NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Agenda
Reliability and Security Technical Committee

Virtual Meeting via WebEx

December 16, 2020 | 1:00–4:00 p.m. Eastern

Attendee WebEx Link: Join Meeting

Call to Order

NERC Antitrust Compliance Guidelines and Public Announcement

Introductions and Chair's Remarks

1. **Inverter-based Resources Performance Working Group (IRPWG) Scope and Work Plan* - Approve –** *Jeff Billo, IRPWG Vice Chair*

   The IRPWG sponsor, leadership, and NERC Staff revised and enhanced the previous version of their scope document. They are seeking approval of the updated IRPWG Scope document.

2. **Security Integration and Technology Enablement Subcommittee (SITES) Scope and Draft Work Plan* - Approve –** *David Zwergel, Chair SITES*

   The SITES sponsor and leadership, along with NERC Staff and RSTC volunteers, revised and enhanced the previously presented draft scope for the SITES. They also developed a draft work plan for 2021 for information. They are seeking approval of the SITES Scope document.

3. **Facility Ratings Collaboration: Compliance and Certification Committee (CCC) and Reliability and Security Technical Committee (RSTC)** – **Approve** – *Jennifer Flandermeyer, CCC Chair*

   The CCC is requesting that the Facility Ratings Task Force (FRTF) be expanded into a Joint Task Force to include members of both the CCC and the RSTC. Further, the RSTC members are requested to identify technical participants to provide technical expertise to address facility ratings concerns to support the goals of the FRTF.

4. **Framework to Address Known and Emerging Reliability and Security Risk** – **Endorse** – *Mark Lauby, Chief Engineer and Senior VP*

   The RSTC and the Reliability Issues Steering Committee (RISC) leadership have been developing a framework to coordinate between the two committees. The framework has been finalized and presented to the NERC Board. We are seeking RSTC endorsement of the coordinated framework document.

5. **Forum and Group Reports** – **Information**

   a. North American Generator Forum* – *Allen Schriver*

   b. North American Transmission Forum* – *Roman Carter*

6. **Energy Storage System: Lessons Learned Defining Design – Information –** *Anthony Natale, ConEd*

7. **NERC/IRC Whitepaper on Ensuring Energy Adequacy – Information** - *Pete Brandien and Mark Lauby*

   Seeking volunteers to work with us on where the work should be assigned within RSTC structure (e.g., IRPWG, SPIDERWG)

8. **RSTC 2020 Calendar Review –** *Stephen Crutchfield*

2021 Meeting Dates	Time	Location	Hotel
March 2, 2021 March 3, 2021	1:00 to 4:00 p.m. 1:00 to 4:00 p.m.	WebEx	None
June 8, 2021 June 9, 2021	Please reserve entirety of both days	TBD	TBD
September 22, 2021 September 23, 2021	Please reserve entirety of both days	TBD	TBD
December 14, 2021 December 15, 2021	Please reserve entirety of both days	TBD	TBD

9. **Chair’s Closing Remarks and Adjournment**

*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.

In all cases, a final report may be considered for approval, endorsement, or acceptance if the RSTC, as outlined above, decides to act sooner.

Possible Actions for other Deliverables

1. **Approve:**

   The RSTC has reviewed the deliverable and supports the content and development process, including any recommendations.

2. **Accept:**

   The RSTC has reviewed the deliverable and supports the development process used to complete the deliverable.

3. **Remand:**

   The RSTC remands the deliverable to the originating subcommittee, refer it to another group, or direct other action by the RSTC or one of its subcommittees or groups.

4. **Endorse:**

   The RSTC agrees with the content of the document or action, and recommends the deliverable for the approving authority to act on. This includes deliverables that are provided to the RSTC by other NERC committees. RSTC endorsements will be made with recognition that the deliverable is subject to further modifications by NERC Executive Management and/or the NERC Board. Changes made to the deliverable subsequent to RSTC endorsement will be presented to the RSTC in a timely manner. If the RSTC does not agree with the deliverable or its recommendations, it may decline endorsement. It is recognized that this does not prevent an approval authority from further action.

RSTC Meetings – Governance Management

Chair will state the governance management of the meeting as follows:

- For each topic, the Chair will state the primary motion, ask for first/second, speaker will present, committee then has discussion.
- **At the conclusion of the discussion,** a secondary motion can be offered, the Chair will ask for first/second, discussion/debate; the Chair will then call for a vote.
- If the secondary motion does not receive a second or is voted down, the Chair will go back and restate the primary motion. At this point, the following actions may proceed:
  - Debate on that primary motion again;
  - Another secondary motion can be offered;
  - Motion could be offered to postpone, table, etc. Management of next action will follow the first two bullets.

The Chair is able to initiate a motion to end a debate.

Motions can encompass accepting minor revisions as provided during the discussions and reflected in the words of the motion.

Guiding principle is one thing at a time.

Inverter-based Resources Performance Working Group (IRPWG) Scope and Work Plan

Action
Approve

Summary
The IRPWG sponsor, leadership, and NERC Staff revised and enhanced the previous version of their scope document. They are seeking approval of the updated IRPWG Scope document.

Inverter-Based Resource Performance Working Group (IRPWG)

Website: IRPWG
Chair: Al Schriver
NERC Lead: Ryan Quint; Rich Bauer
Hierarchy: Reports to PC and OC
Vice Chair: Jeff Billo
Scope Update: December 2020

#	Task Description	Risk Profile(s)	Strategic Focus Area(s)	Target Completion	Requested PC Action	Status
1	**Review IRPWG Scope** *Revised scope with new IRPWG group.*			Q4 2020	Approve	Seeking approval at December 2020 RSTC meeting.
2	**San Fernando Disturbance Follow-Up** *Discussion of NERC San Fernando Disturbance Report and identification of any next steps for IRPWG to add to work plan.*			Q4 2020	None	IRPWG will meet in November to determine next steps.
3	**IEEE p2800 Monitoring and Support** *Monitor and support the activities of IEEE p2800, and provide technical expertise and input as requested.*			Ongoing	None	Ongoing, as needed.
4	**Reliability Guideline: BPS-Connected BESS and Hybrid Plant Performance, Modeling, and Studies** *Reliability Guideline on recommended performance, modeling, and studies for BPS-connected BESS and hybrid power plants.*			Q1 2021	Approve	Seeking RSTC authorization to post for industry comment at December 2020 meeting.
5	**White Paper: BPS-Connected IBR and Hybrid Plant Capabilities for Frequency Response** White paper on utilizing the full capabilities of inverter-based resources and hybrid plants for providing frequency response.			Q2 2021	Approve	New task; on track.
6	**Reliability Guideline: Electromagnetic Transient Modeling and Simulations** *Reliability Guideline on EMT modeling and simulations of BPS-connected inverter-based resources.*			Q3 2021	Approve	On track.
7	**White Paper: Energy Transition to Increasing Penetrations of BPS-Connected Inverter-Based Resources** *Brief strategic white paper of ensuring BPS reliability with increasing BPS-connected inverter-based resources.*			Q4 2021	Approve	On track.
8	**Reliability Guideline: Recommended Approach to Interconnection Studies for BPS-Connected Inverter-Based Resources** Focused guidance on improving the study process for BPS-connected inverter-based resources, particularly with increasing penetrations of these resources and the growing complexity of performing sufficient studies to ensure BPS reliability.			Q3 2021	Approve	New task; on track.

Inverter-Based Resource Performance Working Group (IRPWG)

Scope Document

Updated: December 2020

Purpose

The purpose of the Inverter-Based Resource Performance Working Group (IRPWG) is to explore the performance characteristics of bulk power system (BPS)-connected inverter-based resources.[1] The IRPWG will provide technical support to any analyses of BPS disturbances involving BPS-connected inverter-based resources. The IRPWG will also focus on developing technical documents to support BPS planning and operations under increasing penetrations of BPS-connected inverter-based resources. The technical materials are intended to help transmission and generation entities better understand the performance aspects, modeling, and system studies of BPS-connected inverter-based resources.

Activities

The IRPWG will focus on the following activities:

1. Monitor, review, and document characteristics of BPS-connected inverter-based resources, as identified by events analyses, dynamic simulations, performance analyses, and discussions within the IRPWG to provide guidance to industry for recommended performance of inverter-based resources
2. Provide technical support, guidance, and industry leadership to the development and interconnection of BPS-connected inverter-based resources; ensure new technologies such as battery energy storage and hybrid plants are reliably interconnected to the BPS
3. Provide recommendations and technical materials related to changing essential reliability services and grid dynamics when faced with increasing penetrations of inverter-based resources. This includes concepts associated with low short circuit strength systems, fast frequency response, low inertia systems, and other related concepts
4. Ensure there are no potential gaps or areas for improvements related to BPS-connected inverter-based resources in the NERC Reliability Standards as new grid events occur and as new technologies evolve
5. Coordinate and support any data collection activities and interconnection-wide analyses related to inverter-based resource performance or modeling
6. Develop guidance on steady-state, dynamic, electromagnetic transient, and short-circuit modeling and studies related to BPS-connected inverter-based resources

[1] Inverter-based resources generally include solar photovoltaic (PV), wind power resources, battery energy storage, high voltage dc (HVDC) systems, and flexible ac transmission system (FACTS) devices.

7. Perform system studies, as needed, to provide technical basis to recommendations or to study the potential impacts of emerging reliability issues
8. Conduct industry technical workshops and webinars to share key findings, lessons learned, and best practices
9. Coordinate with FERC, IEEE, UL, NFPA, and state jurisdictions to ensure unified solutions to any identified potential reliability issue; coordinate with and monitor IEEE P2800 and P2800.1 Working Group activities to ensure they align with BPS reliability needs
10. Regularly update existing NERC Reliability Guidelines and other relevant documents previously developed by this group
11. Proactively analyze and study any emerging reliability issues that may be identified and that may have an impact on the North American BPS
12. Coordinate with system protection groups such as NERC System Protection and Controls Subcommittee (SPCS) to study the impacts that increasing penetrations of inverter-based resources may have on BPS protection systems
13. Other activities as directed by the NERC Reliability and Security Technical Committee
14. Assess technical capabilities of inverter-based resources and recommend changes to system planning and operations to utilize those capabilities to enhance system reliability and resilience

Deliverables

The IRPWG may develop the following deliverables based on the aforementioned activities:

1. Reliability guidelines, technical reference documents, or white papers related to emerging topics for BPS-connected inverter-based resource performance, modeling, studies, technology, and security
2. Assessments of the modeling, modeling practices, and studies being performed across North America involving BPS-connected inverter-based resources
3. Detailed interconnection-wide studies of any potential reliability risks under high penetration of inverter-based resources (particularly solar PV and battery energy storage)
4. Revised or updated Reliability Guidelines previously developed by the group, as deemed necessary

Membership

The IRPWG includes members with expertise in the following areas:

- Understanding of inverter design, controls, and manufacturing for inverter-based resources
- Plant-level controls and the relationship between these controls and individual inverter controls
- Inverter-based resource performance characteristics, particularly performance during faults and abnormal voltage and frequency conditions, phase angles changes, phase lock loop dynamics, etc.
- Performing transient stability simulations and modeling of inverter-based resources, including modeling and model parameters for these resources
- Performing model verification testing for inverter-based resources
- BPS angular, frequency, and voltage stability, particularly under high penetration of inverter-based resources

The IRPWG consists of a chair and vice chair nominated by the group and approved by the RSTC. NERC staff will be assigned as staff coordinator(s). Working group decisions will be consensus-based, led by the chairmen and staff coordinators. Any minority views will be included in an addendum.

Reporting and Duration

The IRPWG jointly reports to the NERC RSTC, and will regularly submit a work plan for approval of tasks. The IRPWG will review its scope and work plan regularly.

Meetings

The IRPWG will have two to three meetings (remote or in-person), supplemented with conference calls to continue workload throughout the year.

