

Agenda

Reliability Issues Steering Committee

March 15, 2019 | 8:00 a.m.–12:00 p.m. Eastern | Breakfast served at 7:30 a.m.

The Mayflower Hotel
1127 Connecticut Ave NW
Washington, DC 20036

Meeting Room: Chinese Room (Lobby Level)

Introduction and Chair's Remarks

NERC Antitrust Compliance Guidelines and Public Announcement*

Agenda Items

- 1. 2019 Reliability Leadership Summit Post Mortem**
 - a. What worked well, opportunities for improvement
 - b. New risks
- 2. Next Steps for ERO Reliability Risk Priorities Report**
 - a. Review Updated Emerging Risks Survey Template
 - i. Risks that should be considered for removal
 - ii. Consolidation of risks, review Planning Committee proposal
 - iii. New risks
 - iv. Determine distribution group
 - b. Enhancements Needed to Improve the [Report from 2017](#)
 - c. Review Report Timeline
- 3. 2019 Industry Dashboard Metrics**
- 4. Future Meeting Dates (To be determined)**

*Background materials included.

Antitrust Compliance Guidelines

I. General

It is NERC's policy and practice to obey the antitrust laws and to avoid all conduct that unreasonably restrains competition. This policy requires the avoidance of any conduct that violates, or that might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition.

It is the responsibility of every NERC participant and employee who may in any way affect NERC's compliance with the antitrust laws to carry out this commitment.

Antitrust laws are complex and subject to court interpretation that can vary over time and from one court to another. The purpose of these guidelines is to alert NERC participants and employees to potential antitrust problems and to set forth policies to be followed with respect to activities that may involve antitrust considerations. In some instances, the NERC policy contained in these guidelines is stricter than the applicable antitrust laws. Any NERC participant or employee who is uncertain about the legal ramifications of a particular course of conduct or who has doubts or concerns about whether NERC's antitrust compliance policy is implicated in any situation should consult NERC's General Counsel immediately.

II. Prohibited Activities

Participants in NERC activities (including those of its committees and subgroups) should refrain from the following when acting in their capacity as participants in NERC activities (e.g., at NERC meetings, conference calls and in informal discussions):

- Discussions involving pricing information, especially margin (profit) and internal cost information and participants' expectations as to their future prices or internal costs.
- Discussions of a participant's marketing strategies.
- Discussions regarding how customers and geographical areas are to be divided among competitors.
- Discussions concerning the exclusion of competitors from markets.
- Discussions concerning boycotting or group refusals to deal with competitors, vendors or suppliers.

- Any other matters that do not clearly fall within these guidelines should be reviewed with NERC's General Counsel before being discussed.

III. Activities That Are Permitted

From time to time decisions or actions of NERC (including those of its committees and subgroups) may have a negative impact on particular entities and thus in that sense adversely impact competition. Decisions and actions by NERC (including its committees and subgroups) should only be undertaken for the purpose of promoting and maintaining the reliability and adequacy of the bulk power system. If you do not have a legitimate purpose consistent with this objective for discussing a matter, please refrain from discussing the matter during NERC meetings and in other NERC-related communications.

You should also ensure that NERC procedures, including those set forth in NERC's Certificate of Incorporation, Bylaws, and Rules of Procedure are followed in conducting NERC business.

In addition, all discussions in NERC meetings and other NERC-related communications should be within the scope of the mandate for or assignment to the particular NERC committee or subgroup, as well as within the scope of the published agenda for the meeting.

No decisions should be made nor any actions taken in NERC activities for the purpose of giving an industry participant or group of participants a competitive advantage over other participants. In particular, decisions with respect to setting, revising, or assessing compliance with NERC reliability standards should not be influenced by anti-competitive motivations.

Subject to the foregoing restrictions, participants in NERC activities may discuss:

- Reliability matters relating to the bulk power system, including operation and planning matters such as establishing or revising reliability standards, special operating procedures, operating transfer capabilities, and plans for new facilities.
- Matters relating to the impact of reliability standards for the bulk power system on electricity markets, and the impact of electricity market operations on the reliability of the bulk power system.
- Proposed filings or other communications with state or federal regulatory authorities or other governmental entities.
- Matters relating to the internal governance, management and operation of NERC, such as nominations for vacant committee positions, budgeting and assessments, and employment matters; and procedural matters such as planning and scheduling meetings.

Agenda

2019 Reliability Leadership Summit

March 14, 2019 | 8:30 a.m. – 4:30 p.m. Eastern

The Mayflower Hotel
1127 Connecticut Ave NW
Washington, DC 20036

Meeting Room: District Ballroom – Lower Level

Continental Breakfast **7:30–8:30 a.m.**

Welcome Remarks **8:30–8:45 a.m.**

Nelson Peeler, Senior Vice President, Chief Transmission Officer, Duke Energy, and RISC Chair

Mark Lauby, Senior Vice President and Chief Reliability Officer, NERC

Morning Keynote **8:45–9:15 a.m.**

Bruce Walker, Assistant Secretary, Office of Electricity, U.S. Department of Energy

Panel 1 – Regulatory and Policymaking during Unprecedented Change **9:15–10:30 a.m.**

Panelists

Bruce Walker, Assistant Secretary, Office of Electricity, U.S. Department of Energy

Thad LeVar, Chairman, Public Service Commission of Utah

Matt Schuerger, Commissioner, Minnesota Public Utilities Commission

David Morton, Chairman and CEO, British Columbia Utilities Commission

David Ortiz, Deputy Director of the Office of Electric Reliability, Federal Energy Regulatory Commission

Moderator

Chris Shepherd, Principal of Information and Critical Infrastructure Security, Gannett Fleming

The North American Bulk Power System (BPS) is experiencing transformational change due to a shift in generation resources and accelerated technology deployment. Public policies, consumer preferences, technology, and market factors are contributing to evolutionary changes to the fuel mix. The integration of new technologies which augments changes in fuel type and the make-up of the resources being added to the system, is affecting the visibility and management of resources. Collectively, these factors are creating a new paradigm along with new reliability risks for the BPS. Regulators and policymakers are on the front lines of these challenges. This panel includes regulators and policy makers who are managing the present and the future. Panelists will provide their views on addressing risk and the collaborative effort required to better shape the energy landscape of the future.

Break **10:30–10:45 a.m.**

Panel 2 – Identification and Mitigation of Significant Risks to Reliability: Existing and Emerging Landscape of Risks **10:45 a.m.–12:00 p.m.**

Panelists

Brian Harrell, Assistant Director, Cybersecurity and Infrastructure Security Agency (CISA), US Department of Homeland Security

David Weaver, Vice President, Transmission Strategy and Planning, Exelon and former NERC Planning Committee Chair

Rich Hydzik, Senior Transmission Operations Engineer, Avista Corp, formerly Chair of the NERC DERTF

Patrick Doyle, Chief Strategies and Operational Direction, Hydro-Québec

Bill Lawrence, Chief Security Officer, Vice President, Director of E-ISAC, NERC

Moderator

Brian Evans-Mongeon, President and CEO, Utility Services, Inc., current Planning Committee Chair

The nation’s critical infrastructure serves as the backbone of our nation’s economy, security, and health. Maintaining the security of our nation’s critical infrastructure, both physical and cyber, and addressing reliability challenges from extreme natural events, will continue to be a high priority for industry, policy makers, and regulators. As the risk landscape evolves, efforts will be needed to further our understanding of the impacts from new potentially disruptive events which challenge the security and reliability of the BPS.

Do opportunities exist for industry to further strengthen BPS security, reliability, and resilience through careful planning so new technology integration supports reliability and organizational goals, while at the same time not increasing vulnerabilities? Beyond the current NERC Reliability Standards, how can industry include security perspectives alongside reliability and resilience of the BPS in its planning and operations? This panel will also discuss existing and emerging international, national, and regional BPS reliability risks. Potential mitigation approaches and next generation modeling requirements will also be discussed.

Lunch **12:00–1:00 p.m.**

Afternoon Keynote **1:00–1:30 p.m.**
Mark P. Mills, Senior Fellow, Manhattan Institute

Panel 3 – Providing Assurance for the Availability of Adequate Fuel Delivery to Satisfy Energy Needs

1:30–2:45 p.m.

Panelists

Don Gulley, President and CEO, Southern Illinois Power Cooperative

Gordon van Welie, President and CEO, ISO New England

Woody Rickerson, Vice President, Grid Planning and Operations, ERCOT

Gerry Yupp, Senior Director, Wholesale Operations, Florida Power and Light Company

Jeffrey Cook, Vice President, Transmission Planning and Asset Management, Bonneville Power Administration

Moderator

Mark Rothleder, Vice President, Market Quality and Renewable Integration, CAISO

As the system transforms to a future generation-mix that includes gas, wind, solar, and battery at higher levels than the current levels, the ability to assure sufficient energy is available to meet the needs of consumers is being emphasized. To assure resource adequacy and operational reliability, addressing this transition is crucial. How should industry, policy makers, and the ERO Enterprise work together to ensure sufficient infrastructure is in place to assure that generation and necessary fuel resources are available to support the continued reliable operation of the BPS during this transition?

Break

2:45–3:00 p.m.

Panel 4 – Open Discussion

3:00–4:15 p.m.

Moderators

Nelson Peeler, Senior Vice President, Chief Transmission Officer, Duke Energy

Charles King, Vice President and Chief Information Officer, Kansas City Power & Light Co.

In this open-format discussion, Summit attendees will share thoughts and ideas on the priority and significance of BPS reliability risks. This discussion will concentrate on distilling the observations and themes discussed in the earlier panels, identifying potential blind spots or risks not revealed during the Summit panels or from general industry experience, and outlining strategic approaches for consideration by the ERO Enterprise, industry, policy makers, regulators, and other stakeholders in addressing significant emerging reliability risks. Discussion items can be, but are not limited to, practical BPS operations and planning, policy development at the FERC, NERC, or Regional Entity level (*e.g.*, standards and requirements), critical infrastructure protection, etc. See reference material: [2018 ERO Reliability Risk Priorities Report](#).

Closing Remarks

4:15–4:30 p.m.

Jim Robb, President and CEO, NERC

Review Updated Emerging Risks Survey Template

Action

Review and approve distribution group for the Emerging Risks Survey template.

Summary

In your review of the template consider the following items and come prepared for discussion and finalization of template with approval of a defined distribution group.

- Review the [Charter](#)
 - Focus should be on the bulk power system
 - Focus should be on significant (strategic) risks
 - Should not be on routine items already managed by industry, standards, etc.
- To the fullest extent possible, the RISC should use objective performance data as input to identifying topics and relative priority.
- Need early group alignment on whether to focus on “inherent” risks, “residual” risks or both?
 - In last cycle’s report there was some late stage disagreement.
 - ***Inherent Risk (or Baseline Risk)***: The ***probability*** of loss arising out of circumstances or existing in an ***environment***, in the absence of any ***action*** to ***control*** or modify the circumstances.
 - ***Effectiveness Risk Control***: The effectiveness that an ***action*** has to ***control*** or modify the circumstances.
 - ***Residual Risk***: A risk that remains after all efforts have been made to ***mitigate*** or ***eliminate risks*** associated with a ***business*** process or ***investment*** (essentially, Inherent Risk reduced by the Effectiveness Risk Control).
- The controls in the template needs to be actionable, and not the “how and who” .
- The report should be direct, concise, and actionable.

Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹	Baseline Likelihood	Risk Control	Effectiveness Impact	Effectiveness Likelihood	Ongoing activities
				Mitigation Actions Description (Include any shared internal controls)			
Changing Resource Mix	<p>1. Public inputs, along with the influence of regulatory and socio-economic policies, are continuing to drive the evolution of the change in power resources. The shift away from rotating synchronous central-station generators toward a new mix of natural-gas-fired generation, renewable forms of asynchronous generation, demand response, storage, smart- and micro-grids, and other technologies will continue to challenge generation planners and operators. Looking forward, regulatory initiatives, along with expected lower production costs and aging generation infrastructure, will likely alter the nature, investment needs, and dispatch of generation.</p> <p>2. Industry's ability to foresee and address reliability issues associated with these changes to the resource mix are complicated by:</p> <p>a. Potential impact on Essential Reliability Services (ERS). The further erosion of large rotating synchronous central station generating units can alter ancillary services needed for BPS reliability, such as ERS (e.g., voltage control and reactive support, frequency response, ramping/balancing). Changes to non-traditional generation types may impact blackstart capability as well.</p> <p>b. Technology with Different Performance Characteristics. The continuing integration of large amounts of new resource technologies, including DER and grid-connected inverter-based resources, grid-scale energy storage; the lack of low-voltage ride through; may lead to inaccurate load data for forecasting anticipated demand and the inability to observe and control these types of resources.</p> <p>c. New Data and Information Requirements. The need for data and information about resource characteristics in the planning, operational planning, and operating time horizons may prevent the system from being properly planned and operated.</p> <p>d. The interaction and performance of control systems during transient events that may result in new common-mode</p>			<p>Near-term (1–2 year time frame)</p> <p>1. The ERO Enterprise (NERC and the Regional Entities) and industry need to provide effective guidance on controllable device settings² and how the potential effect on BPS reliability, particularly during transient conditions.</p> <p>a. NERC must continue to track and trend occurrences and events to identify, analyze, and provide recommendations for risk mitigation. NERC should augment collaboration with the technical committees by including vendors and manufacturers in the technical analysis of equipment performance and specifications when possible.</p> <p>2. The ERO Enterprise should support approaches to gather data and insights into DER, and Reliability Coordinators should formulate plans to achieve the appropriate level of visibility and control such that implications to the BPS can be better understood.</p> <p>3. Expand the collaboration, through the technical committees, with the RTOs/ISOs Council, Balancing Authorities in non-RTO/ISO market areas, other registered entities, and regulators on ERS recommendations for effective to catalogue and account for new resources and their ERS impacts, some of which are outside the ERO Enterprise jurisdiction.</p> <p>4. Based on assessments on the reliability impacts of the changing resource mix, and generation retirements, industry, stakeholders, and policymakers should review planning processes and market mechanisms to mitigate reliability risks. Regulators and policymakers should consider ways to expedite regulatory and environmental permitting processes to respond to changing infrastructure needs.</p> <p>5. As the Inverter Based Resource Performance Task Force (IRPTF) completes its scope of work, the ERO Enterprise</p>			<p>1.a. SAMS is developing a white paper on Applicability of Standards to Transmission Connected Reactive Power Resources (2019)</p> <p>1.b NERC Alert for Blue Cut Fire addresses</p> <p>2.a SPIDERWG was established to address issues in planning timeframe; workscope includes efforts in modeling, verification, studies, and coordination.</p> <p>2.b RAS/NERC LTRA collects information on DER penetration</p> <p>3. ERS Recommendations have been assigned to OC and PC subcommittees or are part of</p>

Commented [PC5]: Recommendation 2-3 from 2018 SOR

Commented [PC1]: Identified as an emerging issue in the 2018 LTRA

Commented [PC2]: this seems to belong under "c" need for data and info.

Commented [PC3]: challenge with getting DER information (Distribution-level) belongs here.

Commented [PC4]: seems we would need to account for location and configuration.

¹ Scale - 10 is the highest and one is the lowest, effectiveness baseline and likelihood have to be at or less then the baseline impact or likelihood.

² For example, inverter based resources, protective relay schemes, remedial action schemes, static synchronous compensators (STATCOMs)/static VAR compensators (SVCs), generation distributed control systems, power system stabilizers, etc.

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	<p>failures that may not have been anticipated, (e.g., the inverter performance as demonstrated during the Blue Cut fire and other inverter related events).</p> <p>3. The need to effectively incorporate utility scale energy storage systems into the BPS.</p>			<p>should consider and implement the recommendations needed to maintain reliability, to include addressing any gaps in NERC Reliability Standards.</p> <p>6. Work toward aligning IEEE, ANSI, and other standards for DER/sub-BPS resources with NERC standards.</p>			<p>industry practice.</p> <p>4. New recommendation, for implementation at policymaker level</p> <p>5. PRC-024 SAR project initiated with SC.</p>
Bulk Power System Planning	<p>1. Planning and operating the BPS is becoming more complex due to:</p> <p>a. The further erosion of generation resources, especially the loss of, conventional synchronous generation, coupled with the increasing integration of renewable, distributed, and asynchronous resources.</p> <p>b. Increased risks with the transition from a traditionally diverse resource portfolio to one that is predominately natural gas and variable energy resources, with new fuel supply and technology risks.</p> <p>c. Fuel sourcing and disruption capabilities, from weather events and other nature-based extreme conditions, are driving new scenarios and case studies.</p> <p>2. BPS Planners require new information to perform BPS transient, mid-term, long-term, and small-signal stability studies, including consideration of interaction of BPS and resource controls, inertia/frequency response, voltage support (adequate dynamic and static reactive compensation), and ramping/balancing constraints due to the dynamic performance of the resource mix that changes throughout the day.</p> <p>3. The ability to perform accurate long-term planning assessments is more difficult due to:</p> <p>a. The need for more comprehensive load models.</p>			<p>Near-term (1–2 year time frame)</p> <p>1. The ERO Enterprise should identify the type and periodicity of information needed from DER ensure the aggregate technical specifications of generation connected to local distribution grids are known to planners and operators. This data supports accurate system planning models, load forecasting, coordinated system protection, and real-time situational awareness.</p> <p>2. NERC, and industry should improve interconnection frequency response modeling. Recent forward-looking interconnection-wide assessment for the Eastern and Western Interconnections highlighted need for improvement to address low-inertia conditions, locational constraints in parts of the system, and representation of DERs in load models. NERC and the Eastern, Western, and Texas interconnection study groups should work together to develop improved frequency response base case and scenario assessments</p> <p>3. Establishing clear interconnection standards on all facilities (DERs, Storage, etc.) to BPS and identify the roles and responsibilities of the BES, BPS, and distribution operations.</p>			<p>1. SPIDERWG established to address issues in planning timeframe; workscope includes guidelines for DER data collection and modeling.</p> <p>2. New recommendation</p> <p>4. EGWG established; scope addresses identified reliability objectives</p>

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	<ul style="list-style-type: none"> i. . The uncertainty and lack of visibility into load composition and situations where distributed generation mask the actual load along with evolving models. ii. Complex load and local resource controls and their unknown interaction with power electronics devices on a large scale at the distribution level that may affect BPS operations during disturbances (e.g., fault-induced delayed voltage recovery).³ b. The increased deployment of DER within the distribution or behind-the-meter configurations that will impact how the BPS responds. c. Uncoordinated integration of controllable device settings and power electronics installed to stabilize the system. d. Changing and uncoordinated regulations of policymakers and regulatory authorities complicated by jurisdictional boundaries. 			<p>Mid-term (3–5 year time frame)</p> <ul style="list-style-type: none"> 4. Develop Guidelines to Assess Fuel Limitations and Disruption Scenarios. Given the increased reliance on natural gas generation, system planners should identify potential system vulnerabilities that could occur under extreme, but realistic, contingencies and under various future supply portfolios. In addition, NERC’s Planning Committee should leverage industry experience and develop a reliability guideline that establishes a common framework for assessing fuel disruptions of various types. The industry-developed assessments can then be used to address potential regulatory needs or establish market mechanisms to better promote fuel assurance. 			
Resource Adequacy and Performance	<ul style="list-style-type: none"> 1. The traditional methods of assessing resource adequacy may not accurately or fully reflect the new resource mix ability to supply energy and reserves for all operating conditions. 2. Forecasting BPS resource requirements to meet customer demand is becoming more difficult due to the penetration of DER, which can mask the customer’s electric energy use and the operating characteristics of distributed resources without sufficient visibility. 3. Conventional steam resources that operate infrequently due to economics may not operate reliably when dispatched for short peak-demand periods during seasonally hot or cold temperatures. 4. Historic methods of assessing and allocating ancillary services such as regulation, ramping, frequency response, and voltage support may not ensure ERS or sufficient contingency reserves are available at all times during real-time operations. Ramping capacity concerns, which up to now have been largely confined to limited locations, will expand as solar generation continues to grow. 			<p>Near-term (1–2 year time frame)</p> <ul style="list-style-type: none"> 1. The ERO Enterprise and the industry should continue to expand the use of probabilistic approaches to develop resource adequacy measures that reflect variability and overall reliability characteristics of the resources and composite loads, including non-peak system conditions. 2. Improve load forecasting that takes into account behind-the-meter resources, and coordination between BPS and distribution system planners and operators by analyzing data requirements necessary to ensure there is sufficient detail on the capability and performance of the BPS as it is impacted by DER. The industry should gather data beyond simple demand forecasts and expand to identify resource capacity, location, and ERS capability. 3. The ERO Enterprise and industry should continue to assess vulnerabilities from fuel availability as part of evaluating adequacy and capability to deliver resources. . This should 			<ul style="list-style-type: none"> 1. Addressed in RAS/PAWG scope 2. In scope for SPIDERWG and RAS. SPIDERWG is developing data collection and load forecasting guidelines. RAS collects info on DER penetration, and is a forum for developing solutions to

³ FIDVR Alert

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	5. Fuel constraints and environmental limitations may not be reflected in resource adequacy assessments.			<p>include the addition and refinement of the Generator Availability Data System (GADS) to collect more information on fuel availability and its impact.</p> <p>4. NERC should lead the electric industry in developing approaches and metrics to assess energy adequacy. The changing resource mix can alter the energy and availability characteristics of the generation fleet. Analysis is needed to determine energy sufficiency, including off-peak periods and locations where energy-limited resources are prominent.</p> <p>5. Continue to promote frequency response capabilities of BPS resources. Regulators and markets should continue to support modifications and improvements to generator interconnection agreements that provide for frequency responsive generation. NERC should enhance performance analysis to be able to observe the effects of the changing resource mix on frequency response and voltage support. NERC should also expand collaboration with NAGF and other stakeholders to increase frequency response awareness and capabilities.</p> <p>6. Planners should ensure sufficient flexible ramping capacity is available to meet needs of increasing variable energy resources.</p>			<p>resource adequacy challenges.</p> <p>3. NERC and GADSWG are reviewing GADS data coll enhancement for fuel assurance</p> <p>4. New recommendation, for NERC, PC, RAS action.</p> <p>5. New recommendation from SOR 2018</p> <p>6. New recommendatoin from 2018 LTRA</p>
Increasing Complexity in Protection and Control Systems	<p>1. Increasingly complex protection and control systems on the BPS and the DER systems that must be properly designed, coordinated, managed, and maintained to prevent or mitigate events.</p> <p>2. BPS remedial action scheme failures as well as protection and control system misoperations that exacerbate the impact from events, which significantly increases the risk for uncontrolled cascading of the BPS.</p> <p>3. DER and renewable resource control systems that exacerbate the impact from events, and could increase the risk for cascading of the BPS.</p>			<p>Near-term (1–2 year time frame)</p> <p>1. NERC should work with industry experts and the forums to promote the development of industry guidelines on protection and control system management to improve performance.</p> <p>2. NERC should publish detailed data reporting instructions (DRI) for misoperations to create better alignment of entity understanding and more consistent misoperatoin data.</p> <p>3. Outreach across the ERO Enterprise is needed, including education and training with industry and stakeholders to reduce protection system misoperations. NERC should</p>			<p>1. Work is underway by MIDASWG</p> <p>2, 3. Recommendationns from the SOR.</p> <p>4. Several potential updates to PRC family of standards are in</p>

Commented [PC6]: New recommendation from 2018 LTRA

Commented [PC7]: SOR 2018 recommendation

Commented [PC8]: SOR 2018 report recommendation

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				<p>also continue to support sharing good industry practices and lessons learned to maintain a downward trend in misoperations rate.</p> <p>Mid-term (3–5 year time frame)</p> <p>4. The ERO Enterprise should encourage industry forums, research organizations, and technical committees to share technologies or processes on condition monitoring, failure prevention, spare sharing, resilience, and recovery. The ERO Enterprise should provide the technical basis for BPS resilience enhancements.</p> <p>Long-term (greater than 5-year time frame)</p> <p>5. Recognize the risks of shorter technology lives for protection and control system components and the need to implement replacement programs that do not impact BPS reliability.</p>			consideration, including IRPTF's SAR on PRC-024, SPCS SAR for PRC-023, 019 standards, and implementation guidance for PRC-019.
Human Performance and Skilled Workforce	<ol style="list-style-type: none"> Organizations not implementing improvements based on past events, experiences, good industry practices, or keeping an eye on the implementation of new technologies that can hinder future operations improvements; gaps in skillsets or organizational improvement must be a priority. Significant increase in operational complexity resulting in more extensive training needs associated with new technology and related compliance control strategy. Turnover of key skilled or experienced workers (e.g., relay technicians, operators, engineers, IT support, and substation maintenance) that will lead to more protection and control system misoperations. Complicated new multi-discipline control and protection schemes that are beyond the skillset of the existing workforce. A lack of training programs that prevent closing skillset gaps quickly. Inadequate management oversight or controls leads to organizational weaknesses and inefficiencies. Ineffective corrective actions lead to repeated HP errors. 			<p>Near-term (1–2 year time frame)</p> <ol style="list-style-type: none"> The ERO Enterprise and industry forums should expand their communication and encourage sharing of good industry practices for increasing HP effectiveness (publishing lessons learned/good industry practices and supporting the NERC and NATF HP conference and other related workshops). NERC should encourage industry and trade associations to identify skill gaps and develop recommendations to address them (e.g., curricula, programs, industry support, and educational pipeline programs), including those which may be associated with protection and control schemes. The ERO Enterprise and the industry should promote the use of NERC cause codes to establish a common understanding of HP triggers, collect and evaluate trends in data, and develop metrics as needed. The industry should leverage data sources such as event analysis, Transmission Availability Data System (TADS), Generating Availability Data System (GADS), Demand Response Availability Data System (DADS), relay 			

