A range of governmental entities policy and regulations impact reliability, but they do not directly regulate just the electric utility industry. Homeland Security and the Federal Communications Commissions will greatly influence cyber regulations. The EPA and state commissions will greatly impact the implementation of the CPP final rule, distributed energy resources, and resource mix in each state.
- **Distribution:** The line between transmission and distribution is beginning to blur, and the influx of distribution-located resources on both sides of the meter. Additionally, these technologies do not always contribute directly to reliability as conventional resources. To maintain the reliability of the interconnected grid, synthesized ERSs may be required, increasing the challenge of the implementation of coordinated controls. In some cases these provisions could be addressed through interconnection agreements or equipment technical Reliability Standards. Additionally, operator reliability activities such as observability, controllability, and dispatchability of these resources will be required.

Perspectives and Conclusions

The preceding summary presents the RISC's conclusions about key reliability risk groupings and the associated priority where NERC should allocate resources to preserve reliability in 2015 and beyond. These observations and conclusions are supported by the collective expertise within the RISC, the various efforts and deliverables produced by NERC, the FERC Technical Conference themes, the focused industry executive interviews, and the themes emerging from the Reliability Leadership Summit. Overall these inputs provide a strong foundation for these results and recommend them to the Board for their consideration as an important ingredient in the development of strategic, budget, and implementation plans for the ERO for 2016 and beyond. These considerations further reinforce and validate that the overall approach among the ERO, the Board, FERC, and the RISC for identifying reliability risks and setting recommended priorities.