Activities Completed To-Date

The following activities have been completed by the NERC IRPWG (formerly the IRPTF) since its inception:

1. NERC Alert: Loss of Solar Resources during Transmission Disturbances due to Inverter Settings – June 2017
2. Webinar: Inverter-Based Resource Disturbance Analysis – February 2018
3. Report: Resource Loss Protection Criteria Assessment – March 2018
4. NERC Alert: Loss of Solar Resources during Transmission Disturbances due to Inverter Settings II – May 2018
5. Webinar: Loss of Solar Resources during Transmission Disturbances due to Inverter Settings II – May 2018
6. Webinar: Modeling Momentary Cessation and Voltage Ride-Through – July 2018
7. Reliability Guideline: BPS-Connected Inverter-Based Resource Performance – September 2018

8. PRC-024-2 Gaps Whitepaper and SAR – November 2018
9. Technical Workshop: Inverter-Based Resource Performance and Modeling – February 2019
10. Reliability Guideline: Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources – September 2019
11. Whitepaper: Fast Frequency Response – March 2020
12. Whitepaper: Review of NERC Reliability Standards – March 2020
13. Webinar: Fast Frequency Response – April 2020
14. Technical Report: IBR Modeling and Simulations – May 2020
15. Standard Authorization Requests: 1. FAC-001-3 and FAC-002-2; 2. MOD-026-1 and MOD-027-1; 3. PRC-002-2; 4. VAR-002-4.1 – June 2020
16. Webinar: IBR Modeling and Simulations – June 2020

Security Integration and Technology Enablement Subcommittee (SITES) Scope and Draft Work Plan

Action
Approve

Summary
The SITES sponsor and leadership, along with NERC Staff and RSTC volunteers, revised and enhanced the previously presented draft scope for the SITES. They also developed a draft work plan for 2021 for information. They are seeking approval of the SITES Scope document.

Security Integration and Technology Enablement Subcommittee

Scope Document
December 2020

Purpose

The *2019 ERO Reliability Risk Priorities Report*[1] highlighted "Grid Transformation" and "Security Risks" as two of four high level risk categories for the ERO Enterprise and electric industry. At the same time, the operational and technological environment of the electrical grid is evolving significantly and rapidly. To proactively support industry efforts to mitigate possible risks, the NERC Security Integration and Technology Enablement Subcommittee (SITES) will identify, assess, recommend, and support the integration of technologies on the Bulk Power System (BPS) in a secure, reliable, and effective manner. SITES recognizes the convergence of information and operational technology cited by the RISC and will recommend practices to incorporate cyber and physical security aspects into conventional planning, operations, design, and restoration activities across North America. The goal of the subcommittee is to identify potential barriers (e.g., regulatory, technological, complexity) and support the removal of these barrier to enable industry to adopt emerging technologies and develop cyber-informed engineering practices.

Activities

SITES activities are intended to help industry adopt emerging technologies in a secure, reliable, and resilient manner to ensure reliability, security, and resilience of the BPS. This includes a focus on work products that assist in integrating emerging technologies in a manner that complements grid planning, design, operations, and restoration practices. Key activities and work products of the SITES include, but are not limited to, the following:

Technology Enablement:

1. Provide guidance to industry with recommendations for cyber and physical security practices, emerging technology solutions (e.g., cloud computing, virtualization), and approches to appropriately secure operational technology systems.
    a. Enhance the effective use of emerging technologies and support the convergence of operational and information technology solutions. Examples include, but are not limited to, inverter-based resources, new digital communications strategies, and advanced BPS hardware and software systems.
    b. Identify solutions that remediate or mitigate potential risks to BPS reliability, security, and resilience resulting from increased threat vectors[2] (i.e., cyber attacks) or improperly implemented or configured technologies.

[1] https://www.nerc.com/comm/RISC/Related%20Files%20DL/RISC%20ERO%20Priorities%20Report_Board_Accpeted_November_5_2019.pdf

[2] A threat vector is a path or a means by which a cybercriminal gains access into a computer system by exploiting a vulnerability

2. Develop and promote industry education through materials that address emerging technologies and how they can the impact BPS reliability and resilience and encourage an industry culture of cybersecurity awareness when adopting new technologies and when planning, designing, and operating the BPS.

Security Integration:

1. Develop recommendations in coordination with other NERC stakeholder groups (as appropriate) to ensure that cyber and physical security are an integral component of BPS planning, design, operations, and restoration:
    a. To effectively *plan* a future BPS by considering existing and emerging security vulnerabilities, equipping planners with knowledge necessary to remediate or mitigate vulnerabilities. This includes the need to consider balancing economies of scale against the risk of a centralized attack surface, developing methods, models, and tools that simulate BPS threat vector scenarios, and establish industry best pratices for cyber resilience.[3]
    b. To effectively *operate* the existing and future BPS by using new technologies in an effective way that does not introduce unforeseen cybersecurity vulnerabilities. Empower grid operators by identifying solutions that integrate cyber and physical security intelligence into the real-time operating environment.
    c. To effectively *design* a BPS infrastructure to minimize potential cybersecurity threats while leveraging state-of-the-art capabilities and equipment.
    d. To effectively *restore* the BPS if a cyber or physical attack were to affect a geographically diverse area and comprise various types of operating entities. This addresses system restoration coordination activities under severe cyber attack, or coordinated physical attack conditions.
2. Provide an assessment of the transformation of the BPS operational and technological environments across North America; define recommended practices that support secure, reliable operation of the BPS with the the convergence of information and operational technology (IT/OT); the growing reliance on emerging technologies, and; assess current and future potential risks that these changes present to the BPS.
3. Develop a cybersecurity framework[4] to determine baseline cybersecurity maturity metrics for BPS cyber systems. Identify ways to further protect the BPS during its rapid transformation. Key areas of focus for security consideration include, but are not limited to: BPS-connected inverter-based resource physical and cyber security, distributed energy resources (as well as aggregators and management systems), microgrid communications, and cloud computing.
4. Identify potential security threats across all applicable entities and areas of the BPS and define the potential impacts (i.e. BPS planning, operations, design, restoration activities) from an overall BPS system perspective, as well as individual elements.

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[3] Cyber resilience is the ability of an organization to prepare, respond, and recover when cyber attacks happen.
[4] Leveraging the NIST Cybersecurity Framework: https://www.nist.gov/cyberframework

   a. Identify and assess potential risks to the BPS arising from adoption of emerging technologies. Examples include, but are not limited to, the following: cybersecurity vulnerabilities within distributed energy resource management systems, diverse data locations in cloud environments, supply chain risk management, contingency events from high-altitude EMP, and other geographically diverse threats.
   b. Identify potential security threats and determine the impacts to critical energy infrastructure from possible electrically and geographically diverse threats.
   c. Coordinate with the NERC Electricity Information Sharing and Analysis Center (E-ISAC) to support the cyber-informed engineering practices in planning, designing, and operating the BPS.
   d. Deliver recommended risk mitigation strategies to industry in an appropriate fashion for implementation.
5. Develop planning, operating, design, or restoration metrics that could be used to measure adequate levels of reliability of the BPS in the context of cyber and physical security.
6. Develop collaborative partnerships with industry, governmental partners, national laboratories, research and development institutes, academia, and other organization to determine the current state-of-the-art in cyber and physical security designs, cutting-edge tools, and expertise.
   a. Provide a forum for open discussion about new research, tools, and initiatives across North America.
   b. Encourage the development of partnerships between NERC, research partners, and asset owners that help streamline the piloting and eventual adoption of new solutions.

Coordination with NERC and Other Industry Technical Groups:

1. Collaborate with other NERC stakeholder groups within the Reliability and Security Technical Committee (RSTC) on applicable topics to eliminate potential overlaps, avoid duplicative efforts, and ensure alignment of assignments and responsibilities. The goal of these activities will be to coordinate and effectively leverage expertise across groups to the extent possible.
   a. This includes close coordination with the NERC Security Working Group to advise them of planning and operational issues, trends, and other factors that should inform their discussions about security matters.
   b. This includes coordination with other NERC technical groups focused in these areas to provide them with useful perspectives on security-related issues that may affect them.
2. Provide requested support to the development of the NERC Long Term Reliability Assessment and State of Reliability Report, as well as other assessments pertaining to emerging technologies and grid transformation.
3. Take input from the Electricity Subsector Coordinating Council (ESCC), and consult with the Institute of Electrical and Electronics Engineers (IEEE), and other industry technical groups, as needed.
4. Any other activities or assignments defined by the RSTC.

Deliverables

The SITES will develop work products in the following areas to support industry efforts relating to integrating emerging technologies and security enhancements into conventional planning, operations, and design practices:

- Technical reference documents, technical reports, white papers, and tools
- Reliability Guidelines and Security Guidelines
- Compliance Implementation Guidance
- Standard Authorization Requests
- Supporting materials to other NERC work products (e.g., NERC Long Term Reliability Assessment)
- Other educational materials (webinars, workshops, conferences, etc.)

Membership

The SITES will include members with expertise in the following areas:

- Design and implemention of cybersecurity infrastructure, systems and networks in BPS control centers, transmission systems, generation facilities, systems critical to BPS resoration, special protection systems, and other systems impacting users, owners, and operators of the BPS
- Understanding state-of-the-art and emerging technologies (e.g., software-as-a-service (SaaS), cloud computing) and how these technologies can be put into practice to improve BPS reliability, security, and resilience
- Cybersecurity threat vectors and risks posed by changing technologies for owners, operators, and end-users of the BPS as well as new operating paradigms for the BPS (e.g., distributed energy management systems)
- Identifying and defining physical and cyber security risks with respect to BPS reliability and resilience
- Relevant information security standards and NERC Reliability Standards
- BPS planning practices and how security concepts could be integrated into these practices more effectively and efficiently
- BPS operating processes and procedures and how cybersecurity concepts could be integrated into these practices
- BPS design practices (e.g., field operations, substation design) and how cybersecurity concepts could be integrated into these practices

SITES will consist of a Chair and Vice Chair with a two year term limit, nominated by SITES and approved by the RSTC leadership. NERC staff will be assigned as Coordinator(s). SITES operates under the direction and coordination of the Reliability and Security Technical Committee (RSTC). Decisions made by the membership will be consensus-based, led by the chair and staff coordinators. Any minority views will be documented, as necessary. The RSTC will assign a Sponsor to help advocate SITES activities and to coordinate with RSTC and its other sub-groups.

Reporting & Duration

The SITES will report to the NERC RSTC. The group will submit a work plan to the RSTC following its inception and maintain its work plan throughout its existence. The duration of the SITES is expected to be indefinite so long as the group is deemed by the RSTC to be effectively accomplishing its purpose.

Meetings

SITES will have two to three meetings (in-person or remote) per year, supplemented with regular conference calls to continue workload as needed.

Approved by the NERC Reliability and Security Technical Committee on ______, 2020.

Security Integration and Technology Enablement Subcommittee (SITES)

Website: SITES | **Chair**: David Zwergel | **NERC Lead**: Ryan Quint; Tom Hofstetter
Hierarchy: Reports to RSTC | **Vice Chair**: Benny Naas | **Scope Update**: December 2020

#	Task Description	Risk Profile(s)	Strategic Focus Area(s)	Target Completion	Requested PC Action	Status
	"State of Technology Report" *Technical report providing industry with strategic guidance regarding new or emerging technology solutions and risk-based considerations for their successful implementation* *(Scope Activity Technology Enablement #1)*			Q4 2021 / Q1 2022	None	Initial work plan item for team consideration.
	SITES Industry Workshop *SITES will hold an industry-wide technical workshop (likely remotely) to highlight strategic areas of focus related to new technologies, technology enablement, and security integration.* *(Scope Activity Technology Enablement #2)*			Q4 2021	None	Initial work plan item for team consideration.
	Reliability / Security Guideline: Integration of Cyber and Physical Security with BPS Planning, Operations, Design, and System Restoration *Recommendations for industry regarding ways that BPS planning, operations, design, and restoration activities can be enhanced by considering cyber and physical security aspects to improve BPS reliability and resilience; recommendations regarding the convergence of IT and OT networks.* *(Scope Activity Security Integration #1 and #2)*			Q4 2021	None	Initial work plan item for team consideration.
	White Paper: Review and Enhancement of Cybersecurity Maturity Metrics *Review and enhancement of metrics to track the capabilities and maturity of cybersecurity and its integration with BPS reliable operation on a broad level; considerations at a macro-scale, integrating all aspects of overall BPS security, reliability, and resilience.* *(Scope Activity Security Integration #3 and #5)*			Q4 2021	None	Initial work plan item for team consideration.
	White Paper: Risk-Based Physical and Cybersecurity Threats and their Impacts to BPS Reliability and Resilience *Guidance and reference materials providing information about possible security threats and ways that Registered Entities can plan, design, and operate the system to mitigate these potential risks. High-level recommendations for industry to consider in their own engineering and security practices for mitigating potential BPS reliability risks. Considerations for generation, transmission, and distribution-level risks as well as such as the natural gas infrastructure, and end-use* *(Scope Activity Security Integration #4)*			Q4 2021	None	Initial work plan item for team consideration.
	Coordination Activities *Ongoing coordination with other RSTC technical groups to avoid any overlap or duplication; engagement with external stakeholders and industry groups to gather information and share SITES developments; coordination with E-ISAC, ESCC, IEEE, NATF, NAGF, EPRI, and other technical groups.* *(Scope Activity Coordination #1, #2, #3, and #4)*			Q4 2021	None	Initial work plan item for team consideration.