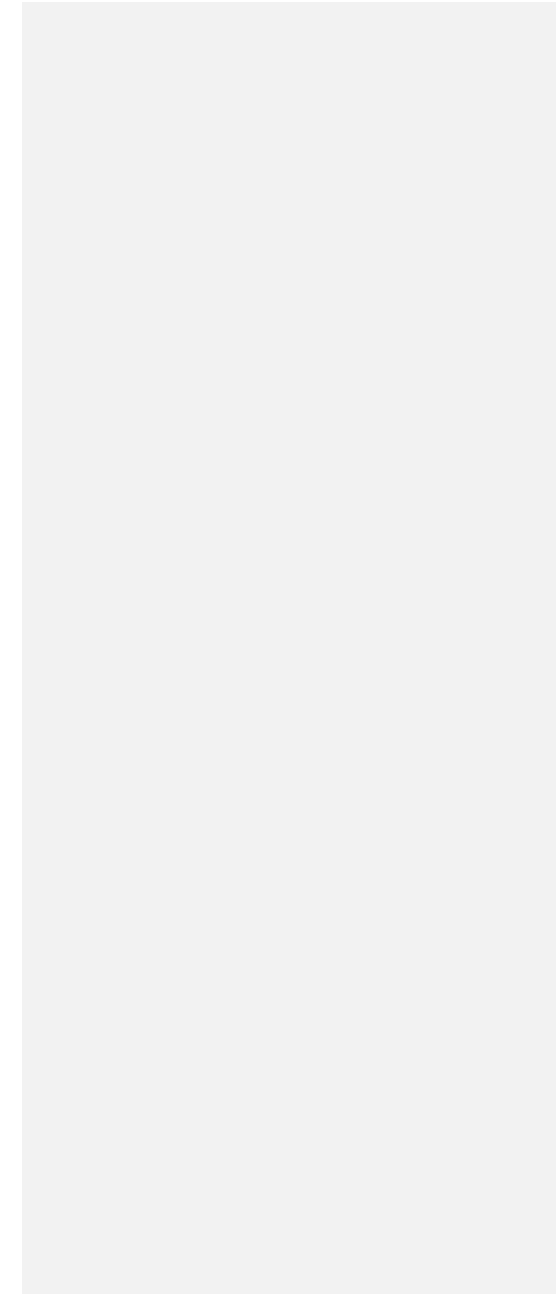
Commented [PC9]: 2018 SOR Recommendation

Commented [PC10]: Does this recommendation apply to the P&C risk category, or is it for one of the extreme event categories below? May need to be reworded to make the connection clearer.

Commented [PC11]: This recommendation does not seem to be well correlated to an identified risk, either in this table or in NERC's assessments. It should be removed, or linked to a risk description.

Baseline Risk				Risk Mitigation Activities			
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	<ul style="list-style-type: none"> 8. Legacy systems and new technology result in disparity of the skillsets needed for BPS reliability. 9. Need for professionals with OT/ICS/SCADA cybersecurity experience in general. 			<p>misoperations, EOP-004/OE-417 Reports, and AC equipment failures to identify patterns and risk.</p> <p>Long-term (greater than 5-year time frame)</p> <ul style="list-style-type: none"> 5. Industry and trade organizations, such as NATF, should develop and implement a sustainable process to analyze and disseminate good industry practices for HP. 6. Industry standards and regulatory rules should consider the human skillset changes and training needs as part of their development. <p>Provide cross training and rotational career opportunities for legacy engineering roles to train or rotate into cyber roles or rotate security resources into operations roles; pursue more creative recruiting practices for cyber roles, pursuing internships at the high school and college level to grow longer-term employee base.</p> <ul style="list-style-type: none"> 7. Consider exploration of an independent 3rd party being responsible for receiving near miss reports in order to address hesitation that may otherwise exist in reporting near misses to a compliance affiliated body. 			
Loss of Situational Awareness	<ul style="list-style-type: none"> 1. Limited real-time visibility to and beyond the immediate neighboring facilities. 2. A lack of common status information on infrastructures and resources on which operators rely (e.g., gas, dispersed resources, DER, and data and voice communications). 3. Information overload during system events. 4. Inadequate tools or fully capable back-up tools to address reliability. 5. Lack of training on the tools and information to assess system reliability at a given point in time. 6. Incomplete data and model accuracy used to feed into real-time operations. 7. Dependency on telecommunications systems for situational awareness. 			<p>Near-term (1–2 year time frame)</p> <ul style="list-style-type: none"> 1. The ERO Enterprise should evaluate whether key applications such as real time contingency analysis are over reliant on a service provider and identify mitigating actions to reduce the risk. 2. The ERO Enterprise should identify the type and frequency of information needed from DER for real-time situational awareness. 3. Continue a strong event analysis program, look at EMS outages and failures, and share lessons learned as well as use the data and information gained to inform the annual NERC Monitoring and Situation Awareness conference. 4. Industry and the E-ISAC should continue to enhance their understanding and sharing of information regarding the operational technology (OT) system cyber security risks and associated mitigation strategies. 			

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Risk Name	Description of Risk	Baseline Impact ¹	Baseline Likelihood	Risk Control	Effectiveness Impact	Effectiveness Likelihood	Ongoing activities
				Mitigation Actions Description (Include any shared internal controls)			
	<p>8. Cyber risk and vulnerabilities pose threat to operational technology control systems.</p> <p>9. Current Federal Communications Commission (FCC) proposal to open up the wireless communication band heavily used by utilities (6 GHz spectrum) for unlicensed use. There is a fear among industry trade groups that this could lead to a high potential for radio frequency interference that may underpin the safety and reliability of the grid.</p>			<p>Mid-term (3–5 year time frame)</p> <p>5. NERC, in concert with industry and trade organizations, should improve its set of real-time indicators of interconnection health.</p> <p>6. NERC should work with industry to engage EPRI to develop a supplement or companion to the <i>Interconnected Power System Dynamics Tutorial</i> that deals with wide-area monitoring under a changing resource mix based on the near-term deliverables above.</p> <p>7. The industry, trade organizations, and other industry groups such as the North American Synchrophasor Initiative (NASPI) should develop a suite of supplemental tools that use synchrophasor data (e.g., state estimator, contingency analysis, etc.) to improve situational awareness, provide early warning for operators regarding deteriorating conditions, and assist in recovery from disturbances.</p> <p>8. Evaluate the risks of private telecommunication systems as compared to use of public systems for Supervisory Control and Data Acquisition (SCADA) systems.</p> <p>Long-term (Greater than 5-year time frame)</p> <p>9. The ERO Enterprise should engage with industry and trades organizations to identify options for the delivery of data critical for situational awareness in situations where EMS systems are down for extended periods.</p> <p>10. The ERO Enterprise should work with industry and EMS vendors to establish forums to identify options for improving situational awareness tools utilizing EMS data including the integration of synchrophasor data.</p>			



Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹	Baseline Likelihood	Risk Control	Effectiveness Impact	Effectiveness Likelihood	Ongoing activities
				Mitigation Actions Description (Include any shared internal controls)			
Extreme Natural Events	<ol style="list-style-type: none"> Lack of preparation for GMD events could lead to widespread loss of load due to voltage instability in certain regions. Widespread damage to certain types of BPS infrastructure can extend outages due to unavailability of nearby replacement equipment or specialized capabilities. Physical damage to equipment and fuel supply sources, such as natural gas pipelines or other energy storage facilities including hydro. Damage to voice and data communications, as well as water supplies, can make certain critical facilities vulnerable and reduce the ability to serve load. The industry does not have full knowledge, shared documentation, or coordination in accessing and assessing compatibility of the existing spare equipment inventory across geographical and political boundaries. 			<p>Near-term (1–2 year time frame)</p> <ol style="list-style-type: none"> Study multiple simultaneous limitations on natural gas deliveries during extreme weather. NERC should encourage participation in mutual assistance programs, with collaboration from government and non-government authorities. Mutual assistance agreements provide essential personnel, equipment, and material, as observed in recent hurricane experiences. NERC, in collaboration with industry, should publish information to promote effective drone use during emergencies. Coordination with government and first responders is critical for successful drone use. NERC and industry should plan a workshop that is coordinated with U.S., Canadian, and Mexican federal agencies and governmental authorities to address high-impact low-frequency event response, recovery, and communications vulnerabilities. <p>Mid-term (3–5 year time frame)</p> <ol style="list-style-type: none"> NERC should conduct detailed special assessments of extreme natural event impacts that integrate: <ol style="list-style-type: none"> Infrastructure interdependencies (e.g., telecommunications, water supply, generator fuel supply). Analytic data trend insights regarding resilience under severe weather conditions, identifying preventable aspects for BPS reliability. Better understand the interdependence of the telecommunication infrastructure and electric infrastructure during a natural disaster. <p>Long-term (greater than 5-year time frame)</p> <ol style="list-style-type: none"> Analyze data from GMD events to further the understanding of geomagnetically induced current effects 			<ol style="list-style-type: none"> Analysis of GMD events and data is in scope for the GMDTF. <ol style="list-style-type: none"> NERC Staff and GMDTF are implementing the NERC RoP Sect 1600 Data Request for GMD Data Collection.

Commented [PC12]: Does this recommendation still fit in the RISC Report, given the activities underway following SPOD and LTRA? If it remains a recommendation it should be directed at a group for action (ERO-Enterprise)

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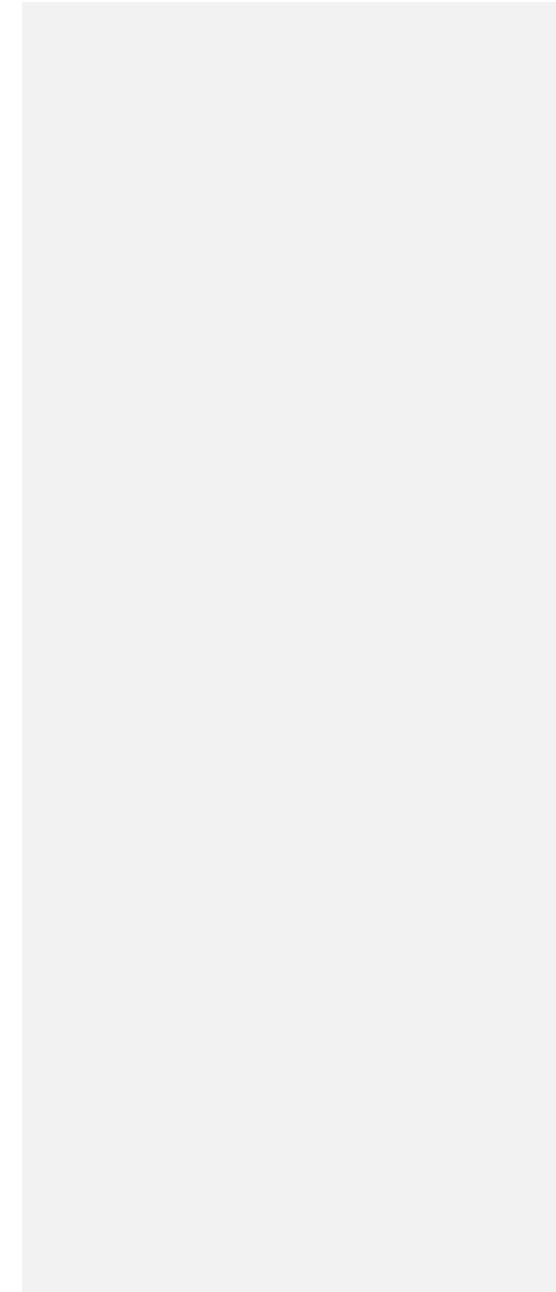
Baseline Risk				Risk Mitigation Activities			
Baseline Risk				Risk Control			
Risk Name	Description of Risk	Baseline Impact ¹	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact	Effectiveness Likelihood	Ongoing activities
				<p>on BES facilities to support enhancements to models and standards.</p> <p>8. To facilitate preparedness, consider preparing sensitivity analyses to simulate the impacts from the most extreme natural events experienced to date in a planning area.</p>			
Physical Security Vulnerabilities	<ol style="list-style-type: none"> 1. Evolving threat around physical attacks. 2. The exposed nature of parts of the grid makes it difficult to protect. 3. Long lead times associated with manufacturing and replacing some equipment, which can increase complexity of restoration after physical attacks that damage BPS equipment. 4. Incorrect assumptions on availability of replacement equipment. 5. Physical damage to generation fuel sources and transport networks which could degrade the reliable operations of the BPS. 6. Damage to necessary telecommunications and water supplies, which could make certain critical facilities vulnerable and reduce the ability to serve load. 			<p>Near-term (1–2 year time frame)</p> <ol style="list-style-type: none"> 1. The ERO Enterprise should develop performance metrics measuring and prioritizing potential physical attacks that will result in system disturbances while differentiating them from vandalism or theft incidents. 2. Assess the risks of physical attack scenarios on midstream or interstate natural gas pipelines, particularly where natural gas availability will impact generation and the reliability of the BPS. 3. Based on recommendations and identified risks outlined in EPRI's EMP report⁴ and soon to be released results for EMP shielding requirements, determine the need to develop Reliability Standards, reliability guidelines, industry webinars, or additional analysis to address EMP events as necessary. 4. NERC should seek input from water, telecommunications, and gas ISACs in the development of physical security Reliability Standards. 			

⁴ See *Magnetohydrodynamic Electromagnetic Pulse Assessment of the Continental U.S. Electric Grid: Geomagnetically Induced Current and Transformer Thermal Analysis*: <https://publicdownload.epri.com/PublicDownload.svc/product=000000003002009001/type=Product>

Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹	Baseline Likelihood	Risk Control	Effectiveness Impact	Effectiveness Likelihood	Ongoing activities
				Mitigation Actions Description (Include any shared internal controls)			
				Mid-term (3–5 year time frame) 5. Conduct a special regional assessment that addresses natural gas availability and pipeline impacts under physical attack scenarios. 6. National government agencies (e.g., Department of Energy, Natural Resources Canada, Secretaría de Energía (SENER)), industry, trades, and forums should identify appropriate mitigation strategies to fill spare equipment gaps and transportation logistics shortcomings.			
Cybersecurity Risk	1. Cybersecurity threats result from exploitation of both external and internal vulnerabilities: <ol style="list-style-type: none"> Exploitation of employee and insider access. Weak security practices of host utilities, third-party service providers and vendors⁵, and other organizations. Unknown, undisclosed, or unaddressed vulnerabilities in cyber systems. Growing sophistication of bad actors, nation states, and collaboration between these groups. 2. Interdependencies from the critical infrastructure sectors, such as Communications, Financial Services, Oil and Natural Gas Subsector, and Water, where sector-specific vulnerabilities can impact BPS reliability. 3. Legacy architecture coupled with the increased connectivity of the grid expands the attack surface of BPS protection and control systems: <ol style="list-style-type: none"> Increased automation of the BPS through control systems implementation. 			Near-term (1–2 year time frame) 1. In collaboration with the CIPC and industry stakeholders, develop a risk process to address the potential impacts of cybersecurity threats and vulnerabilities. 2. The E-ISAC should continue information sharing protocols among interdependent ISACs to increase the visibility into cyber and physical security threats. 3. Facilitate planning considerations to reduce the number and exposure of critical cyber facilities to attack. 4. The ERO Enterprise and the E-ISAC should develop metrics regarding the trend of cyber-attacks and potential threats. 5. The industry should develop focused training and education programs and/or share best practices to address the shortage of skilled and experienced cybersecurity professionals, as well as IT professionals with BPS operations experience. 6. Industry and the E-ISAC should take steps to increase its knowledge and understanding of systemic cyber risks affecting the sector, as well as cross sector dependencies and develop appropriate mitigation strategies			

⁵ See Reliability Standard CIP-013-1, Supply Chain Risk Management: <http://www.nerc.com/pa/Stand/Reliability%20Standards/CIP-013-1.pdf>.

Baseline Risk				Risk Mitigation Activities			
Baseline Risk				Risk Control			
Risk Name	Description of Risk	Baseline Impact ¹	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact	Effectiveness Likelihood	Ongoing activities
	<ul style="list-style-type: none"> b. The trend towards increased integration of IT operating systems may increase in the attack surface and associated attack risk. c. IT/operational technology (OT) control system infrastructure management, out-of-date operating systems, and the lack of patching capability/discipline. 4. Technologies and services <ul style="list-style-type: none"> a. Increased reliance on third-party service providers and cloud-based services for BPS operations and support with the opportunity to increase security if managed properly b. Cybersecurity risks in the supply chain: software integrity and authenticity; vendor remote access; information system planning; and vendor risk management and procurement controls. 5. Ineffective teamwork and collaboration among the federal, provincial, state, local government, private sector and critical infrastructure owners can exacerbate cyber events. 6. A lack of staff that is knowledgeable and experienced in cybersecurity of control systems and supporting IT/OT networks (historically separate organizations and skillsets). This risk is symptomatic across all industries and is a risk because it hinders an organization's ability to prevent, detect, and respond to cyber incidents due to organizational silos. 7. The rapid growth in sophistication and widespread availability of tools and processes designed to exploit vulnerabilities and weaknesses in BPS technologies and in connected IT networks and systems. 8. Lack of in-depth understanding of systemic cyber risks affecting the electricity sector and related cross sector dependencies 			<p>Mid-term (3–5 year time frame)</p> <ul style="list-style-type: none"> 7. The ERO Enterprise should develop a feedback mechanism from CIP standards implementation to evaluate the standard and lessons learned from new technology deployments. 8. The ERO Enterprise with industry should develop agreed-upon levels of cyber-resilience suitable for BPS planning and operations. 9. Take advantage of data correlation tools and services provided by software tools and services such as those provided by E-ISAC and Fusion Centers. 10. Take advantage of peer cyber program reviews and third-party security assessments to help ensure strong cyber program processes and tools spanning prevention, detection, and response. <p>Long-term (greater than 5-year time frame)</p> <ul style="list-style-type: none"> 11. The ERO Enterprise and industry should develop methods, models, and tools to simulate cyber impacts on system reliability, enabling BPS planning to withstand an agreed-upon level of cyber resilience. 			



Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
Changing Resource Mix	<p>1. <u>Public inputs, along with the influence of regulatory and socio-economic policies, are continuing to drive the evolution of the change in power resources. The shift away from rotating synchronous central-station generators toward a new mix of natural-gas-fired generation, renewable forms of asynchronous generation, demand response, storage, smart- and micro-grids, and other technologies will continue to challenge generation planners and operators. The intensity and pace of change (penetration rates of certain resources) and the types of change (the specific resources) are influenced by policy and economic factors in addition to state, provincial, and federal initiatives, which sometimes influence one region, province, or state in a certain direction more than another. Since the BPS is interconnected, these effects cannot be isolated to stay within political boundaries. Looking forward</u> Over time, regulatory initiatives, along with expected lower production costs and aging generation infrastructure, will likely alter the nature, investment needs, and dispatch of generation, considering the replacement of large rotating synchronous central-station generators with natural gas-fired generation, renewable forms of asynchronous generation, demand response, storage, smart- and micro-grids, and other technologies. Planners and operators may be challenged to integrate these inputs and make necessary changes.</p> <p>2. Industry's ability to foresee and address reliability issues associated with these changes to the resource mix are complicated by: The ability of regulators and industry to foresee and address reliability issues associated with these changes to the resource mix is complicated by:</p> <p>a. <u>Potential impact on Essential Reliability Services (ERS). The further erosion of large rotating synchronous central station generating units can alter Ancillary services needed for BPS reliability, such as the Essential Reliability Services (ERS) (e.g., voltage control and reactive support, frequency response, ramping/balancing); Changes to non-traditional generation types may impact blackstart capability as well on the BPS</u></p>			<p>Near-term (1–2 year time frame)</p> <p>1. <u>The ERO Enterprise (NERC and the Regional Entities) and industry need to provide more effective guidance to evaluate and improve on controllable device settings² and how the potential interaction between these devices can affect on BPS reliability, particularly during transient conditions.</u></p> <p><u>a. NERC must continue to track and trend occurrences and events to identify, analyze, and provide recommendations for risk mitigation. NERC should augment collaboration with the technical committees by including vendors and manufacturers in the technical analysis of equipment performance and specifications when possible.</u></p> <p>1-2. <u>The ERO Enterprise should support the development approaches of new systems to gather data and insights into DER (i.e., customer, distribution, or otherwise), and Reliability Coordinators should formulate plans to achieve the appropriate level of transparency-visibility and control such that implications to the BPS can be better understood.</u></p> <p>2-3. <u>Expand the collaboration, through the technical committees, with the RTOs/ISOs Council, Balancing Authorities in non-RTO/ISO market areas, other registered entities, and regulators on ERS recommendations for effective implementation responses in terms of cataloguing and taking into catalogue and account for new resources and their ERS impacts, some of which are outside the ERO Enterprise jurisdiction.</u></p> <p>3-4. <u>Based on assessments on the reliability impacts of the changing resource mix, and generation retirements, industry, stakeholders, and policymakers should review planning processes and market mechanisms to mitigate reliability risks. Regulators and policymakers should</u></p>			<p><u>1.a. SAMS is developing a white paper on Applicability of Standards to Transmission Connected Reactive Power Resources (2019)</u></p> <p><u>1.b NERC Alert for Blue Cut Fire addresses</u></p> <p><u>2.a SPIDERWG was established to address issues in planning timeframe; workscope includes efforts in modeling, verification, studies, and coordination.</u></p> <p><u>2.b RAS/NERC LTRA collects information on DER penetration</u></p> <p><u>3. ERS Recommendations have been assigned to OC and PC subcommittees or are part of</u></p>

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¹ Scale - 10 is the highest and one is the lowest, effectiveness baseline and likelihood have to be at or less than the baseline impact or likelihood.

² For example, inverter based resources, protective relay schemes, remedial action schemes, static synchronous compensators (STATCOMs)/static VAR compensators (SVCs), generation distributed control systems, power system stabilizers, etc.

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	<p>that could be further eroded by the retirement of many large rotating synchronous central station generating units.</p> <p>b. Technology with Different Performance Characteristics. The continuing integration of large amounts of new resource technologies, including DER and grid-connected inverter-based resources, grid-scale energy storage; the lack of low-voltage ride through; may lead to inaccurate load data for forecasting anticipated demand and the inability to observe and control these types of resources.</p> <p>b. The integration of large amounts of new resource technologies, DER, and behind-the-meter resources; the lack of low-voltage ride through; inaccurate load data to accurately forecast anticipated demand; and the inability to observe and control DER.</p> <p>c. New Data and Information Requirements. The need for data and information about resource characteristics in the planning, operational planning, and operating time horizons may prevent the system from being properly planned and operated.</p> <p>c. The need for data and information about the character of resources in the planning, operational planning, and operating time horizons so the system can be planned and operated while accounting for the contributions and implications to reliability of all resources, regardless of their location or configuration.</p> <p>d. The interaction and performance of control systems during transient events that may result in new common-mode failures that may not have been anticipated, (e.g., the inverter performance as demonstrated during the Blue Cut fire and other inverter related events).</p> <p>3. <u>The need to effectively incorporate utility scale energy storage systems into the BPS.</u></p>			<p><u>consider ways to expedite regulatory and environmental permitting processes to respond to changing infrastructure needs.</u> policymakers should promote and engage in high-level collaboration among market operators (RTOs/ISOs), balancing authorities in non-RTO/ISO market areas, and provinces and states to establish long-term strategies for aligning policies with reliability needs.</p> <p>5. <u>NERC should ensure that</u> As the <u>Inverter Based Resource Performance Task Force</u> (IRPTF) completes its scope of work, <u>the ERO Enterprise should consider and</u> and implements the recommendations needed to maintain reliability, <u>to</u>. The recommendations should include addressing any gaps in NERC Reliability Standards.</p> <p>4-6. <u>Work toward aligning IEEE, ANSI, and other standards for DER/sub-BPS resources with NERC standards.</u></p>			<p><u>industry practice.</u></p> <p>4. <u>New recommendation for implementation at policymaker level</u></p> <p>5. <u>PRC-024 SAR project initiated with SC.</u></p>

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Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
Bulk Power System Planning	<p>1. Planning and operating the BPS is becoming more complex due to:</p> <p>a. The <u>further erosion of generation resources, especially the loss of increased and accelerated rate of plant retirements, especially</u> conventional synchronous generation, coupled with the increasing integration of renewable, distributed, and asynchronous resources.</p> <p>b. <u>Increased risks with the transition from a traditionally diverse resource portfolio to one that is predominately natural gas and variable energy resources, with new fuel supply and technology risks.</u></p> <p>c. <u>Fuel sourcing and disruption capabilities, from weather events and other nature-based extreme conditions, are driving new scenarios and case studies.</u></p> <p>b. <u>Increased risks with the transition from a balanced resource portfolio, addressing fuel and technology risks, to one that is predominately natural gas and variable energy resources.</u></p> <p>2. <u>BPS Planners require incomplete new information exists</u> to perform BPS transient, mid-term, long-term, and small-signal stability studies, including consideration of interaction of BPS and resource controls, inertia/frequency response, voltage support (adequate dynamic and static reactive compensation), and ramping/balancing constraints due to the <u>timing and</u> dynamic performance of the <u>new</u> resource mix that changes throughout the day.</p> <p>3. The ability to perform accurate long-term planning assessments is more difficult due to:</p> <p>a. The need for more comprehensive load models.</p> <p>i. <u>The uncertainty and lack of visibility into load composition and resource mix along with imprecise or evolving models. The uncertainty and lack of visibility into load composition and situations where distributed generation mask the actual load along with evolving models.</u></p> <p>ii. <u>Complex load model and interaction with power electronics devices on a large scale at the distribution</u></p>			<p>Near-term (1–2 year time frame)</p> <p>1. The ERO Enterprise should identify the type and periodicity of information needed from DER <u>ensure the aggregate technical specifications of generation connected to local distribution grids are known to planners and operators. This data supports accurate system planning models, load forecasting, coordinated system protection, and real-time situational awareness to improve load and generator modeling and address coordination requirements between BPS and distribution system planners and operators to account for the uncertainty introduced by integration of variable generation, including the impact of weather on these resources.</u></p> <p>2. NERC, and industry should improve <u>interconnection frequency response modeling. Recent forward-looking interconnection-wide assessment for the Eastern and Western Interconnections highlighted need for improvement to address low-inertia conditions, locational constraints in parts of the system, and representation of DERs in load models. NERC and the Eastern, Western, and Texas interconnection study groups should work together to develop improved frequency response base case and scenario assessments working with the industry and forums, should develop guidelines and good industry practices for developing and maintaining accurate system and electromagnetic models that include the resources, load, and controllable devices that provide ERS, including the addition of benchmarking of dynamic models with PMU measurements based on actual system response to disturbance.</u></p> <p>3. <u>Establishing clear interconnection standards on all facilities (DERs, Storage, etc.) to BPS and clearly identify the control roles and responsibilities of the BES, BPS, and distribution operations roles and responsibilities.</u></p>			<p>1. SPIDERWG established to address issues in planning timeframe; workscope includes guidelines for DER data collection and modeling.</p> <p>2. New recommendation</p> <p>4. EGWG established; scope addresses identified reliability objectives</p>