Facility Ratings Collaboration: Compliance and Certification Committee (CCC) and Reliability and Security Technical Committee (RSTC)

Action

Approve. The CCC is requesting that the Facility Ratings Task Force (FRTF) be expanded to a joint Task Force between the CCC and RSTC (see attached Scope). Further, the RSTC members are requested to identify technical participants to provide technical expertise to address facility ratings concerns to support the goals of the FRTF.

Summary

Facility Ratings are required for certain facilities per the NERC Reliability Standard FAC-008-3, Facility Ratings. While the list is not exhaustive or meant to reproduce the body of standards on this topic, under the requirements, a Generator Owner must have documentation of its determination of facility ratings while a Transmission Owner must have a documented methodology for determining facility ratings. There has been substantive work across the industry on facility ratings related to processes, programs, frameworks, controls and best practices. Facility ratings continues to be an area that is challenging and complex – for numerous reasons. The implied view is that all equipment and / or components are created equal from a risk perspective. From a system operating perspective, the risk from all elements on the grid are not equal (from an individualized registered entity view) even though the standard suggests that is the case. In addition, the current "blanket" application of the FAC-008-3 requirements can be costly to implement and thus requires a risk-based perspective to ensure these costs are providing corresponding reliability benefits. The cost implications are not a prohibition to adhere to standards, but a framework is needed to ensure that scarce technical resources are appropriately focused on the highest risk elements. In the end, solutions that strengthen reliability and the resilience of the grid are desired. However, the current approach to Facility Ratings does not provide a straightforward way to implement a risk-based framework in the linkage of reliability and resiliency risks to adherence under the FAC-008-3 standard.

Realizing this challenge, the NERC CCC formed the Facility Ratings Task Force (FRTF) (Roster) to evaluate and align the risk assessment and risk appetite related to facility ratings. Some of that discussion has been informed broadly by compliance to the Facility Ratings Standards (FAC-008-3) and industry performance as evaluated under the CMEP from a lessons learned perspective. The potential areas this task force is evaluating relate to alignment of industry's processes and procedures to conduct compliance oversight discussions, institute controls, assess risk and analytics, and prioritize resources with those processes and procedures that focus on prioritization of reliability risks and corresponding resources.

There could be broad concern with the FERC NOPR released in the staff report at the meeting on Thursday, November 19, 2020. The NOPR is suggesting a move from static to dynamic facility ratings to maximize the capability of those facilities. This NOPR and the potential changes it will cause in the already complex issue of Facility Ratings make it even more critical that technical experts are involved in the evaluation of Facility Rating-related processes, procedures, oversight direction, risk assessment, etc. to ensure that the approach taken is based on a risk-mitigation mindset.

The objective of expanding the FRTF by including the RSTC is to incorporate broader technical, risk-based perspective into ongoing activities around the current FAC-008 standards. In addition, the FRTF output would ensure that perspective is carried into any future activities related to FAC-008-5, dynamic facility ratings, or other topics which may arise as a result of the NOPR.

Facility Ratings Task Force Scope

December 16, 2020

Purpose

The North American Electric Reliability Corporation (NERC) Compliance and Certification Committee (CCC) has a role to provide stakeholder feedback to the Electric Reliability Organization (ERO) related to Enterprise Programs, Standards adherence and Enterprise Tools. The Reliability and Security Technical Committee (RSTC) is a standing committee that strives to advance the reliability and security of the interconnected BPS of North America by:

- Creating a forum for aggregating ideas and interests, drawing from diverse industry stakeholder expertise, to support the ERO Enterprise's mission; and,
- Leveraging such expertise to identify solutions to study, mitigate, and/or eliminate emerging risks to the BPS for the benefit of industry stakeholders, the NERC Board of Trustees (Board) and ERO Enterprise staff and leadership.

The NERC joint CCC and RSTC Facility Ratings Task Force (FRTF) will address risks associated with the FAC-008, *Facility Ratings Standards*. The potential areas this task force is evaluating relate to alignment of industry's processes and procedures to conduct compliance oversight discussions, institute controls, assess risk and analytics, and prioritize resources with those processes and procedures that focus on prioritization of reliability risks and corresponding resources.

Roles and Activities

Facility Ratings continue to be a source of discussion in the industry related to operational performance, enforcement actions and regulator views about future considerations. Future considerations related to facility ratings are more complex and consider use of utility assets in different manners as compared to a historical view. In order to effectively accommodate that type of conversation, the industry needs to assess the current processes and expectations to ensure the "basics" are covered. The CCC and RSTC, in their roles obtaining stakeholder engagement and feedback, will delegate responsibility to the FRTF to carry out activities to:

- Provide information to industry on the issues,
- Support industry readiness and success on this topic,
- Foster and facilitate discussions around the issues, risk and potential mitigations or course corrections, and
- Gather industry feedback around recommended solutions that are actionable by either registered entities or industry groups (membership forums, trade associations, technical committees, etc.).

The FRTF will report its work and deliverables to the CCC and RSTC, and the CCC and RSTC maintain ultimate responsibility for decisions and recommendations to NERC.

The FRTF will provide suggestions on issues for discussion and recommendations to NERC as follows:

- Industry's perspective related to the ERO Problem Statement around facility ratings,
- Gather detailed information on the Facility Rating performance issues.
  - Identify support needs and use CCC and RSTC subcommittees or individual members that have the expertise to review the issues.
  - Reach to industry for input on potential readiness issues (e.g., trade associations, membership organization, compliance forums, registered entities, etc.).
  - Initiate or request FRTF discussions as issues are identified.
  - Identify issues representing specific concerns quickly and facilitate swift resolution or communications.
- Evaluate options for industry outreach.
- Develop suggested recommendations related to the issues.
- Present work outcomes to the CCC and RSTC for awareness.
- Determine appropriate path for recommendations to be considered and action taken.

Membership

The FRTF membership will be comprised of those CCC and RSTC members and observers appointed by the CCC and RSTC Chairs. It is desired and highly encouraged that CCC and RSTC leadership as well as NERC and Regional Entity management participate.

1. Composition
   a. CCC and RSTC Members
   b. CCC and RSTC Active Participants (Observers)
2. Leadership
   a. The FRTF will be co-chaired with one person from each committee.
3. Observers
   a. The FRTF Chair may invite observers to participate in meetings, which may include additional NERC or Regional Entity staff, as well as other CCC and RSTC members. Observers may actively participate in the discussion and FRTF deliverables.

Meetings

The FRTF meetings will be scheduled based on workload, as determined by the members. Due to the short duration of the FRTF, it is likely meetings will be monthly and will be conducted by conference call. Meetings may also occur in conjunction with the regular CCC or RSTC meetings. The FRTF meetings will be open to other participants. The FRTF Chair will approve this participation and work with the CCC and RSTC Chairs for any necessary appointments.

Framework to Address Known and Emerging Reliability and Security Risks

Action
Endorse

Summary
The ERO's mission requires establishing a consistent framework to identify, prioritize, and address known and emerging reliability and security risks. The *Framework to Address Known and Emerging Reliability and Security Risks* (Whitepaper), which has been reviewed by the Reliability and Security Technical Committee (RSTC) and Reliability Issues Steering Committee (RISC), identifies the policies, procedures, and programs developed by the ERO to support its mission and incorporates them into an iterative six-step risk management framework. The mitigation of risks to Bulk Electric System (BES) reliability and security are classified according to the likelihood of the risk occurring and the severity of its impact. The ERO's policies, procedures, and programs are mapped to target risk mitigation against severity and likelihood. Further, the Whitepaper reviews how resilience is an important component of reliability risk management. Finally, the whitepaper considers the application of ERO policies, procedures, and programs, within time required to apply the mitigation and the likelihood and severity.

The Framework was issued as part of the Policy Input letter for the NERC Board of Trustees in October 2020 and comments were reviewed and incorporated as applicable. A matrix of these comments is included as **Attachment 2.** NERC plans to request Board endorsement of the Whitepaper at the Board's open meeting in February 2021.

Attachment
1. *Framework to Address Known and Emerging Reliability and Security Risks*
2. *MRC Policy Input: Risk Framework Comment Response Matrix*

Framework to Address Known and Emerging Reliability and Security Risks

November 2020

This document outlines a risk framework for the ERO and details how such a framework provides an important extension of the ERO's core activities. The ERO mission[1] requires establishing a consistent framework to identify, prioritize and address known and emerging reliability and security risks. To support its mission the ERO has developed policies, procedures and programs, which are identified and briefly described in Section I. These policies, procedures and programs have been incorporated into an iterative six-step risk management framework outlined in Section II. Mitigation of risks to Bulk Electric System (BES) reliability can be classified according to the likelihood of the risk occurring and the severity of its impact. Section III addresses how the ERO's policies, procedures and programs identified in Section II map into the risk likelihood and severity space. Resilience is an important component of reliability risk management and is discussed in Section IV. Section V cover the application of ERO Policies, Procedures and Programs, within time required to apply the mitigation and the likelihood and severity.

I. ERO Policies, Procedures and Programs

The ERO's mission ultimately exists to serve the public interest, and it must serve that interest by developing and using the ERO Policies, Procedures and Programs to monitor and mitigate risks to the BES, balancing their use by considering what is possible against what is reasonable and necessary. Further, ensuring reliability and security also require improving the resilience of the BES by building the robustness to withstand unexpected events, supporting controlled degradation when an event is beyond design basis (providing an Adequate Level of Reliability), and supporting restoration following an event.

The ERO identifies risk both in a leading and lagging manner. The ERO scans the horizon for emerging risks such as grid transformation and critical infrastructure interdependencies (leading). At the same time, the ERO is gathering data and information on the performance of the existing bulk power system to uncover unexpected risks such as large quantities of photovoltaic generation ceasing to operate under certain system conditions (lagging). In addition, the ERO annually releases its State of Reliability Report that documents the annual system performance in a comparative fashion. The ERO's Policies, Procedures and Programs are then used to address mitigation of these identified risks.

Five of NERC's most significant reliability risk mitigation activities are Reliability Standards, Assurance and Enforcement activities; Reliability Guidelines; Technical Engagement; Reliability and Risk Assessments; and Alerts:

1. **Reliability Standards, Assurance, and Enforcement** processes are the common way to address reliability and security risks when addressing sustained risks with moderate impacts which are

[1] Electric Reliability Organization (ERO) consists of NERC and the 6 Regional Reliability Organizations. The ERO's mission is to assure the reliability and security of the North American bulk electric system (BES). The ERO is supported by subject matter expertise from the owners and operators of the bulk electric system. In the United States the ERO is authorized the Energy Policy Act of 2003 and overseen by FERC.

likely (e.g., inaccurate planning models), and high impacts, whether likely or unlikely (e.g., vegetation management and geomagnetic disturbances). Standards provide the greatest degree of certainty for risk mitigation. Following NERC and Regional Reliability Standards should not be seen as a burden but rather an outcome of good reliability performance, with that desired outcome on each individual system contributing to the reliability of the entire interconnection, and ultimately, the North American BES.

As a matter of public policy, Reliability Standards should credibly address primary risks that are sustained, high impact and likely. Establishing a baseline of Reliability Standards assures accountability for the public's benefit when minimum expectations of performance or behavior are not met. The public expects a regulator to enforce accountability on at least those actions related to sustained, high impact, and likely risks within its scope of oversight.

A key factor in the success of compliance monitoring and enforcement of mandatory standards rests on a common understanding among industry and the ERO as set forth in the ERO's Compliance Monitoring and Enforcement Program (CMEP) which details how compliance will be monitored and enforced. Implementation Guidance is developed by industry and/or vetted through pre-qualified organizations to show examples of compliant implementations. These vetted examples can then be submitted to the ERO for endorsement, and, if endorsed, the ERO would give the example deference during CMEP activities with consideration of facts and circumstances.