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	<p>level that may affect BPS operations during disturbances. <u>Complex load and local resource controls and their unknown interaction with power electronics devices on a large scale at the distribution level that may affect BPS operations during disturbances</u> (e.g., fault-induced delayed voltage recovery).³</p> <p>b. An increasing need for transmission and system planning activities to include DER; however, limited data availability, information sharing, enhanced models required for both system and electro-magnetic transients, and a lack of coordination can hinder the ability of planners to complete this analysis.</p> <p>e-b. The increased deployment of DER within the distribution or behind-the-meter configurations that will impact how the BPS responds.</p> <p>d-c. Uncoordinated integration of controllable device settings and power electronics installed to stabilize the system.</p> <p>e-d. Changing and uncoordinated regulations of policymakers and regulatory authorities complicated by jurisdictional boundaries.</p> <p>4. Common mode or single points of failure, such as fuel delivery systems, that are emerging or have yet to be determined or evaluated.</p>			<p>Mid-term (3–5 year time frame)</p> <p>4. Develop Guidelines to Assess Fuel Limitations and Disruption Scenarios. Given the increased reliance on natural gas generation, system planners should identify potential system vulnerabilities that could occur under ex-treme, but realistic, contingencies and under various future supply port-folios. In addition, NERC’s Planning Committee should leverage industry experience and develop a reliability guideline that establishes a common framework for assessing fuel disruptions of various types. The industry-developed assessments can then be used to address potential regulatory needs or establish market mechanisms to better promote fuel assurance.</p> <p>2. The ERO Enterprise should collaborate with Planning Coordinators to assess the impact on reliability from well head, storage, and fuel delivery issues and how to assess them in long term planning studies.</p> <p>3. NERC should coordinate with Planning Coordinators to continually review existing and identify new planning methods and tools needed to respond to the changing system.</p>			

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³ FIDVR Alert

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Resource Adequacy and Performance	<ol style="list-style-type: none"> The traditional methods of assessing resource adequacy may not accurately or fully reflect the new resource mix ability to supply energy and reserves for all operating conditions. Forecasting BPS resource requirements to meet customer demand is becoming more difficult due to the penetration of DER, which can mask the customer's electric energy use and the operating characteristics of distributed resources without sufficient visibility. Conventional steam resources that operate infrequently due to economics may not operate reliably when dispatched for short peak-demand periods during seasonally hot or cold temperatures. Historic methods of assessing and allocating ancillary services such as regulation, ramping, frequency response, and voltage support may not ensure ERS or sufficient contingency reserves are available at all times during real-time operations. <u>Ramping capacity concerns, which up to now have been largely confined to limited locations, will expand as solar generation continues to grow.</u> Fuel constraints and environmental limitations may not be reflected in resource adequacy assessments. 			<p>Near-term (1-2 year time frame)</p> <ol style="list-style-type: none"> NERC should continue to address the recommendations from the Bulk Power System Impacts Due to Disruptions on the Natural Gas System⁴ special assessment. <ol style="list-style-type: none"> The ERO Enterprise and the industry should continue to expand the use of probabilistic approaches to develop resource adequacy measures that reflect variability and overall reliability characteristics of the resources and composite loads, including non-peak system conditions. Improve load forecasting that takes into account behind-the-meter resources, and coordination between BPS and distribution system planners and operators by analyzing data requirements necessary to ensure there is sufficient detail on the capability and performance of the BPS as it is impacted by DER. The industry should gather data beyond simple demand forecasts and expand to identify resource capacity, location, and ERS capability. The ERO Enterprise and industry should continue to assess vulnerabilities from fuel availability as part of evaluating adequacy and capability to deliver resources. This should include the addition and refinement of the <u>Generator Availability Data System</u> (GADS) to collect more information on fuel availability and its impact. <u>NERC should lead the electric industry in developing approaches and metrics to assess energy adequacy. The changing resource mix can alter the energy and availability characteristics of the generation fleet. Analysis is needed to determine energy sufficiency, including off-peak periods and locations where energy-limited resources are prominent.</u> <u>Continue to promote frequency response capabilities of BPS resources. Regulators and markets should continue to support modifications and improvements to generator interconnection agreements that provide for frequency responsive generation. NERC should enhance performance</u> 			<ol style="list-style-type: none"> Addressed in RAS/PAWG scope In scope for SPIDERWG and RAS. SPIDERWG is developing data collection and load forecasting guidelines. RAS collects info on DER penetration, and is a forum for developing solutions to resource adequacy challenges. NERC and GADSWG are reviewing GADS data coll enhancement for fuel assurance New recommendation for NERC PC RAS action. New recommendation

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⁴ http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_SPOD_11142017_Final.pdf

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				<p>analysis to be able to observe the effects of the changing resource mix on frequency response and voltage support. NERC should also expand collaboration with NAGF and other stakeholders to increase frequency response awareness and capabilities.</p> <p>4-6. Planners should ensure sufficient flexible ramping capacity is available to meet needs of increasing variable energy resources.</p>			<p>n from SOR 2018</p> <p>6. New recommendation from 2018 LTRA</p>
Increasing Complexity in Protection and Control Systems	<p>1. <u>Increasingly complex protection and control systems that must be properly designed, coordinated, managed, and maintained to prevent or mitigate events. Increasingly complex protection and control systems on the BPS and the DER systems that must be properly designed, coordinated, managed, and maintained to prevent or mitigate events.</u></p> <p>2. BPS remedial action scheme failures as well as protection and control system misoperations that exacerbate the impact from events, which significantly increases the risk for uncontrolled cascading of the BPS.</p> <p>4-3. <u>DER and renewable resource control systems that exacerbate the impact from events, which significantly and could increase the risk for increases the risk for uncontrolled cascading of the BPS.</u></p>			<p>Near-term (1-2 year time frame)</p> <p>1. NERC should work with industry experts and the forums to promote the development of industry guidelines on protection and control system management to improve performance.</p> <p>2. <u>NERC should publish detailed data reporting instructions (DRI) for misoperations to create better alignment of entity understanding and more consistent misoperation data.</u></p> <p>3. <u>Outreach across the ERO Enterprise is needed, including education and training with industry and stakeholders to reduce protection system misoperations. NERC should also continue to support sharing good industry practices and lessons learned to maintain a downward trend in misoperations rate.</u></p> <p>2. <u>The ERO Enterprise should determine whether enhancements are required to the current family of protection and control (PRC) standards or related NERC guidance materials.</u></p> <p>Mid-term (3-5 year time frame)</p> <p>2. <u>The ERO Enterprise should encourage industry forums, research organizations, and technical committees to share technologies or processes on condition monitoring, failure</u></p>			<p>1. <u>Work is underway by MIDASWG</u></p> <p>2, 3. <u>Recommendations from the SOR.</u></p> <p>4. <u>Several potential updates to PRC family of standards are in consideration, including IRPTF's SAR on PRC-024, SPCS SAR for PRC-023, 019 standards, and implementation guidance for PRC-019.</u></p>

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Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Control Risk Risk Control	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
				<p>prevention, spare sharing, resilience, and recovery, failure prevention, spare sharing, resilience, and recovery.</p> <p>4. <u>The ERO Enterprise should provide the technical basis for BPS resilience enhancements.</u></p> <p>Long-term (greater than 5-year time frame)</p> <p>4-5. <u>Recognize the risks of shorter technology lives for protection and control system components and the need to implement replacement programs that do not impact BPS reliability.</u></p>			
Human Performance and Skilled Workforce	<ol style="list-style-type: none"> Organizations not implementing improvements based on past events, experiences, good industry practices, or keeping an eye on the implementation of new technologies that can hinder future operations improvements; gaps in skillsets or organizational improvement must be a priority. Significant increase in operational complexity resulting in more extensive training needs associated with new technology and related compliance control strategy. Turnover of key skilled or experienced workers (e.g., relay technicians, operators, engineers, IT support, and substation maintenance) that will lead to more protection and control system misoperations. Complicated new multi-discipline control and protection schemes that are beyond the skillset of the existing workforce. A lack of training programs that prevent closing skillset gaps quickly. Inadequate management oversight or controls leads to organizational weaknesses and inefficiencies. Ineffective corrective actions lead to repeated HP errors. Legacy systems and new technology result in disparity of the skillsets needed for BPS reliability. 			<p>Near-term (1–2 year time frame)</p> <ol style="list-style-type: none"> The ERO Enterprise and industry forums should expand their communication and encourage sharing of good industry practices for increasing HP effectiveness (publishing lessons learned/good industry practices and supporting the NERC and NATF HP conference and other related workshops). NERC should encourage industry and trade associations to identify skill gaps and develop recommendations to address them (e.g., curricula, programs, industry support, and educational pipeline programs), including those which may be associated with protection and control schemes. The ERO Enterprise and the industry should promote the use of NERC cause codes to establish a common understanding of HP triggers, collect and evaluate trends in data, and develop metrics as needed. The industry should leverage data sources such as event analysis, Transmission Availability Data System (TADS), Generating Availability Data System (GADS), Demand Response Availability Data System (DADS), relay misoperations, EOP-004/OE-417 Reports, and AC equipment failures to identify patterns and risk. 			

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Commented [PC10]: Is this specifically related to protection systems, or is it general resilience. Unclear.

Commented [PC11]: Does this recommendation apply to the P&C risk category, or is it for one of the extreme event categories below? May need to be reworded to make the connection clearer.

Commented [PC12]: This recommendation does not seem to be well correlated to an identified risk, either in this table or in NERC's assessments. It should be removed, or linked to a risk description.

Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
	9. Need for professionals with OT/ICS/SCADA cybersecurity experience in general.			<p>Long-term (greater than 5-year time frame)</p> <p>5. Industry and trade organizations, such as NATF, should develop and implement a sustainable process to analyze and disseminate good industry practices for HP.</p> <p>6. Industry standards and regulatory rules should consider the human skillset changes and training needs as part of their development.</p> <p>Provide cross training and rotational career/role opportunities for legacy engineering roles to train or rotate into cyber roles or rotate security resources into operations roles; pursue more creative recruiting practices for cyber roles, pursuing internships at the high school and college level to grow longer-term employee base.</p> <p>6-7. Consider exploration of an independent 3rd party being responsible for receiving near miss reports in order to address hesitation that may otherwise exist in reporting near misses to a compliance affiliated body.</p>			
Loss of Situational Awareness	<ol style="list-style-type: none"> Limited real-time visibility to and beyond the immediate neighboring facilities. A lack of common status information on infrastructures and resources on which operators rely (e.g., gas, dispersed resources, DER, and data and voice communications). Information overload during system events. Inadequate tools or fully capable back-up tools to address reliability. Lack of training on the tools and information to assess system reliability at a given point in time. Incomplete data and model accuracy used to feed into real-time operations. Dependency on telecommunications systems for situational awareness. 			<p>Near-term (1–2 year time frame)</p> <ol style="list-style-type: none"> The ERO Enterprise should evaluate whether key applications such as real time contingency analysis are over reliant on a service provider and identify mitigating actions to reduce the risk. The ERO Enterprise should identify the type and frequency of information needed from DER for real-time situational awareness. Continue a strong event analysis program, look at EMS outages and failures, and share lessons learned as well as use the data and information gained to inform the annual NERC Monitoring and Situation Awareness conference. Industry and the E-ISAC should continue to enhance their understanding and sharing of information regarding the operational technology (OT) system cyber security risks and associated mitigation strategies. 			