Risk elements associated with the Reliability Standards are documented annually in the ERO CMEP Implementation Plan, which provides guidance to industry on North American-wide and regional risks that the ERO's Reliability Assurance and Enforcement staff will be focusing on addressing in the coming year. Regional Entities review the risks each individual registered entity may have, and identify which Reliability Standards they wish to focus on based on these risks. This risk-based approach enables focus on the most important risks to reliability, and review of the controls in place to address them for each individual organization.

Information and data gathered as a result of compliance monitoring and enforcement activities can inform about the effectiveness of a Reliability Standard or the need for enhancements. At a high level, this recommendation can be passed on through the Standards Development process for consideration.

2. **Reliability Guidelines** are the common approach to use when addressing moderate impact sustained risks that are unlikely, and low impact sustained risks that are unlikely or likely (such as reduced or lack of equipment maintenance resulting in the loss of an individual element which is a low impact to BPS reliability, while the probability of failure increases over time). Reliability Guidelines are also used for those issues that are or are not in the ERO's jurisdiction, but are practices that improve reliability. Guidelines provide three advantages:

   - Together with a strong minimum baseline fabric of standards, guidelines can be a strong and timely way to address risk.
   - Reliability Guidelines enable the ERO to highlight expectations or priorities on appropriate practices for a given subject area.

- Reliability Guidelines may also be used to establish performance expectations for emerging risks rather than or prior to codifying those expectations into Reliability Standards.

3. **Technical Engagement** can be used to address sustained risks or one-and-done activities with low impacts, whether likely or unlikely. Activities here include webinars, site visits, presentation and reports, workshops, conferences and technical meetings. This includes not only activities of the ERO, but the ERO supporting industry engagement through the reliability ecosystem, such as the North American Transmission and Generation Forums, professional organizations, researchers, and government. Technical engagement also serves to promote future sustained risk mitigation and support for using Reliability Guidelines, industry notices, newsletters, bulletins, or Reliability Standards.

4. **Reliability and Risk Assessments** coupled with the biennial report outlining the Reliability Issues Steering Committee's (RISC) findings identifies risks, whether likely or unlikely.[2] Generally, these activities are used to inform and influence policymakers, industry leaders, and the general public about the impact of important public and energy policy issues impacting BPS reliability.

5. **Alerts** are used for sharing information, especially time-sensitive information, to request action or direct action. They can also serve as a more nimble, foundational activity for other ERO Policies, Procedures and Programs. As part of its normal course of business, NERC often either discovers, identifies, or is provided with information that is critical to ensuring the reliability of the bulk power system in North America. In order to effectively disseminate this information, NERC utilizes email-based "alerts" designed to provide concise, actionable information to the electricity industry. As defined in its Rules of Procedure, NERC alerts are divided into three distinct levels, as follows:

   - **Level 1 Industry Advisory**: Purely informational, intended to alert registered entities to issues or potential problems. A response to NERC is not necessary.

   - **Level 2 Recommendation to Industry**: Recommends specific action be taken by registered entities. A response from recipients, as defined in the alert, is required.

   - **Level 3 Essential Action**: Identifies actions deemed to be "essential" to bulk power system reliability and requires NERC Board of Trustees' approval prior to issuance. Like recommendations, essential actions also require recipients to respond as defined in the alert.

   Since Level 2 and Level 3 alerts require acknowledgement of receipt and response to the alerts, they are used in higher risk impact situations than Level 1 alerts, which are purely informational.

II. ERO Iterative Risk Management Framework

During the last ten years, the ERO has expanded its implementation of risk-based approaches across its program areas. During this transition, the ERO has continued to lead industry in reliability, resilience, and security initiatives to identify known and emerging risks, and to engage industry in a collaborative approach to mitigating that risk. The primary reliability, resilience, and security activity for risk mitigation the ERO currently deploys includes, but is not limited to: outreach events such as webinars and conferences, Reliability Guidelines, Alerts, Reliability Standard development, registration and certification, and compliance monitoring and enforcement. In addition, the ERO can engage Forums

[2] Instead of using "mitigating risks," the RISC uses "managing risks." These terms are used interchangeably and mean the same thing in this whitepaper.

such as the North American Transmission Forum (NATF) and the North American Generator Forum (NAGF), as well as the industry trade associations, industry groups such as the Energy Systems Integration Group (ESIG), and research organizations such as the Electric Power Research Institute and the Power Systems Engineering Research Center (PSERC) to assist with development of best practices, increased awareness, Implementation Guidance, and other solutions used to address identified risks.

Additionally, a set of industry indicators has been developed to measure reliability and security. These indicators need further refinement, maturation and linkage to industry performance, as they are key to evaluating the effectiveness of mitigation efforts, identifying the residual risk that remains, and considering whether the remaining risk is at acceptable levels.

This framework is meant to guide the ERO in the prioritization of risks and provide guidance on the application of ERO Policies, Procedures, and Programs, to inform resource allocation and project prioritization in the mitigation of those risks. Additionally, the framework accommodates measuring residual risk after mitigation is in place, enabling the ERO to evaluate the success of its efforts in mitigating risk, which provides a necessary feedback for future prioritization, mitigation efforts, and program improvements.

The successful reduction of risk is a collaborative process between the ERO, industry, and the technical committees including the Reliability and Security Technical Committee (RSTC) and RISC. The framework provides a transparent process using industry experts in parallel with ERO experts throughout the process, from risk identification, deployment of mitigation strategies, to monitoring the success of these mitigations.

Six specific steps have been identified, consistent with risk management frameworks used by other organizations and industries: 1) Risk Identification; 2) Risk Prioritization; 3) Mitigation Identification and Evaluation; 4) Deployment; 5) Measurement of Success; and 6) Monitoring. Each of these steps will require process development, including stakeholder engagement, validation/triage approaches, residual risk monitoring, ERO's level of purview over a risk, etc. These processes will be developed once the framework has been finalized.

1. **Risk Identification and Validation:** As mentioned above, the ERO identifies risks using both leading and lagging approaches. The RISC biennial report and Long-Term and Seasonal Reliability Assessments (leading) have successfully brought together industry experts to identify and prioritize emerging risks, as well as suggest mitigation activities. A partnership between the ERO leadership and both the RISC and RSTC enables input from the ERO program areas, industry Forums and trade associations to provide additional context in risk identification.

   Once the ERO, NERC Committees, Forums, or industry subject matter experts identify and validate a risk, it is critical that the corresponding recommendation for mitigation describe, explain, and provide support for the basis for selecting the particular approach to mitigation. A template will be created, that mirrors the Standards Authorization Request template, that requires an explanation of the risk, approach(es) for mitigation, and estimate of residual risk.

   Risk Identification: The ERO has a number of ways that it identifies risks:

   - ERO stakeholder supported technical organizations, industry forums, and associated subject matter experts

- Focused Compliance monitoring activities
- Reliability and Risk Assessments
- Events Analysis
- State of Reliability Report, including the analysis of Availability Data Systems (BASS, TADS, GADS, DADS, MIDAS, etc.)
- Frequency Response, Inertia, and other essential reliability service measurements
- Interconnection simulation base case quality and fidelity metrics
- Reliability Issues Steering Committee (RISC) Biennial Risk Report
- Regional Risk Assessments
- Communication with external parties, such as DOE, DHS, Natural Resources Canada, CEA and EPRI
- Shared public and/or government intelligence with special emphasis on cyber security

Risk Validation: The ERO and industry subject matter experts continuously work together validating risks to the reliable and secure operation of the bulk power system based on analysis of ongoing performance of the system (lagging). Validation of the magnitude and priority of the risks includes analysis from the ERO databases of system performance and Events Analysis. These outputs are generally covered in NERC's State of Reliability Report. In addition, the risks are further validated through working with NERC Committees, and socializing them with Forums, government, and research organizations. Leading risk validation requires analysis of system simulations, forecasts, and performance projections.

2. **Risk Prioritization:** Prioritizing risks is accomplished through an analysis of their exposure, scope, and duration as well as impact and likelihood. The primary sources of data used to support this analysis come from the Risk Identification step. Deciding if the risk requires near-term mitigation or continued monitoring is informed by technical expertise. Depending on the complexity of the risk, new models, algorithms and processes may need to be developed to better understand the potential impacts of the risk, which is necessary to develop risk mitigation tactics. The process would be consistent with other risk management frameworks used by other industries, and was recently successfully tested in collaboration with industry through a survey issued by the RISC, based upon the risks that group prioritized in early 2019.

   A ERO risk registry and heat maps will be developed encompassing prior RISC report findings, ongoing technical committee activities, and risks being monitored. This registry would be developed by the end of the second quarter of 2021. Work plans of the technical committees will then be periodically reviewed to ensure that ongoing activities are tied to identified risks in the risk registry. Further, if new risks emerge they can be added to the registry, and if it is deemed that the risks are sufficiently mitigated, they will be moved to the monitored portion of the risk registry. As the RSTC develops its annual work plan and following the publication of the biennial ERO Reliability Risk Priorities Report, the risk registry is reviewed by the RISC and the RSTC to evaluate how completed work addressed these identified risks, whether any new risks have been identified by either committee that need to be added to the risk register, and documenting monitored risks which require no additional mitigation.

3. **Remediation and Mitigation Identification and Evaluation:** The right mix of mitigation activities is balanced against both the effective and efficient use of resources and the potential risk impact and likelihood. Further, the risk tolerances needs to balanced against potential impacts so that the remediation/mitigation plans can be developed accordingly. Determining the best mix depends on a number of factors, such as:

    - What is the potential impact or severity of the risk?
    - How probable is the risk? Is it sustained, decreasing or growing?
    - Is the risk here today or anticipated in the next 3-5 years?
    - How pervasive is the risk?
    - Is mitigation expected to be a one-time action, or ongoing?
    - Have we had experience with events being exacerbated by the risks, or there is no experience, but the probability is growing (i.e. cyber or physical security)?
    - Have previous mitigation efforts been deployed? If so, were they effective? Why or why not?
    - What is an acceptable residual risk level after mitigating activities have been deployed?
    - Is the risk man-made or by natural causes?
    - Does the mix of mitigations vary based on jurisdictional or regional differences?
    - Is the risk fully or partially within the purview of the ERO?

    Input from, and allocation of, subject matter expertise through multiple sources is part of this consideration, including resources within the ERO and its stakeholders (such as standing technical committees and their subgroups, or standard drafting teams). External parties are important sources as well, such as the North American Transmission and Generation Forums (NATF and NAGF), North American Energy Standards Board (NAESB), the Institute of Electrical and Electronic Engineers (IEEE), and EPRI, to name a few.

    Once a risk to the BES has been prioritized according to its impact and likelihood, the ERO, NERC Committees, Forums, and industry subject matter experts recommend and can take on potential mitigation activities and assess their anticipated effectiveness. Coordination is key to avoid duplication and provide supportive, rather than conflicting actions.

    The ERO remains responsible for risks to the reliable and secure operation of the BES. Risk mitigation should still be followed by the ERO no matter which organization takes on activities. Examples of mitigation efforts include, but not limited to:

    - Reliability Standards, with Compliance and Enforcement for risks that are:
        - Sustained, moderate to severe impact, and likely
        - Sustained, severe impact, and unlikely
        - Focused monitoring based on risk, and in response to major events
    - Reliability Guidelines for risks that are:
        - Sustained, low to moderate impact, and likely

- Lessons Learned for risks that are:
  - Sustained, low impact, and likely
- Assist Visits for risks that are:
  - Compliance-related
  - Focused on a very specific situation or configuration
  - Generally on specific industry or entity practices or conditions
- Analysis of Major Events for risks that are:
  - Identified after a Major Event (e.g., Category 3 or higher)
  - Discreet/one-time, severe impact, unlikely
  - identified through recommended reliability improvements or best practices and lessons learned
- Analysis of "Off-Normal" Events for risks that are
  - Identified after an unusual operational condition has occurred and likely not a categorized event.
  - Discreet/one-time, moderate impact, unlikely
  - Identified through recommended reliability improvements or best practices and lessons learned
- Advisories, Recommendations or Essential Actions[3]
- Alerts[4]
- Technical Conferences and Workshops

When reviewing the type and/or depth of remediation and mitigation, a form of cost-effectiveness analysis may be considered to understand impacts and potential burdens. This analysis can then be compared to potential impacts of the risk.