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Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
	<p>8. Cyber risk and vulnerabilities pose threat to OT-operational technology control systems.</p> <p>9. Current Federal Communications Commission (FCC) proposal to open up the wireless communication band heavily used by utilities (6 GHz spectrum) for unlicensed use. There is a fear among industry trade groups that this could lead to a high potential for radio frequency interference that may underpin the safety and reliability of the grid.</p>			<p>Mid-term (3-5 year time frame)</p> <p>5. NERC, in concert with industry and trade organizations, should improve its set of real-time indicators of interconnection health.</p> <p>6. NERC should work with industry to engage EPRI to develop a supplement or companion to the <i>Interconnected Power System Dynamics Tutorial</i> that deals with wide-area monitoring under a changing resource mix based on the near-term deliverables above.</p> <p>7. The industry, trade organizations, and other industry groups such as the North American Synchrophasor Initiative (NASPI) should develop a suite of supplemental tools that use synchrophasor data (e.g., state estimator, contingency analysis, etc.) to improve situational awareness, provide early warning for operators regarding deteriorating conditions, and assist in recovery from disturbances.</p> <p>8. Evaluate the risks of private telecommunication systems as compared to use of public systems for Supervisory Control and Data Acquisition (SCADA) systems.</p> <p>Long-term (Greater than 5-year time frame)</p> <p>9. The ERO Enterprise should engage with industry and trades organizations to identify options for the delivery of data critical for situational awareness in situations where EMS systems are down for extended periods.</p> <p>10. The ERO Enterprise should work with industry and EMS vendors to establish forums to identify options for improving situational awareness tools utilizing EMS data including the integration of synchrophasor data.</p>			

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Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Control Risk Risk Control	Effectiveness Impact (Scale 1-10-See Risk Criteria)	Effectiveness Likelihood (Scale 1-10-See Risk Criteria)	Ongoing activities
Extreme Natural Events	<ol style="list-style-type: none"> Lack of preparation for GMD events could lead to widespread loss of load due to voltage instability in certain regions. Widespread damage to certain types of BPS infrastructure can extend outages due to unavailability of nearby replacement equipment or specialized capabilities. Physical damage to equipment and fuel supply sources, such as natural gas pipelines or other energy storage facilities including hydro. Damage to voice and data communications, as well as water supplies, can make certain critical facilities vulnerable and reduce the ability to serve load. The industry does not have full knowledge, shared documentation, or coordination in accessing and assessing compatibility of the existing spare equipment inventory across geographical and political boundaries. 			<p>Near-term (1-2 year time frame)</p> <ol style="list-style-type: none"> <u>Study multiple simultaneous limitations on natural gas deliveries during extreme weather.</u> <u>NERC should encourage participation in mutual assistance programs, with collaboration from government and non-government authorities. Mutual assistance agreements provide essential personnel, equipment, and material, as observed in recent hurricane experiences.</u> <u>NERC, in collaboration with industry, should publish information to promote effective drone use during emergencies. Coordination with government and first responders is critical for successful drone use.</u> <u>NERC and industry should plan a workshop that is coordinated with U.S., Canadian, and Mexican federal agencies and governmental authorities to address high-impact low-frequency event response, recovery, and communications vulnerabilities.</u> <p>Mid-term (3-5 year time frame)</p> <p>4-5 NERC should conduct detailed special assessments of <u>extreme natural event impacts</u> that integrate:</p> <ol style="list-style-type: none"> <u>Infrastructure interdependencies (e.g., telecommunications, water supply, generator fuel supply), in addition to fuel-related, such as telecommunications and water supply.</u> Analytic data trend insights regarding resilience under severe weather conditions, identifying preventable aspects for BPS reliability. <ol style="list-style-type: none"> <u>Better understand the interdependence of the telecommunication infrastructure and electric infrastructure during a natural disaster.</u> 			<p><u>5. Analysis of GMD events and data is in scope for the GMDTF. 5.a. NERC Staff and GMDTF are implementing the NERC RoP Sect 1600 Data Request for GMD Data Collection.</u></p>

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Commented [PC13]: Does this recommendation still fit in the RISC Report, given the activities underway following SPOD and LTRA? If it remains a recommendation it should be directed at a group for action (ERO-Enterprise)

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Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
				<p>Long-term (greater than 5-year time frame)</p> <p>2-7. Analyze data from GMD events to further the understanding of geomagnetically induced current effects on BES facilities to support enhancements to models and standards.</p> <p>2-8. To facilitate preparedness, consider preparing sensitivity analyses to simulate the impacts from the most extreme natural events experienced to date in a planning area.</p>			
Physical Security Vulnerabilities	<ol style="list-style-type: none"> 1. Evolving threat around physical attacks. 2. The exposed nature of parts of the grid makes it difficult to protect. 3. Long lead times associated with manufacturing and replacing some equipment, which can increase complexity of restoration after physical attacks that damage BPS equipment. 4. Incorrect assumptions on availability of replacement equipment. 5. Physical damage to generation fuel sources and transport networks which could degrade the reliable operations of the BPS. 6. Damage to necessary telecommunications and water supplies, which could make certain critical facilities vulnerable and reduce the ability to serve load. 			<p>Near-term (1-2 year time frame)</p> <ol style="list-style-type: none"> 1. The ERO Enterprise should develop performance metrics measuring and prioritizing potential physical attacks that will result in system disturbances while differentiating them from vandalism or theft incidents. 2. Assess the risks of physical attack scenarios on midstream or interstate natural gas pipelines, particularly where natural gas availability will impact generation and the reliability of the BPS. 3. Based on recommendations and identified risks outlined in EPRI's EMP report⁵ and soon to be released results for EMP shielding requirements, determine the need to develop Reliability Standards, reliability guidelines, industry webinars, or additional analysis to address EMP events as necessary. 4. NERC should seek input from water, telecommunications, and gas ISACs in the development of physical security Reliability Standards. 			

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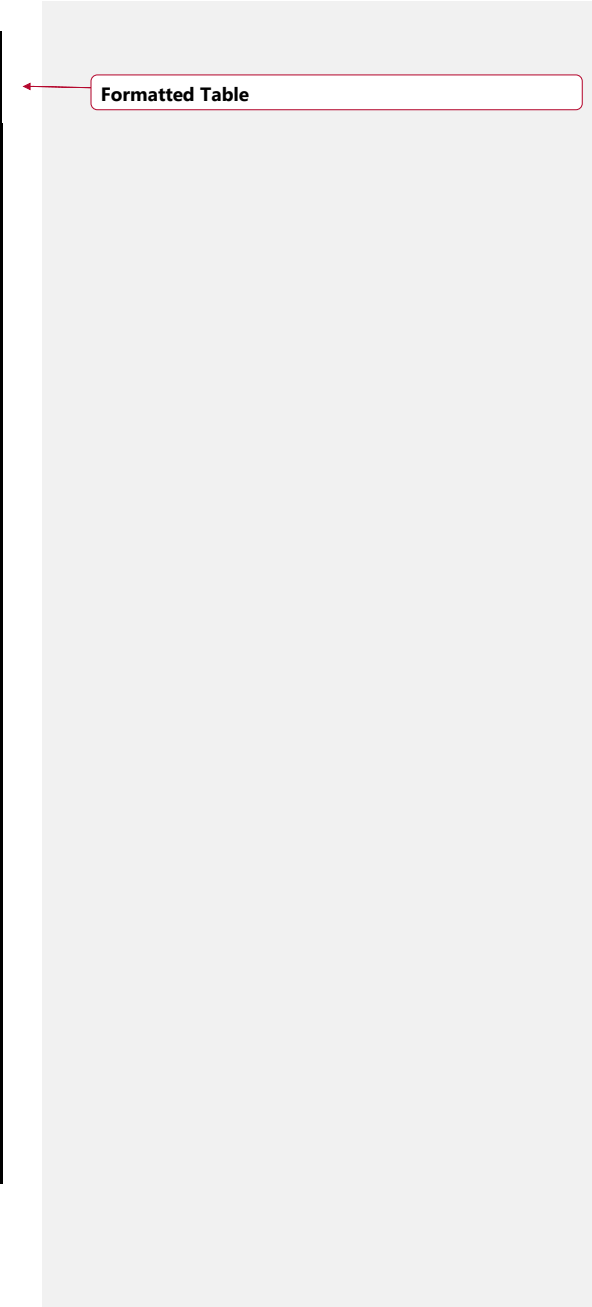
⁵ See *Magneto-hydrodynamic Electromagnetic Pulse Assessment of the Continental U.S. Electric Grid: Geomagnetically Induced Current and Transformer Thermal Analysis*: <https://publicdownload.epri.com/PublicDownload.svc/product=000000003002009001/type=Product>

Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Mitigation Actions Description (Include any shared internal controls)	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
				Mid-term (3–5 year time frame) 5. Conduct a special regional assessment that addresses natural gas availability and pipeline impacts under physical attack scenarios. 6. National government agencies (e.g., Department of Energy, Natural Resources Canada, Secretaría de Energía (SENER)), industry, trades, and forums should identify appropriate mitigation strategies to fill spare equipment gaps and transportation logistics shortcomings.			
Cybersecurity Risk	<ol style="list-style-type: none"> 1. Cybersecurity threats result from exploitation of both external and internal vulnerabilities: <ol style="list-style-type: none"> a. Exploitation of employee and insider access. b. Weak security practices of host utilities, third-party service providers and vendors⁶, and other organizations. c. Unknown, undisclosed, or unaddressed vulnerabilities in cyber systems. d. Growing sophistication of bad actors, nation states, and collaboration between these groups. 2. Interdependencies from the critical infrastructure sectors, such as Communications, Financial Services, Oil and Natural Gas Subsector, and Water, where sector-specific vulnerabilities can impact BPS reliability. 3. Legacy architecture coupled with the increased connectivity of the grid expands the attack surface of BPS protection and control systems: <ol style="list-style-type: none"> a. Increased automation of the BPS through control systems implementation. 			Near-term (1–2 year time frame) <ol style="list-style-type: none"> 1. In collaboration with the CIPC and industry stakeholders, develop a risk process to address the potential impacts of cybersecurity threats and vulnerabilities. 2. The E-ISAC should continue information sharing protocols among interdependent ISACs to increase the visibility into cyber and physical security threats. 3. Facilitate planning considerations to reduce the number and exposure of critical cyber facilities to attack. 4. The ERO Enterprise and the E-ISAC should develop metrics regarding the trend of cyber-attacks and potential threats. 5. The industry should develop focused training and education programs and/or share best practices to address the shortage of skilled and experienced cybersecurity professionals, as well as IT professionals with BPS operations experience. 6. Industry and the E-ISAC should take steps to increase its knowledge and understanding of systemic cyber risks affecting the sector, as well as cross sector dependencies and develop appropriate mitigation strategies 			

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⁶ See Reliability Standard CIP-013-1, Supply Chain Risk Management: <http://www.nerc.com/pa/Stand/Reliability%20Standards/CIP-013-1.pdf>.

Baseline Risk				Risk Mitigation Activities			
Risk Name	Description of Risk	Baseline Impact ¹ (Scale 1-10 See Risk Criteria)	Baseline Likelihood	Control Risk Risk Control	Effectiveness Impact (Scale 1-10 See Risk Criteria)	Effectiveness Likelihood (Scale 1-10 See Risk Criteria)	Ongoing activities
	<ul style="list-style-type: none"> b. The trend towards increased integration of IT operating systems may increase in the attack surface and associated attack risk. c. IT/operational technology (OT) control system infrastructure management, out-of-date operating systems, and the lack of patching capability/discipline. <p>4. Technologies and services</p> <ul style="list-style-type: none"> a. Increased reliance on third-party service providers and cloud-based services for BPS operations and support <u>with the opportunity to increase security if managed properly</u>. b. Cybersecurity risks in the supply chain: software integrity and authenticity; vendor remote access; information system planning; and vendor risk management and procurement controls. <p>5. Ineffective teamwork and collaboration among the federal, provincial, state, local government, private sector and critical infrastructure owners can exacerbate cyber events.</p> <p>6. A lack of staff that is knowledgeable and experienced in cybersecurity of control systems and supporting IT/OT networks (historically separate organizations and skillsets). This risk is symptomatic across all industries and is a risk because it hinders an organization's ability to prevent, detect, and respond to cyber incidents due to organizational silos.</p> <p>7. The rapid growth in sophistication and widespread availability of tools and processes designed to exploit vulnerabilities and weaknesses in BPS technologies and in connected IT networks and systems.</p> <p>8. Lack of in-depth understanding of systemic cyber risks affecting the electricity sector and related cross sector dependencies</p>			<p>Mid-term (3–5 year time frame)</p> <p>7. The ERO Enterprise should develop a feedback mechanism from CIP standards implementation to evaluate the standard and lessons learned from new technology deployments.</p> <p>8. The ERO Enterprise with industry should develop agreed-upon levels of cyber-resilience suitable for BPS planning and operations.</p> <p>9. Take advantage of data correlation tools and services provided by software tools and services such as those provided by E-ISAC and Fusion Centers.</p> <p>10. Take advantage of peer cyber program reviews and third-party security assessments to help ensure strong cyber program processes and tools spanning prevention, detection, and response.</p> <p>Long-term (greater than 5-year time frame)</p> <p>11. The ERO Enterprise and industry should develop methods, models, and tools to simulate cyber impacts on system reliability, enabling BPS planning to withstand an agreed-upon level of cyber resilience.</p>			



RISC Profile Proposal

This is a proposal by the Planning Committee leadership to revise the current slate of “Risk Profiles” currently provided in the latest Reliability Issues Steering Committee report: <https://www.nerc.com/comm/RISC/Related%20Files%20DL/ERO-Reliability- Risk Priorities- Report Board Accepted February 2018.pdf>

Proposal: Make revisions to the RISC Profiles 1 through 3 (1-Changing Resource Mix; 2-BPS Planning; 3-Resource Adequacy and Performance) to reflect more clearly defined “Risk Profiles”.

Current Challenge: The current risk profiles (1-3) have redundant aspects to them and contain unclear boundaries. The color coding in the chart below was created to show apparent redundancies in themes and activities within the current RISC profile template. In addition, the risk profile title should help describe the actual risk. For example, “Changing Resource Mix” is not necessarily a risk. The risk could be many things, such as, “loss of load due to widespread fuel disruption” or “insufficient inertial response to support credible disturbances”.