[3] LEVEL 1 (Advisories) – purely informational, intended to advise certain segments of the owners, operators and users of the Bulk Power System of findings and lessons learned; LEVEL 2 (Recommendations) – specific actions that NERC is recommending be considered on a particular topic by certain segments of owners, operators, and users of the Bulk Power System according to each entity's facts and circumstances; LEVEL 3 (Essential Actions) – specific actions that NERC has determined are essential for certain segments of owners, operators, or users of the Bulk Power System to take to ensure the reliability of the Bulk Power System. Such Essential Actions require NERC Board approval before issuance.

[4] ALERT 1: Industry Action Requested: Fast moving or recently detected, impacts moderate, ALERT 2: Industry Action Required: Fast moving or recently detected, impacts moderate to severe, ALERT 3: Industry Action Mandatory: Fast moving or recently detected, impacts moderate to severe.

4. **Mitigation Deployment**: Mitigation projects will be deployed by the ERO and/or industry stakeholder groups, as determined by the "Mitigation Identification and Evaluation" step. A specific mitigation plan would involve a suitable mix of the ERO policies, procedures and programs discussed in Section I. These mitigations would be coordinated with Canadian, industry partners and stakeholders.

   From time-to-time, the Federal Energy Regulatory Commission (FERC) may order the development of Reliability Standards, which can occur in this step.

5. **Measurement of Success:** Once a set of solutions has been deployed, the effectiveness of the mitigation must be measured to determine if the residual risk has been reduced to an acceptable level. Effectively, if the desired level of risk mitigation is not met, the risk is fed back to Step 1, enabling a new prioritization of risks, factoring in historic mitigation, ensuring resource allocation is adapted to the changing risk landscape. This step also informs future mitigation efforts, as industry and the ERO learn from the effectiveness of mitigation mixes for reducing risk. A partnership between the ERO leadership and both the RISC/RSTC will enable input from the ERO program areas, industry Forums and trade associations to provide additional context in the measurement of success. That said, criteria and other related processes should be developed for determining risk severity, likelihood, and mitigation activity effectiveness.

6. **Monitor Residual Risk:** Once the level of residual risk is at an acceptable level, the risk is monitored through ongoing performance measures to ensure that risk remains at acceptable risk levels. The residual risk should be monitored for progress and to ensure that the mitigations that are in place continue to address the risk (Step 5). At times, mitigations need to be deployed on a periodic basis (e.g. annual workshops, Reliability Guideline updates, etc.) to ensure continued success (Step 4). If the risk levels heighten, or increased mitigation efforts are necessary due to the changing nature of the bulk power system, the risk can be fed back (Step 1) for prioritization and the development of additional mitigation approaches. The ERO, working with its industry partners, technical committees, stakeholders and forums, would determine if the residual risk was acceptable of if additional mitigations required.

From-time-to-time risks are identified and validated which require an accelerated industry attention. The ERO risk framework can support quick implementation of industry awareness and mitigation activities. Figure 1 provides a pictorial flow chart of the ERO's risk management process.

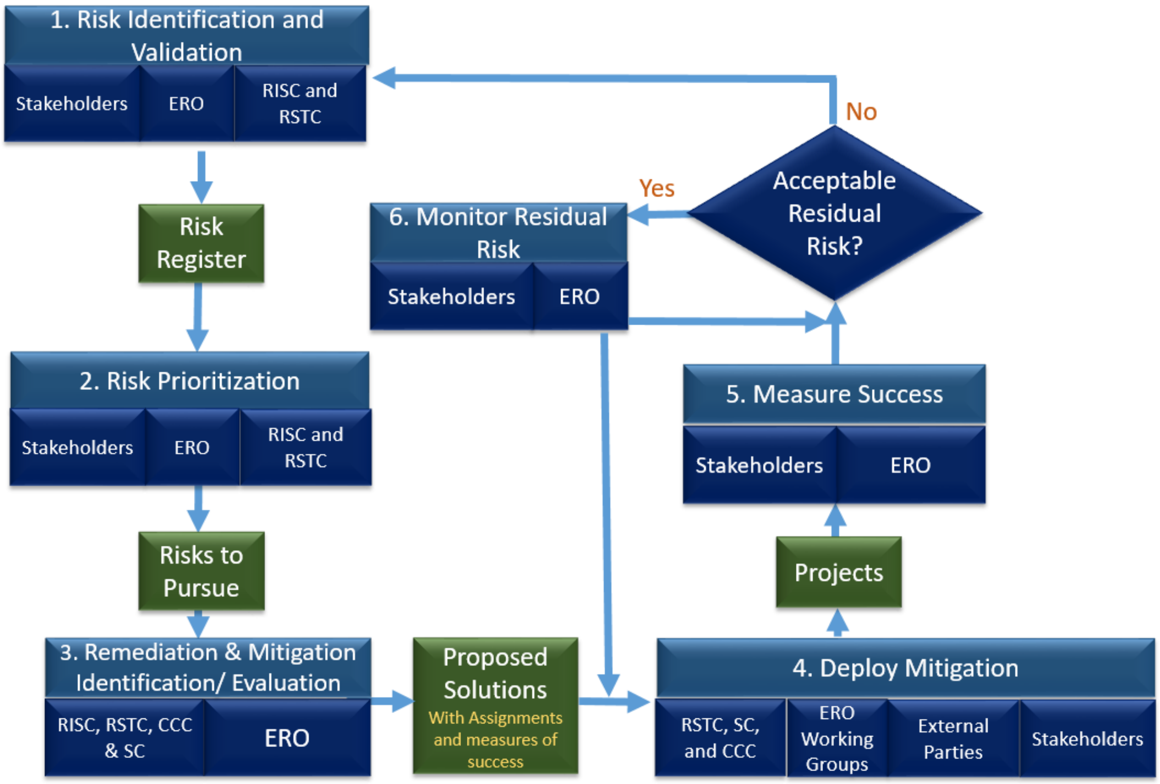

Figure 1: ERO Risk Management Process

In order to coordinate risk mitigation, the RISC and RSTC triage risk mitigations together as called for in the iterative RISC Framework process. The Standards Committee (SC) and the Compliance and Certification Committee (CCC) are key stakeholder groups that are part of this iterative process. Further, the Standing Committee Coordination Group (SCCG) is a group made up of the leadership (Chair and Vice Chair) of each Standing Committee. This group coordinates and aligns the Standing Committees activities. The touch points are shown in Figure 2.

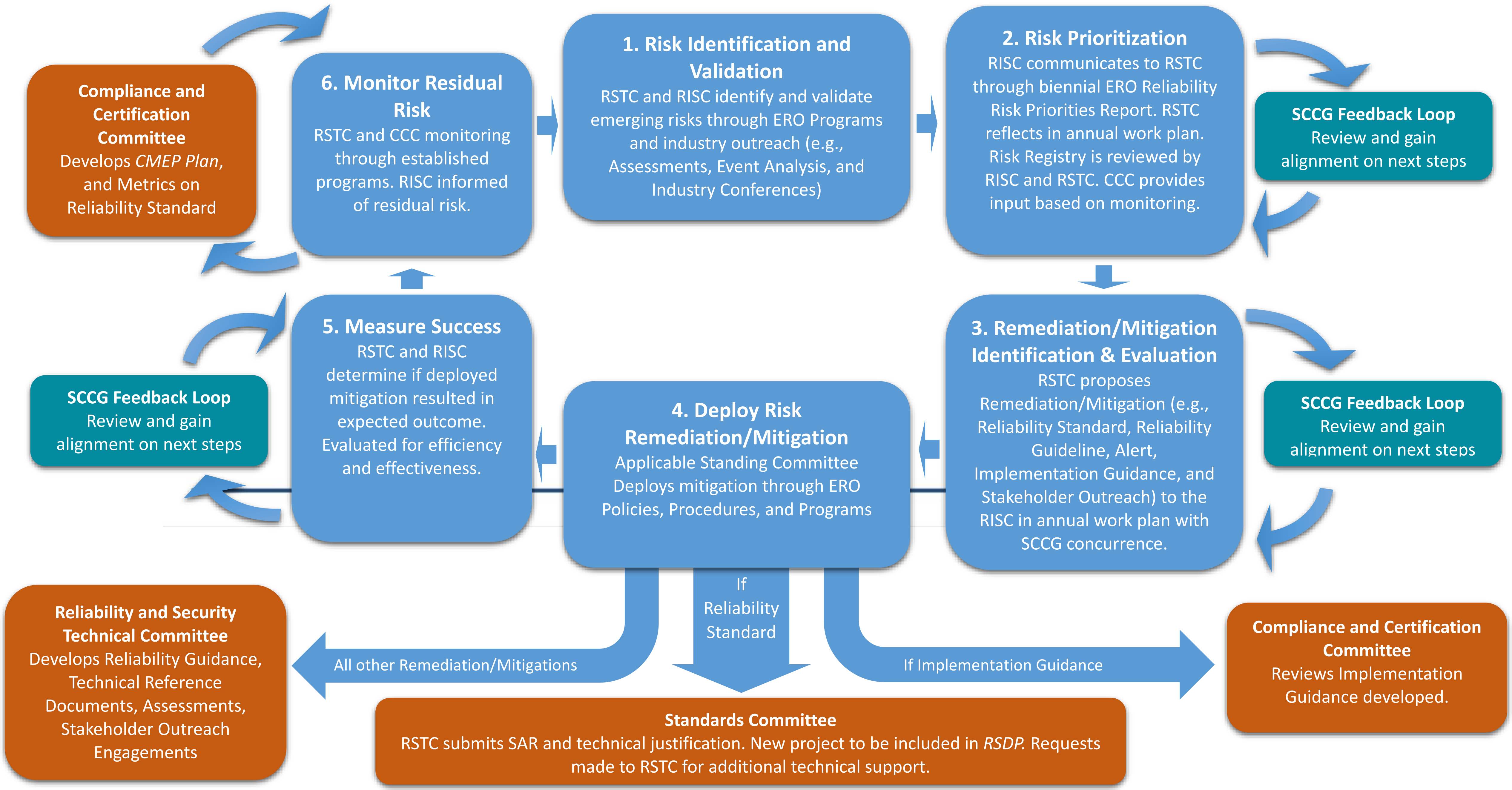

Figure 2: RSTC, RISC,. SC,. and CCC Coordination within the Risk Framework

1. **Risk Identification and Validation** is completed by the RSTC and RISC as they review the annual State of Reliability Report, Long-Term and Seasonal Reliability Assessments, Event Analysis records and with a joint review the biennial RISC Report incorporating prioritized risks into the RSTC's subgroup's work plans. Further, the RSTC coordinates with the RISC on long-term risks and mitigations. In this way, risks determined by monitoring the ongoing performance of the bulk power system and those identified by scanning the horizon. The risk registry will be maintained by the RISC and RSTC to determine if an inherent nature of a risk changes over time, and consider removing risks or adding others.
2. **Reliability Risk Prioritization** is completed collaboratively between the RSTC and RISC on an annual basis. Ongoing activities are calibrated, and newly identified risks are prioritized. The SCCG will serve as a coordination point to ensure broad alignment across the Standing Committees.
3. **Remediation & Mitigation Identification & Evaluation** activities to address the risks are assigned to the appropriate RSTC subgroups accounting for changing needs across the BPS. They create the ERO Policies, Procedures and Programs to address the risks. Frequent communications ensures coordination of ongoing risk prioritization. RSTC will provide updates to the RISC on the subgroup activities being taken on a quarterly basis. The SCCG will serve as a coordination point to ensure broad alignment across the Standing Committees.
4. **Deploy Mitigations** by putting ERO Policies, Procedures and Programs into effect. Depending on the Risk Remediation/Mitigation activities selected, the RSTC, SC, and CCC will be assigned certain activities. If Implementation Guidance is identified, the CCC will be assigned to review the developed guidance. If a Reliability Standard is identified, the RSTC (or identified stakeholder) will need to submit a SAR to the SC and that project is to be included in the annual Reliability Standards Development Plan. For all other mitigation/remediation activities, the RSTC will be responsible for developing remediation/mitigation.
5. **Measure Success** of the strategies/plans which are jointly evaluated for effectiveness, highlighting next steps. RSTC will measure success using its annual performance measurement activities (e.g., State of Reliability Report, Long-Term Reliability Assessment, and Event Analysis). RSTC will provide updates to the RISC on the actions being taken on a quarterly basis.
6. **Residual Risk** is monitored in coordination between the RSTC coordinates and RISC towards maintaining an acceptable level of residual risk. The CCC will be responsible for measuring the effectiveness of Reliability Standard developed, as well as residual risk, and report back to the RISC through its Compliance and Enforcement Implementation Plan and specific metrics used to measure effectiveness. The SCCG will serve as a coordination point to ensure broad alignment across the Standing Committees.

III. Risk Mitigation from Likelihood and Severity Perspective

From a likelihood and impact perspective, the ERO Policies, Procedures, and Programs above overlap based on the specifics of each risk being mitigated. In addition, there are a host of additional activities that work together to manage risks, such as engagement with the reliability ecosystem, (e.g. Forums, professional organizations (IEEE-PES, CIGRE, etc.), and government). A combination can be used towards gaining industry action, setting the stage for standards as well as addressing a risk while a standard is being developed. Likelihood and impact have a bearing when a Reliability Standard is required. Figure 3 provides an illustration that is representative of the principles:

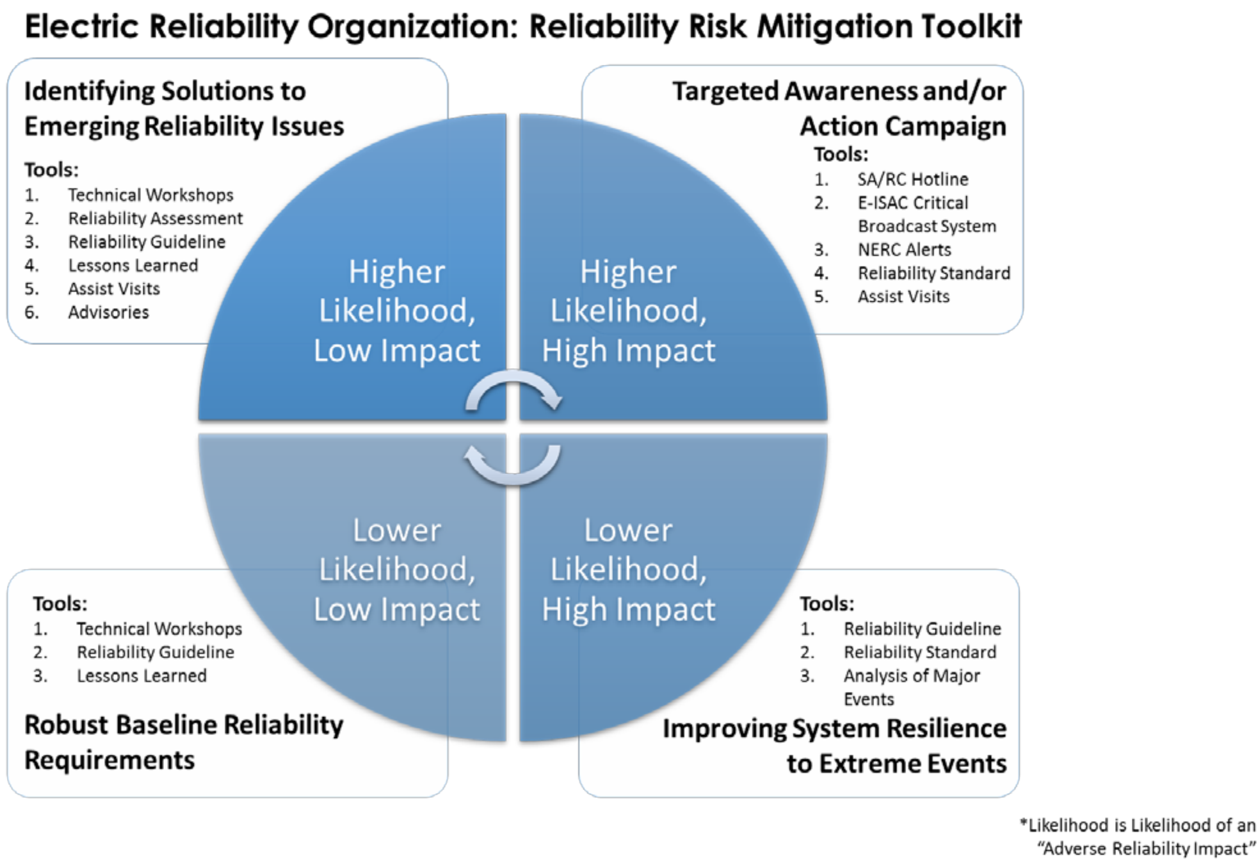

Figure 3: ERO Reliability Risk Mitigation Portfolio

IV. Resilience Impact on Risk Management

In August 2017, the Department of Energy (DOE) issued a Staff Report to the Secretary on Electricity Markets and Reliability (DOE Grid Report) regarding reliability and resilience in light of the changing energy environment. One recommendation in the DOE Grid Report stated that NERC should consider adding resilience to its mission and broadening its scope to address resilience. In response to the DOE report and NERC assessments, the NERC Board of Trustees (NERC Board) directed the Reliability Issues Steering Committee (RISC) to develop a model for resilience and examine resilience in today's environment.

In accordance with the NERC Board's directive, the RISC worked with NERC stakeholders to reexamine the meaning of resilience in today's changing environment and how resilience impacts NERC activities. Meanwhile, the DOE and FERC have continued evaluating the relationship of resilience and reliability.

In November of 2018, the NERC Board accepted the RISC's Report, titled "Reliability Issues Steering Committee Resilience Report." This report summarizes the results of the RISC's examination of resilience, including the RISC Resilience Model.

NERC has developed, filed with FERC, and later updated a definition of the adequate level of reliability (ALR) along with a technical report to guide Reliability Standards development, Reliability Assessments, guideline development, data collection, system analysis and standing committee work. In particular, the ALR, or design basis of the system, is defined as the state that design, planning, and operation the BES will achieve when five ALR performance objectives are met.[5] Each objective addresses Reliable Operation of the BES over four time frames:

1. **Steady state:** the period before a disturbance and after restoration has achieved normal operating conditions
2. **Transient:** the transitional period after a disturbance and during high-speed automatic actions in response
3. **Operations response:** the period after the disturbance where some automatic actions occur and operators act to respond
4. **Recovery and system restoration:** the time period after a widespread outage through initial restoration rebounding to a sustainable operating state and recovery to a new steady state

Further, there is a need to development of additional metrics that measure impacts from emerging risks (e.g. energy sufficiency and transmission/generation operating technology security). These metrics can inform industry on the extent of the condition, level of risk, and relative success of their mitigation.

V. Incorporating Risk Adds a Critical Dimension to the ERO's Mission

Application of ERO Policies, Procedures and Programs provides a multi-dimensional approach to address risks. Namely, some of these approaches can be put in place swiftly, while others require industry collaborative action which can take more time. Further, there are time considerations on the speed of the ERO Policies, Procedures and Programs deployment, as well as the speed at which a risk should be addressed. Figure 4 provides a risk time horizon perspective. The application of mitigation approaches in this Framework are not meant to be static. There are risks, however, that include dynamic forces outside the ERO or risks may not be fully within the ERO's purview. This can and will influence the timing and impact of risks.

The ERO Policies, Procedures and Programs deployed are largely dependent on the likelihood that a given risk would impact reliability. For example, reliability issues that have occurred are generally more

[5] **The ALR Performance Objectives are as follows:**

1. The BES does not experience instability, uncontrolled separation, Cascading, or voltage collapse under normal operating conditions and when subject to predefined Disturbances.
2. BES frequency is maintained within defined parameters under normal operating conditions and when subject to predefined Disturbances.
3. BES voltage is maintained within defined parameters under normal operating conditions and when subject to predefined Disturbances.
4. Adverse Reliability Impacts on the BES following low probability Disturbances (e.g., multiple contingences, unplanned and uncontrolled equipment outages, cyber security events, and malicious acts) are managed.
5. Restoration of the BES after major system Disturbances that result in blackouts and widespread outages of BES elements is performed in a coordinated and controlled manner.

The ALR also lists two assessment objectives for purposes of assessing risks to reliability:

1. BES transmission capability is assessed to determine availability to meet anticipated BES demands during normal operating conditions and when subject to predefined Disturbances.
2. Resource capability is assessed to determine availability to the Bulk Electric System to meet anticipated BES demands during normal operating conditions and when subject to predefined Disturbances.

likely than those that have not occurred, and risks/issues that have occurred are generally more likely to occur again.

Therefore, the ERO Policies, Procedures and Programs used to mitigate risks that have occurred may be different than those used to mitigate longer-term issue that haven't impacted reliability yet. For instance, after analysis of major and/or off-normal events, depending on the potential impacts and reoccurrence likelihood, strong action can be taken by the ERO with nearly immediate response by issuing up to three levels of NERC Alerts, Assist Visits, followed by Reliability Guidelines, technical conferences, and enhancement of Reliability Standards.

Generally, industry action to address medium to high impact and likelihood risks employs Reliability Standards which provide the highest certainty of risk mitigation. Following Reliability Standards is mandatory and provides a high value by creating comfort and certainty for interconnected organizations of expectations and roles, ensuring that the adequate level of reliability will be maintained. In the end, following the Reliability Standards is an outcome of good industry reliability performance.

High-Impact, Low-Frequency-type risks generally do not have a historical record of technical information. Longer-term risks can be difficult to quantify—therefore, much of the work the ERO can do is to assemble industry experts and stakeholders to agree on and validate what the reliability risk is and how it should be considered and addressed within the ERO Policies, Procedures and Programs, including the full reliability ecosystem. These risks require more collaborative effort and more time towards developing technical references, convening industry stakeholders, and conducting independent reliability assessments to determine the best way to mitigate the risk.

The ERO's risk-based approach is fundamental to the success of its mission to ensure the reliability and security of the BES in North America.

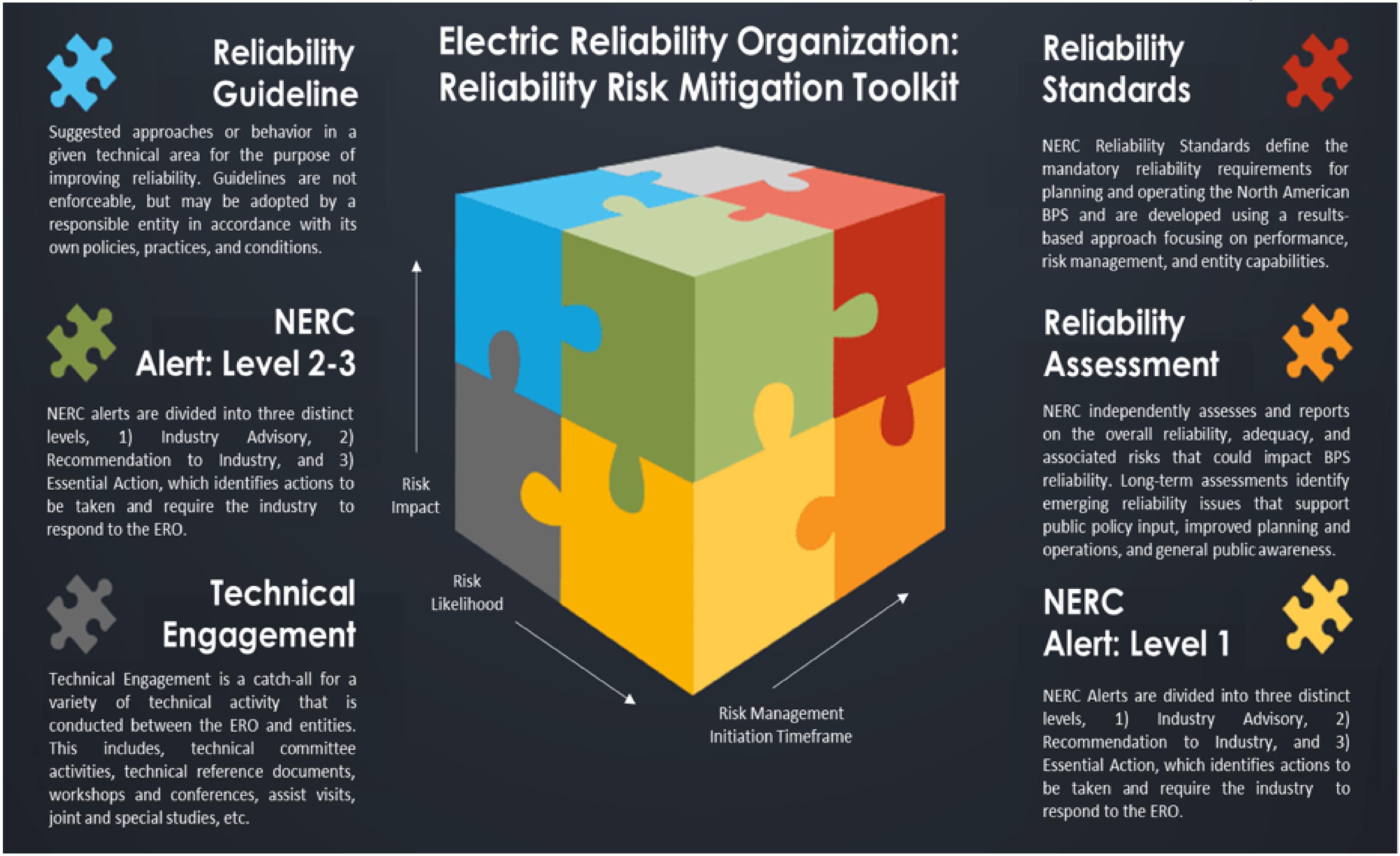

Figure 4: Risk Time Horizon

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Framework to Address Known and Emerging Reliability and Security Risks