Review of Current Profiles:

Review of Current Profiles		
Profile	Key Themes	Recommended Activities
1- Changing Resource Mix	Inverters and control devices	Improve control device settings
	Gas-fired generation and fuel	DER data collection
	Renewable integration	Collaborate on ERS
	Time to adapt	Collaborate with policy makers
	Essential Reliability Services	Complete IRPTF
	Distributed Energy Resources	
2- BPS Planning	Reactive, more complex planning	DER data collection
	Time to adapt	Improve control device settings
	Renewable integration	Improve system models
	Essential Reliability Services	
	Load Models	
	Distributed Energy Resources	
	Inverters and control devices	
	Gas-fired generation and fuel	
3- Resource Adequacy and Performance	Gas-fired generation and fuel	Recommendations to mitigate fuel disruption risks
	Distributed Energy Resources	Expand probabilistic assessment
	Renewable integration	Improve load forecasting
	Essential Reliability Services	Interconnection standards
	Resource Adequacy, Capacity/Energy Reserves	

	Load forecasting	
	Generation availability	

Proposed Risk Profiles:

Proposed Risk Profiles				
Profile Name	Key Themes	Activities	Threats	Vulnerabilities
1- Planning for large amounts of inverter-based resources in <u>Future Periods</u>	Ensure inverter-based resources are integrated properly based on BPS reliability requirements	Improve control device settings	Increasing amounts of inverter-based resources	Planning and modeling requirements do not fully capture the inherent characteristics of inverter-based resource behavior
	Ensure DER doesn't adversely impact BPS reliability	DER data collection guidelines	Increasing amounts of DER	Planning and modeling requirements do not fully capture the inherent characteristics of DER behavior
	Ensure critical system attributes, such as Essential Reliability Services, are maintained	Collaborate on ERS to ensure sufficiency in planning	Retiring generation can reduce ERS	Planning requirements may not be clear on what is needed from ERS
	Ensure system models are of high quality and fidelity, and capture the inherent characteristics of inverter-based resources.	Improve system models, load models	Increasing complexity of modeling requirement	Model building processes and validation
2- Managing Increasing Energy Limitations/Ensuring Energy Adequacy	Ensure renewable generation energy limitations are incorporated into adequacy analysis	Ensure probabilistic and energy adequacy assessments are advancing	Increasing amount of renewables	Supply and demand imbalance
	Ensure limitations from other energy sources, such as liquid fuels, are incorporated into adequacy analysis	Improve load forecasting	Increasing amount of gas-fired generation	Supply and demand imbalance
	Ensure energy limitations and/or fuel disruptions due to extreme conditions are incorporated into adequacy analysis	Assess fuel constraints in extreme conditions	Single points of disruption and/or interrupted fuel supplies.	Supply and demand imbalance

ERO Reliability Risk Priorities Report Timeline

Tasks	Due Date	Responsible Party
NERC Staff Review of the Emerging Risks Survey Template	No later than January 11	NERC Staff
RISC Review of the Updated Emerging Risks Survey Template	No later than January 28	RISC Committee
Standing Committees Review of the Emerging Risks Survey Template	No later than February 28	Standing Committee Chairs
Standing Committee Review of Additional Activities Presented as Part of the RISC Resilience Report	After Completion of March 2019 Standing Committee Meetings	Standing Committee Chairs
2019 Reliability Leadership Summit	March 14	RISC Committee
RISC In-Person Committee Meeting	March 15	RISC Committee
Distribution of Emerging Risks Survey to Determined Industry Pool	No later than March 22	NERC Staff
Draft Inventory of Risks Provided to NERC for Incorporation into Draft NERC Operating Plan	No later than April 19	NERC Staff
Review of Draft Operating Plan/Inventory of Risks by NERC Board	May Board Closed Session	NERC Staff/Board
RISC Committee Meeting to Review Updated Emerging Risks Survey, Update from Standing Committees on Additional Activities – Feed into Draft RISC Report	Mid-May?	RISC Committee
RISC Committee Review Draft RISC Report	Early-June?	RISC Committee
RISC Committee Review of Proposed Final Report	Early July	RISC Committee
RISC Report presented as part of Policy Input	Mid-July	NERC Staff
RISC Report presented to NERC Board for Acceptance	August 15	RISC Committee

2019 Industry Dashboard Metrics

Action

Identify a sub-group or reach out to industry to form a task force to support the development of a background user manual for the Industry Dashboard and make recommendations for the 2020 Industry Dashboard.

Background

The ERO Enterprise continues to refine its metrics to accurately measure industry and organizational performance. This year, the Board of Trustees (Board) approved two elements of performance: 1) ERO Enterprise Work Plan and 2) Industry Dashboard. The 2019 Industry Dashboard is intended to track reliability indicators across the bulk power system as an awareness tool of system performance useful to the ERO and industry as a whole. These metrics will also enable monitoring of key areas of interest such as vegetation management, as well as changes in system performance such as protection system misoperations that might guide the ERO's and industry's work prioritization.

Though many of these metrics are similar to those seen over the past several years, MRC policy input provided valuable insights: 1) desire to put the metrics in context of what actions industry can take towards improvement, 2) currently available data sources, 3) new metrics that provide deeper information about system performance.

The RISC is charged by the Board to review the existing metrics, develop a user manual that supports the current set of metrics (including their context, potential industry actions and data sources), and recommend improvements and/or specific data requirements for the 2020 Industry Dashboard.

Attachment

- **2019 Industry Dashboard Metrics**

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

2019 ERO Enterprise Dashboard Metrics

RELIABILITY | ACCOUNTABILITY



1. Fewer, less severe events (Goals 1-5)*
2. Compliance violations (Goals 1 & 2)
3. Protection system misoperations rate and misoperations with loss of load (Goals 1-4)
4. Events caused by generating unit forced outages due to cold weather or fuel unavailability (Goals 1-4)
5. Reduce AC Transmission line forced outages (Goals 1-4)
6. Unauthorized physical or electronic access (Goals 1-3 & 5)

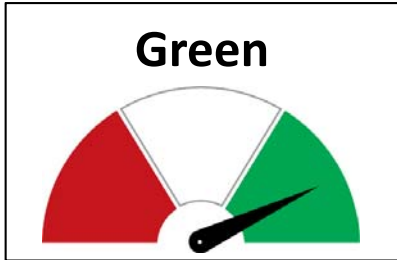
7. Disturbance control events greater than the most severe single contingency (Goals 1-4)
8. Interconnection Frequency Response (Goals 1-4)

* [2017 ERO Enterprise Operating Plan](#) Goals: 1) Risk-responsive Reliability Standards, 2) Objective, risk-informed entity registration, compliance monitoring, mitigation, and enforcement, 3) Reduction of known reliability risks, 4) Identification and assessment of emerging reliability risks, 5) Identification and reduction of cyber and physical security risks, & 6) Improving ERO Enterprise efficiency and effectiveness

Inferential statistics will be calculated when sample sizes are appropriate at a 95% confidence interval.

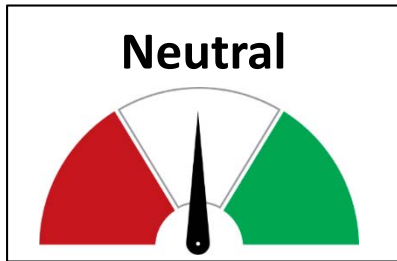
**Dashboards are for illustrative purposes only and are not meant to represent current status or projections.*

Green



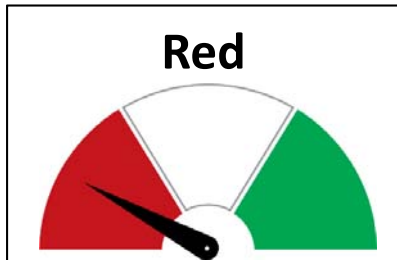
Risk indicator getting better

Neutral



Risk indicator between getting better and getting worse

Red



Risk indicator getting worse

Pass/Fail



Risk indicator either met or did not


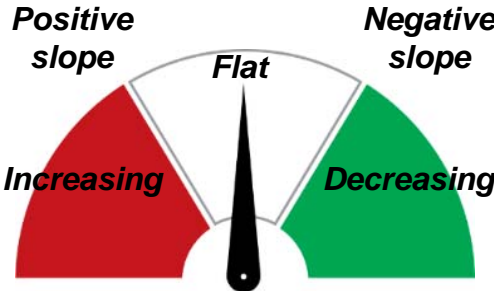
Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

- **Why is it important?**

- Measures risk to the bulk power system (BPS) from events on the Bulk Electric System (BES)




- **How is it measured?**

- Cumulative eSRI line in the composite daily event Severity Risk Index (eSRI) for Category 1–3 events (see pages 2-3 of [ERO Event Analysis Process](#) for category determination)

<p>Data (Annual Measurement)</p> <ul style="list-style-type: none"> ▪ No Category 3 or above events: <i>Zero is green, else is red</i> 	<p>2019 Status</p> 
<p>Data (Compared to a 3-year rolling average)</p> <ul style="list-style-type: none"> ▪ Slope of eSRI line is flat to decreasing and does not show an increase above zero that is statistically significant (95% Confidence Interval) ▪ “2019 Status” relates to the slope of the 3-year rolling average (Positive, Flat or Negative), not just the 2019 performance 	

Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

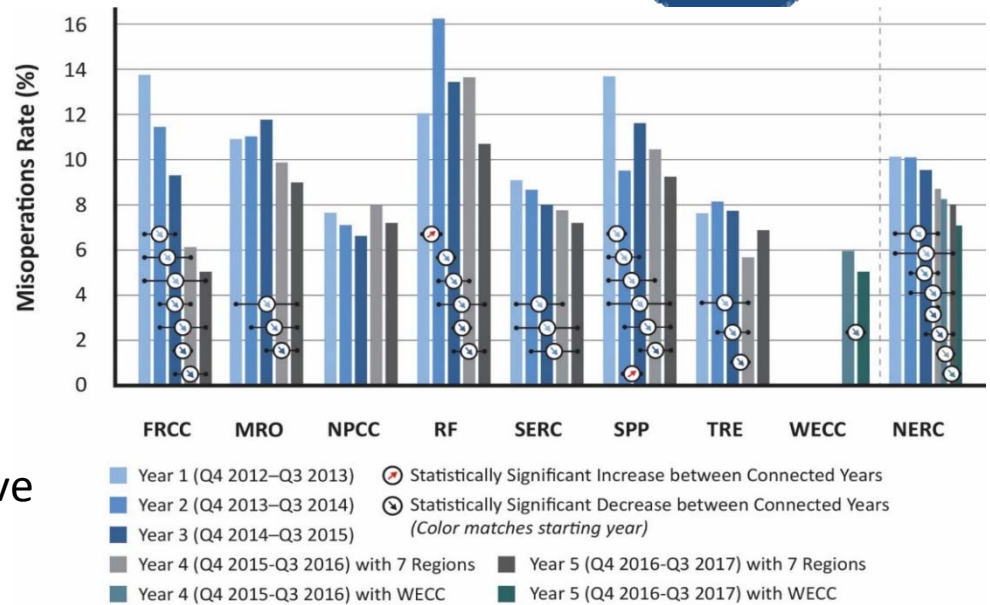
- **Why is it important?**
 - Reduce risk to BPS reliability from Standard violations by registered entities
- **How is it measured?**
 - Compliance History* of moderate/serious risk noncompliance
 - The number of violations discovered through self-reports, audits, etc.
 - Risk to the BPS based on the severity of Standard violations

<p>Data (Annual Measurement)</p> <ul style="list-style-type: none"> ▪ Moderate and serious risk repeat violations filed with FERC on organizations that have Compliance History (based on 2017 metric) 	<p style="text-align: center;">2019 Status</p>  <p>A gauge chart with a needle pointing to the center. The left side is red and labeled '48'. The right side is green and labeled '45'.</p>
<p>Data (Annual Measurement)</p> <ul style="list-style-type: none"> ▪ Percent of noncompliance self-reported (Self-certified noncompliance is not included) (same as 2018 metric) 	 <p>A gauge chart with a needle pointing to the center. The left side is red and labeled '75%'. The right side is green and labeled '80%'.</p>
<p>Data (Compared to a 3-year rolling average)</p> <ul style="list-style-type: none"> ▪ The number of serious risk violations resolved compared to the total noncompliance resolved (based on 2018 metric) 	 <p>A gauge chart with a needle pointing to the center. The left side is red and labeled '5%'. The right side is green and labeled '4%'.</p>

* To measure the effectiveness of the risk-based CMEP in reducing noncompliance, NERC reviews moderate and serious risk violations and includes them in one of three categories: 1) noncompliance with no prior compliance history; 2) noncompliance with prior compliance history that does not involve similar conduct; and 3) noncompliance with compliance history that includes similar conduct.