~~September~~ November 2020

This document outlines a risk framework for the ERO and details how such a framework provides an important extension of the ERO's core activities. The ERO mission[1] requires establishing a consistent framework to identify, prioritize and address known and emerging reliability and security risks. To support its mission the ERO has developed policies, procedures and programs, which are identified and briefly described in Section I. These policies, procedures and programs have been incorporated into an iterative six-step risk management framework outlined in Section II. Mitigation of risks to Bulk Electric System (BES) reliability can be classified according to the likelihood of the risk occurring and the severity of its impact. Section III addresses how the ERO's policies, procedures and programs identified in Section II map into the risk likelihood and severity space. Resilience is an important component of reliability risk management and is discussed in Section IV. Section V cover the application of ERO Policies, Procedures and Programs, within time required to apply the mitigation and the likelihood and severity.

I. ERO Policies, Procedures and Programs

The ERO's mission ultimately exists to serve the public interest, and it must serve that interest by developing and using the ERO Policies, Procedures and Programs to monitor and mitigate risks to the BES, balancing their use by considering what is possible against what is reasonable and necessary. Further, ensuring reliability and security also require improving the resilience of the BES by building the robustness to withstand unexpected events, supporting controlled degradation when an event is beyond design basis (providing an Adequate Level of Reliability), and supporting restoration following an event.

The ERO identifies risk both in a leading and lagging manner. The ERO scans the horizon for emerging risks such as grid transformation and critical infrastructure interdependencies (leading). At the same time, the ERO is gathering data and information on the performance of the existing bulk power system to uncover unexpected risks such as large quantities of photovoltaic generation ceasing to operate under certain system conditions (lagging). In addition, the ERO annually releases its State of Reliability Report that documents the annual system performance in a comparative fashion. The ERO's Policies, Procedures and Programs are then used to address mitigation of these identified risks.

Five of NERC's most significant reliability risk mitigation activities are Reliability Standards, Assurance and Enforcement activities; Reliability Guidelines; Technical Engagement; Reliability and Risk Assessments; and Alerts:

1. **Reliability Standards, Assurance, and Enforcement** processes are the common way to address reliability and security risks when addressing sustained risks with moderate impacts which are

[1] Electric Reliability Organization (ERO) consists of NERC and the 6 Regional Reliability Organizations. The ERO's mission is to assure the reliability and security of the North American bulk electric system (BES). The ERO is supported by subject matter expertise from the owners and operators of the bulk electric system. In the United States the ERO is authorized the Energy Policy Act of 2003 and overseen by FERC.

likely (e.g., inaccurate planning models), and high impacts, whether likely or unlikely (e.g., vegetation management and geomagnetic disturbances). Standards provide the greatest degree of certainty for risk mitigation. Following NERC and Regional Reliability Standards should not be seen as a burden but rather an outcome of good reliability performance, with that desired outcome on each individual system contributing to the reliability of the entire interconnection, and ultimately, the North American BES.

As a matter of public policy, Reliability Standards should credibly address primary risks that are sustained, high impact and likely. Establishing a baseline of Reliability Standards assures accountability for the public's benefit when minimum expectations of performance or behavior are not met. The public expects a regulator to enforce accountability on at least those actions related to sustained, high impact, and likely risks within its scope of oversight.

A key factor in the success of compliance monitoring and enforcement of mandatory standards rests on a common understanding among industry and the ERO as set forth in the ERO's Compliance Monitoring and Enforcement Program (CMEP) which details how compliance will be monitored and enforced. Implementation Guidance is developed by industry and/or vetted through pre-qualified organizations to show examples of compliant implementations. These vetted examples can then be submitted to the ERO for endorsement, and, if endorsed, the ERO would give the example deference during CMEP activities with consideration of facts and circumstances.

~~Annual~~ Risk elements associated with the Reliability Standards are documented annually in the ERO CMEP Implementation Plan, which provides guidance to industry on North American-wide and regional risks that the ERO's Reliability Assurance and Enforcement staff will be focusing on addressing in the coming year. Regional Entities review the risks each individual registered entity may have, and identify which Reliability Standards they wish to focus on based on these risks. This risk-based approach enables focus on the most important risks to reliability, and review of the controls in place to address them for each individual organization.

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Information and data gathered as a result of compliance monitoring and enforcement activities can inform about the effectiveness of a Reliability Standard or the need for enhancements. At a high level, this recommendation can be passed on through the Standards Development process for consideration.

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2. **Reliability Guidelines** are the common approach to use when addressing moderate impact sustained risks that are unlikely, and low impact sustained risks that are unlikely or likely (such as reduced or lack of equipment maintenance resulting in the loss of an individual element which is a low impact to BPS reliability, while the probability of failure increases over time). Reliability Guidelines are also used for those issues that are or are not in the ERO's jurisdiction, but are practices that improve reliability. Guidelines provide three advantages:

- Together with a strong minimum baseline fabric of standards, guidelines can be a strong and timely way to address risk.

- Reliability Guidelines enable the ERO to highlight expectations or priorities on appropriate practices for a given subject area.
- Reliability Guidelines may also be used to establish performance expectations for emerging risks rather than or prior to codifying those expectations into Reliability Standards.

3. **Technical Engagement** can be used to address sustained risks or one-and-done activities with low impacts, whether likely or unlikely. Activities here include webinars, site visits, presentation and reports, workshops, conferences and technical meetings. This includes not only activities of the ERO, but the ERO supporting industry engagement through the reliability ecosystem, such as the North American Transmission and Generation Forums, professional organizations, researchers, and government. Technical engagement also serves to promote future sustained risk mitigation and support for using Reliability Guidelines, industry notices, newsletters, bulletins, or Reliability Standards.
4. **Reliability and Risk Assessments** coupled with the biennial report outlining the Reliability Issues Steering Committee's (RISC) findings identifies risks, whether likely or unlikely.[2] Generally, these activities are used to inform and influence policymakers, industry leaders, and the general public about the impact of important public and energy policy issues impacting BPS reliability.
5. **Alerts** are used for sharing information, especially time-sensitive information, to request action or direct action. They can also serve as a more nimble, foundational activity for other ERO Policies, Procedures and Programs. As part of its normal course of business, NERC often either discovers, identifies, or is provided with information that is critical to ensuring the reliability of the bulk power system in North America. In order to effectively disseminate this information, NERC utilizes email-based "alerts" designed to provide concise, actionable information to the electricity industry. As defined in its Rules of Procedure, NERC alerts are divided into three distinct levels, as follows:
   - **Level 1 Industry Advisory**: Purely informational, intended to alert registered entities to issues or potential problems. A response to NERC is not necessary.
   - **Level 2 Recommendation to Industry**: Recommends specific action be taken by registered entities. A response from recipients, as defined in the alert, is required.
   - **Level 3 Essential Action**: Identifies actions deemed to be "essential" to bulk power system reliability and requires NERC Board of Trustees' approval prior to issuance. Like recommendations, essential actions also require recipients to respond as defined in the alert.

   Since Level 2 and Level 3 alerts require acknowledgement of receipt and response to the alerts, they are used in higher risk impact situations than Level 1 alerts, which are purely informational.

II. ERO Iterative Risk Management Framework

During the last ten years, the ERO has expanded its implementation of risk-based approaches across its program areas. During this transition, the ERO has continued to lead industry in reliability, resilience, and security initiatives to identify known and emerging risks, and to engage industry in a collaborative approach to mitigating that risk. The primary reliability, resilience, and security activity for risk mitigation the ERO currently deploys includes, but is not limited to: outreach events such as webinars and

[2] Instead of using "mitigating risks," the RISC uses "managing risks." These terms are used interchangeably and mean the same thing in this whitepaper.

Commented [A3]: TAPS: footnote explains this word use inconsistency between the RISC report and the framework: manage = mitigate conferences, Reliability Guidelines, Alerts, Reliability Standard development, registration and certification, and compliance monitoring and enforcement. In addition, the ERO can engage Forums such as the North American Transmission Forum (NATF) and the North American Generator Forum (NAGF), as well as the industry trade associations, industry groups such as the Energy Systems Integration Group (ESIG), and research organizations such as the Electric Power Research Institute and the Power Systems Engineering Research Center (PSERC) to assist with development of best practices, increased awareness, Implementation Guidance, and other solutions used to address identified risks.

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Additionally, a set of industry indicators has been developed to measure reliability and security. These indicators need further refinement, maturation and linkage to industry performance, as they are key to evaluating the effectiveness of mitigation efforts, identifying the residual risk that remains, and considering whether the remaining risk is at acceptable levels.

This framework is meant to guide the ERO in the prioritization of risks and provide guidance on the application of ERO Policies, Procedures, and Programs, to inform resource allocation and project prioritization in the mitigation of those risks. Additionally, the framework accommodates measuring residual risk after mitigation is in place, enabling the ERO to evaluate the success of its efforts in mitigating risk, which provides a necessary feedback for future prioritization, mitigation efforts, and program improvements.

The successful reduction of risk is a collaborative process between the ERO, industry, and the technical committees including the Reliability and Security Technical Committee (RSTC) and RISC. The framework provides a transparent process using industry experts in parallel with ERO experts throughout the process, from risk identification, deployment of mitigation strategies, to monitoring the success of these mitigations.

Six specific steps have been identified, consistent with risk management frameworks used by other organizations and industries: 1) Risk Identification; 2) Risk Prioritization; 3) Mitigation Identification and Evaluation; 4) Deployment; 5) Measurement of Success; and 6) Monitoring. Each of these steps will require process development, including stakeholder engagement, validation/triage approaches, residual risk monitoring, ERO's level of purview over a risk, etc. These processes will be developed once the framework has been finalized.

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1. **Risk Identification and Validation:** As mentioned above, the ERO identifies risks using both leading and lagging approaches. The RISC biennial report and Long-Term and Seasonal Reliability Assessments (leading) have successfully brought together industry experts to identify and prioritize emerging risks, as well as suggest mitigation activities. A partnership between the ERO leadership and both the RISC and RSTC enables input from the ERO program areas, industry Forums and trade associations to provide additional context in risk identification.

   Once the ERO, NERC Committees, Forums, or industry subject matter experts identify and validate a risk, it is critical that the corresponding recommendation for mitigation describe, explain, and provide support for the basis for selecting the particular approach to mitigation. A template will be created, that mirrors the Standards Authorization Request template, that requires an explanation of the risk, approach(es) for mitigation, and estimate of residual risk.

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In addition, the ERO and industry subject matter experts continuously work together identifying and validating risks to the reliable and secure operation of the bulk power system based on analysis of ongoing performance of the system (lagging). Validation of the magnitude and priority of the risk includes working with NERC Committees, and socializing it with Forums, government and research organizations.