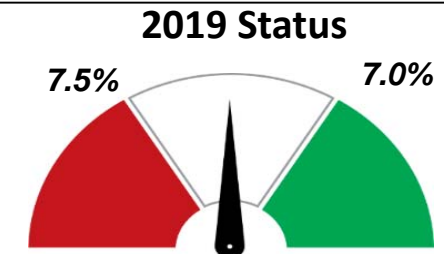
Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

- **Why is it important?**
 - Protection system misoperations exacerbate the impacts
- **How is it measured?**
 - Annual Misoperations rate and the annual cumulative loss of load for events with misoperations (cumulative rate through Q2 2019)



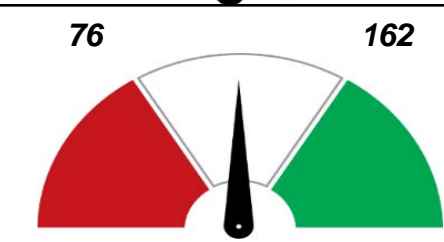
Data (Year-Over-Year Comparison)

- Q3-Q2 comparison misoperations rate based on collection interval (95% Confidence Interval) (Based on 2018 Metric)



Data (Year-Over-Year Comparison)

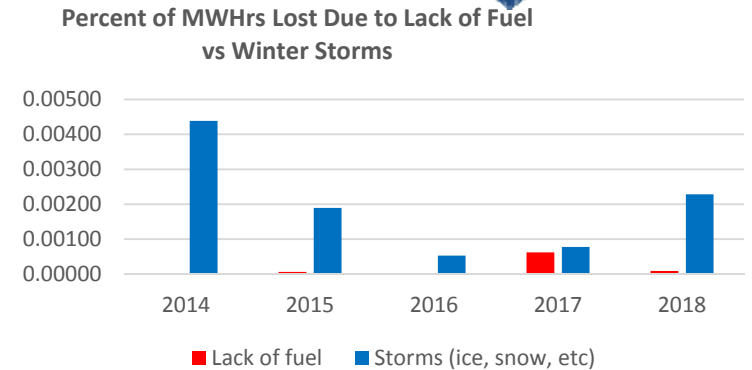
- Q3-Q2 comparison for qualified events with misoperations and loss of load (load loss/number of events) during the collection interval (95% Confidence Interval) (New)



Metric 4: Events Caused by Gas-Fired Unit Forced Outages Due to Cold Weather or Gas Unavailability

Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

- **Why is it important?**
 - Reduce risk to BPS reliability due to gas-fired unit outages during cold weather or gas unavailability
- **How is it measured?**
 - Firm load loss due to cold weather or gas unavailability
 - MWh of potential production lost initiated by cold weather and gas unavailability



<p>Data (Annual Measurement)</p> <ul style="list-style-type: none"> ▪ No firm load loss due to gas-fired unit outages during cold weather: <i>Zero is green, else is red</i> 	<p>2019 Status</p>
<p>Data (Annual Measurement)</p> <ul style="list-style-type: none"> ▪ No firm load loss due to gas unavailability: <i>Zero is green, else is red</i> 	
<p>Data (Compared to a 5-year rolling average)</p> <ul style="list-style-type: none"> ▪ Percentage of winter period net MWh of potential production lost due to gas-fired unit outages during cold weather (Winter season January – March and December of the same calendar year) 	<p>0.192% 0.0898%</p>
<p>Data (Compared to a 5-year rolling average)</p> <ul style="list-style-type: none"> ▪ Percentage of annual net MWh of potential production lost due gas unavailability compared to a 5-year rolling average (Due to data availability, year defined as Q3-Q2) 	<p>0.00149% 0.00053%</p>

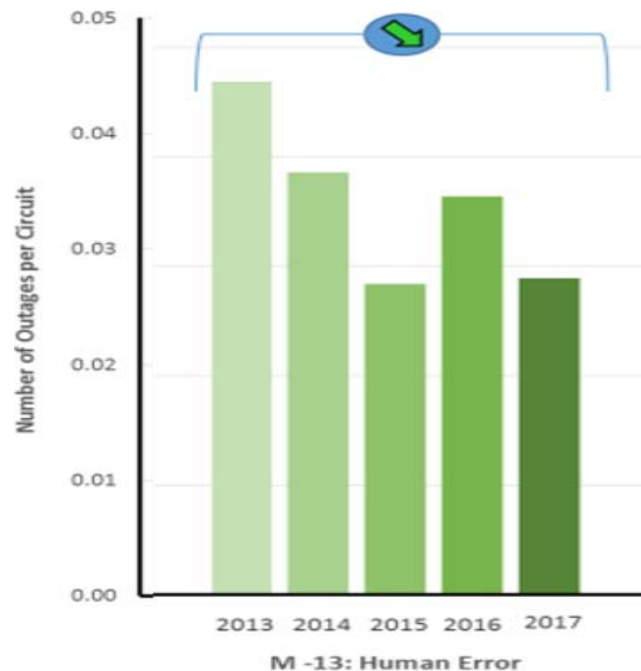
- **Why is it important?**

- Measures risks to BPS reliability from three priority causes:
 1. Operator or other human performance issues
 2. Substation equipment failures or failed circuit equipment
 3. Vegetation encroachment

Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

• **How is it measured?**

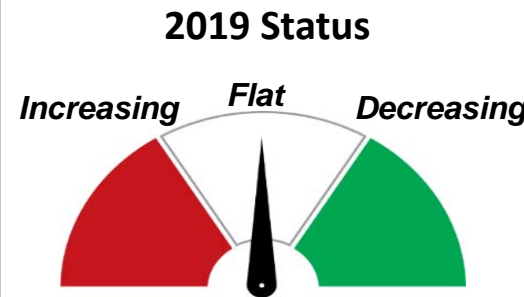
- Number of transmission line outages caused by Human Error divided by the total inventory of circuits



Data (Compared to a 5-year rolling average)

- Annual outage rate* decreasing compared to a 5-year rolling average (95% Confidence Interval) (Based on 2018 metric)

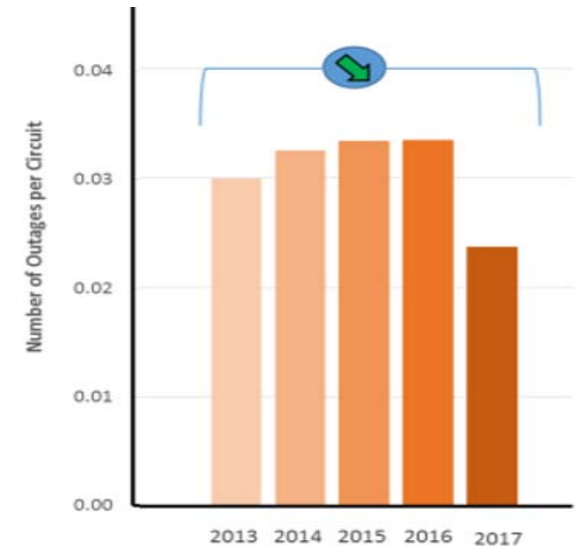
* Due to data availability, collection year defined as Q3-Q2



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• How is it measured?

- Number of transmission line outages caused by AC substation equipment failures and failed AC circuit equipment (such as transformers), divided by the total inventory of circuits



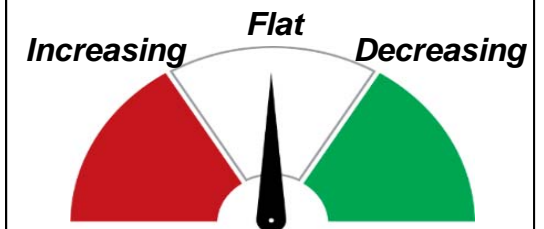
M-14: Failed AC Substation Equipment

Data (Compared to a 3-year rolling average)

- Annual outage rate* decreasing compared to a 3-year rolling average (95% Confidence Interval) (Based on 2018 metric)

* Due to data availability, collection year defined as Q3-Q2

2019 Status



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• How is it measured?

- Number of possible FAC-003 violations*

Year: #

2018: 4

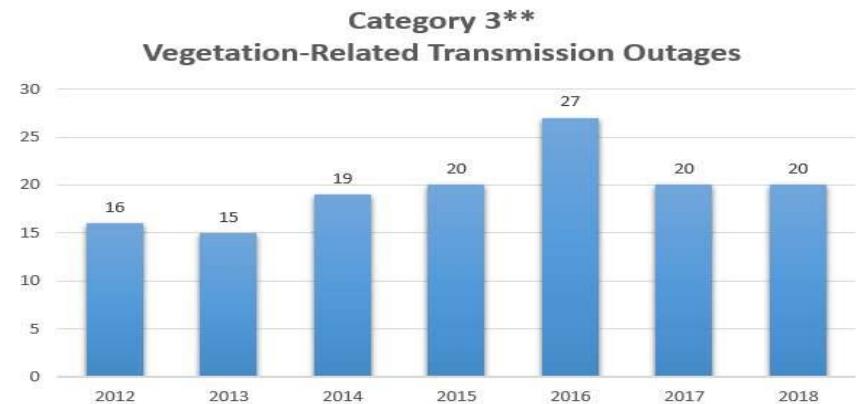
2017: 6

2016: 0

2015: 3

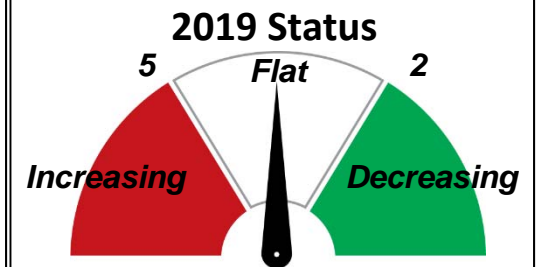
2014: 0

Mean = 2.6 Standard deviation = 2.33



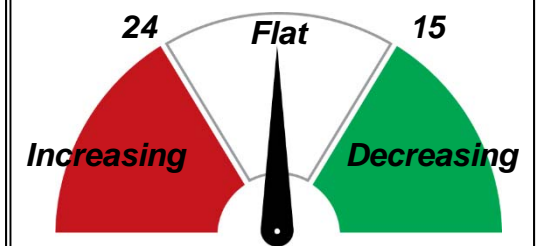
Data* (Compared to a 5-year rolling average)

- Number of vegetation encroachments reported as possible FAC-003 violations decreasing (within one standard deviation, based on small sample size) (Based on 2018 metric)



Data** (Compared to a 5-year rolling average)

- Fall-ins: Number of vegetation fall-ins resulting in sustained outages decreasing (within one standard deviation, based on 6-year sample size)





Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

- **Why is it important?**

- Measures risk and impact to the BPS from cyber or physical security attacks

- **How is it measured?**

- Based on industry-submitted OE-417 and/or EOP-004 Electric Emergency Incident and Disturbance Reports*
- No disruption** of BES operations due to physical attacks

<p>Data (Annual Measurement), based on 2018 metric</p> <ul style="list-style-type: none"> ▪ No disruption** of BES operations due to cyber attacks: <i>Zero is green, else is red</i> 	<p>2019 Status</p> 
<p>Data (Annual Measurement), based on 2018 metric</p> <ul style="list-style-type: none"> ▪ No disruption** of BES operations due to physical attacks: <i>Zero is green, else is red</i> 	

*As more data becomes available this metric will be enhanced to provide increased granularity of this risk.

**A disruption means that a BES facility was removed from service as a result of the cyber or physical incident.

Metric 7: Disturbance Control Events Greater Than the Most Severe Single Contingency

Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

- **Why is it important?**

- Measures risk to the BPS by monitoring the number of Disturbance Control Standard (DCS) events that are greater than the Most Severe Single Contingency (MSSC)

- **How is it measured?**

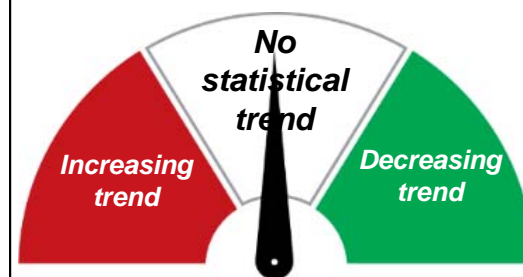
- Information received by NERC based on the BAL-002 Reliability Standard
- Measures a rolling 7 year quarterly time trend testing for statistical significance

Data (Quarterly Measurement), New

- **Green:** a rolling 7 year trend line with a negative slope that compares the number of DCS events greater than the MSSC
- **Middle:** no statistically significant trend for the slope
- **Red:** a rolling 7 year trend line with a positive slope that compares the number of DCS events greater than the MSSC

Calculated quarterly: Green, Middle or Red to 95% confidence level

2019 Status



Dashboards are for illustrative purposes only and are not meant to represent current status or projections.

- **Why is it important?**

- Measures risk and impact to the BPS by measuring the interconnection frequency response performance measure (IFRM) for each BAL-003-1 event as compared to the Interconnection Frequency Response Obligation (IFRO)

- **How is it measured?**

- IFROs are calculated and recommended in the Frequency Response Annual Analysis Report for Reliability Standard BAL-003-1.1 implementation
- IFRM performance is measured for each event by comparing the resource (or load) MW loss to the frequency deviation

Data (Quarterly & Annual Measurement), New

- IFRM for each BAL-003-1 event is compared to the IFRO for each quarter of the 2019 operating year
- Success is no Interconnection experiencing a BAL-003-1 frequency event where IFRM performance is below their respective IFRO

Zero is green, else is red

2019 Status