Risk Identification: The ERO has a number of ways that it identifies risks:

- ERO stakeholder supported technical organizations, industry forums, and associated subject matter experts
- Focused Compliance monitoring activities
- Reliability and Risk Assessments
- Events Analysis
- State of Reliability Report, including the analysis of Availability Data Systems (BASS, TADS, GADS, DADS, MIDAS, etc.)
- Frequency Response, Inertia, and other essential reliability service measurements
- Interconnection simulation base case quality and fidelity metrics
- Reliability Issues Steering Committee (RISC) Biennial Risk Report
- Regional Risk Assessments
- Communication with external parties, such as DOE, DHS, Natural Resources Canada, CEA and EPRI
- Shared public and/or government intelligence with special emphasis on cyber security

Risk Validation: In addition, T the ERO and industry subject matter experts continuously work together identifying and validating risks to the reliable and secure operation of the bulk power system based on analysis of ongoing performance of the system (lagging). Validation of the magnitude and priority of the risks includes analysis from the ERO databases of system performance and Events Analysis. These outputs are generally covered in NERC's State of Reliability Report. In addition, the risks are further validated through working with NERC Committees, and socializing itthem with Forums, government, and research organizations. Leading risk validation requires analysis of system simulations, forecasts, and performance projections.

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1.2. **Risk Prioritization:** Prioritizing risks is accomplished through an analysis of their exposure, scope, and duration as well as impact and likelihood. The primary sources of data used to support this analysis come from the Risk Identification step. Deciding if the risk requires near-term mitigation or continued monitoring is informed by technical expertise. Depending on the complexity of the risk, new models, algorithms and processes may need to be developed to better understand the potential impacts of the risk, which is necessary to develop risk mitigation tactics. The process would be consistent with other risk management frameworks used by other industries, and was recently successfully tested in collaboration with industry through a survey issued by the RISC, based upon the risks that group prioritized in early 2019.

The A ERO risk registry and heat maps will be developed encompassing prior RISC report findings, ongoing technical committee activities, and risks being monitored. This registry would be

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developed by the end of the second quarter of 2021. Work plans of the technical committees will then be periodically reviewed to ensure that ongoing activities are tied to identified risks in the risk registry. Further, if new risks emerge they can be added to the registry, and if it is deemed that the risks are sufficiently mitigated, they will be moved to the monitored portion of the risk registry. As the RSTC develops its annual work plan and following the publication of the biennial ERO Reliability Risk Priorities Report, the risk registry is reviewed by the RISC and the RSTC to evaluate how completed work addressed these identified risks, whether any new risks have been identified by either committee that need to be added to the risk register, and documenting monitored risks which require no additional mitigation.

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~~2.~~3. **Remediation and Mitigation Identification and Evaluation:** The right mix of mitigation activities is balanced against both the effective and efficient use of resources and the potential risk impact and likelihood. Further, the risk tolerances needs to balanced against potential impacts so that the remediation/mitigation plans can be developed accordingly. Determining the best mix depends on a number of factors, such as:

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- What is the potential impact or severity of the risk?
- How probable is the risk? Is it sustained, decreasing or growing?
- Is the risk here today or anticipated in the next 3-5 years?
- How pervasive is the risk?
- Is mitigation expected to be a one-time action, or ongoing?
- Have we had experience with events being exacerbated by the risks, or there is no experience, but the probability is growing (i.e. cyber or physical security)?
- Have previous mitigation efforts been deployed? If so, were they effective? Why or why not?
- What is an acceptable residual risk level after mitigating activities have been deployed?
- Is the risk man-made or by natural causes?
- Does the mix of mitigations vary based on jurisdictional or regional differences?
- Is the risk fully or partially within the purview of the ERO?

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Input from, and allocation of, subject matter expertise through multiple sources is part of this consideration, including resources within the ERO and its stakeholders (such as standing technical committees and their subgroups, or standard drafting teams). External parties are important sources as well, such as the North American Transmission and Generation Forums (NATF and NAGF), North American Energy Standards Board (NAESB), the Institute of Electrical and Electronic Engineers (IEEE), and EPRI, to name a few. ~~Coordination is key to avoid duplication and provide supportive, rather than conflicting actions.~~

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Once a risk to the BES has been prioritized according to its impact and likelihood, the ERO, NERC Committees, Forums, and industry subject matter experts recommend and can take on potential mitigation activities and assess their anticipated effectiveness. Coordination is key to avoid duplication and provide supportive, rather than conflicting actions.

The ERO remains responsible for risks to the reliable and secure operation of the BES. Risk mitigation should still be followed by the ERO no matter which organization takes on activities. Examples of mitigation efforts include, but not limited to:

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- Reliability Standards, with Compliance and Enforcement for risks that are:
  - Sustained, moderate to severe impact, and likely
  - Sustained, severe impact, and unlikely
  - Focused monitoring based on risk, and in response to major events
- Reliability Guidelines for risks that are:
  - Sustained, low to moderate impact, and likely
- Lessons Learned for risks that are:
  - Sustained, low impact, and likely
- Assist Visits for risks that are:
  - Compliance-related
  - Focused on a very specific situation or configuration
  - Generally on specific industry or entity practices or conditions
- Analysis of Major Events for risks that are:
  - Identified after a Major Event (e.g., Category 3 or higher)
  - Discreet/one-time, severe impact, unlikely
  - identified through recommended reliability improvements or best practices and lessons learned
- Analysis of "Off-Normal" Events for risks that are
  - Identified after an unusual operational condition has occurred and likely not a categorized event.
  - Discreet/one-time, moderate impact, unlikely
  - Identified through recommended reliability improvements or best practices and lessons learned
- Advisories, Recommendations or Essential Actions[3]
- Alerts[4]
- Technical Conferences and Workshops

[3] LEVEL 1 (Advisories) – purely informational, intended to advise certain segments of the owners, operators and users of the Bulk Power System of findings and lessons learned; LEVEL 2 (Recommendations) – specific actions that NERC is recommending be considered on a particular topic by certain segments of owners, operators, and users of the Bulk Power System according to each entity's facts and circumstances; LEVEL 3 (Essential Actions) – specific actions that NERC has determined are essential for certain segments of owners, operators, or users of the Bulk Power System to take to ensure the reliability of the Bulk Power System. Such Essential Actions require NERC Board approval before issuance.

[4] ALERT 1: Industry Action Requested: Fast moving or recently detected, impacts moderate, ALERT 2: Industry Action Required: Fast moving or recently detected, impacts moderate to severe, ALERT 3: Industry Action Mandatory: Fast moving or recently detected, impacts moderate to severe.

When reviewing the type and/or depth of remediation and mitigation, a form of cost-effectiveness analysis may be considered to understand impacts and potential burdens. This analysis can then be compared to potential impacts of the risk.

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~~3.~~4. **Mitigation Deployment**: Mitigation projects will be deployed by the ERO and/or industry stakeholder groups, as determined by the "Mitigation Identification and Evaluation" step. A specific mitigation plan would involve a suitable mix of the ERO policies, procedures and programs discussed in Section I. These mitigations would be coordinated with Canadian, industry partners and stakeholders.

From time-to-time, the Federal Energy Regulatory Commission (FERC) may order the development of Reliability Standards, which can occur in this step.

~~4.~~5. **Measurement of Success:** Once a set of solutions has been deployed, the effectiveness of the mitigation must be measured to determine if the residual risk has been reduced to an acceptable level. Effectively, if the desired level of risk mitigation is not met, the risk is fed back to Step 1, enabling a new prioritization of risks, factoring in historic mitigation, ensuring resource allocation is adapted to the changing risk landscape. This step also informs future mitigation efforts, as industry and the ERO learn from the effectiveness of mitigation mixes for reducing risk. A partnership between the ERO leadership and both the RISC/RSTC will enable input from the ERO program areas, industry Forums and trade associations to provide additional context in the measurement of success. That said, criteria and other related processes should be developed for determining risk severity, likelihood, and mitigation activity effectiveness.

~~5.~~6. **Monitor Residual Risk:** Once the level of residual risk is at an acceptable level, the risk is monitored through ongoing performance measures to ensure that risk remains at acceptable risk levels. The residual risk should be monitored for progress and to ensure that the mitigations that are in place continue to address the risk (Step 5). At times, mitigations need to be deployed on a periodic basis (e.g. annual workshops, Reliability Guideline updates, etc.) to ensure continued success (Step 4). If the risk levels heighten, or increased mitigation efforts are necessary due to the changing nature of the bulk power system, the risk can be fed back (Step 1) for prioritization and the development of additional mitigation approaches. The ERO, working with its industry partners, technical committees, stakeholders and forums, would determine if the residual risk was acceptable of if additional mitigations required.

From-time-to-time risks are identified and validated which require an accelerated industry attention. The ERO risk framework can support quick implementation of industry awareness and mitigation activities. Figure 1 provides a pictorial flow chart of the ERO's risk management process.

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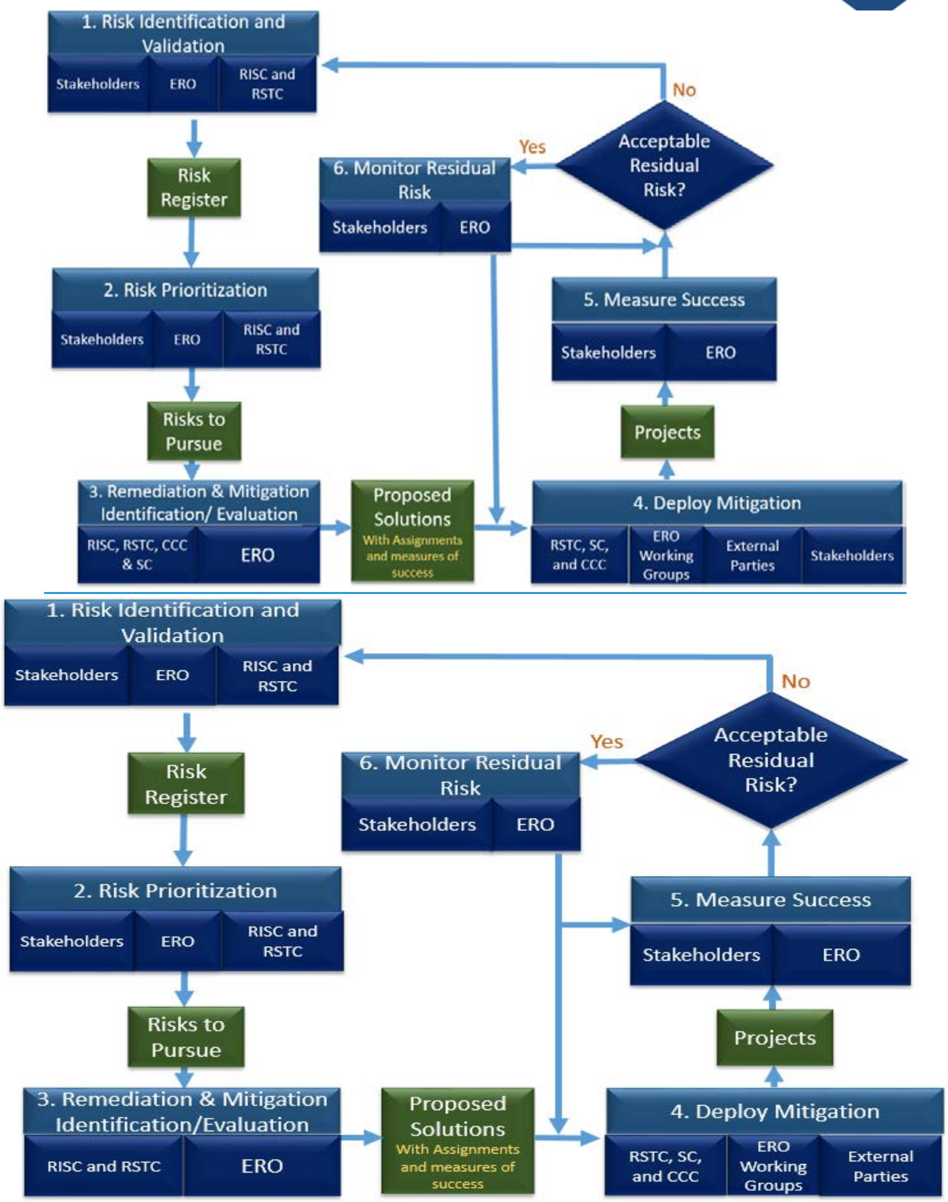

Figure 1: ERO Risk Management Process

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In order to coordinate risk mitigation, the RISC and RSTC triage risk mitigations together as called for in the iterative RISC Framework process. The Standards Committee (SC) and the Compliance and Certification Committee (CCC) are key stakeholder groups that are part of this iterative process. Further, the Standing Committee Coordination Group (SCCG) is a group made up of the leadership (Chair and Vice Chair) of each Standing Committee. This group coordinates and aligns the Standing Committees activities. The touch points are shown in Figure 2.

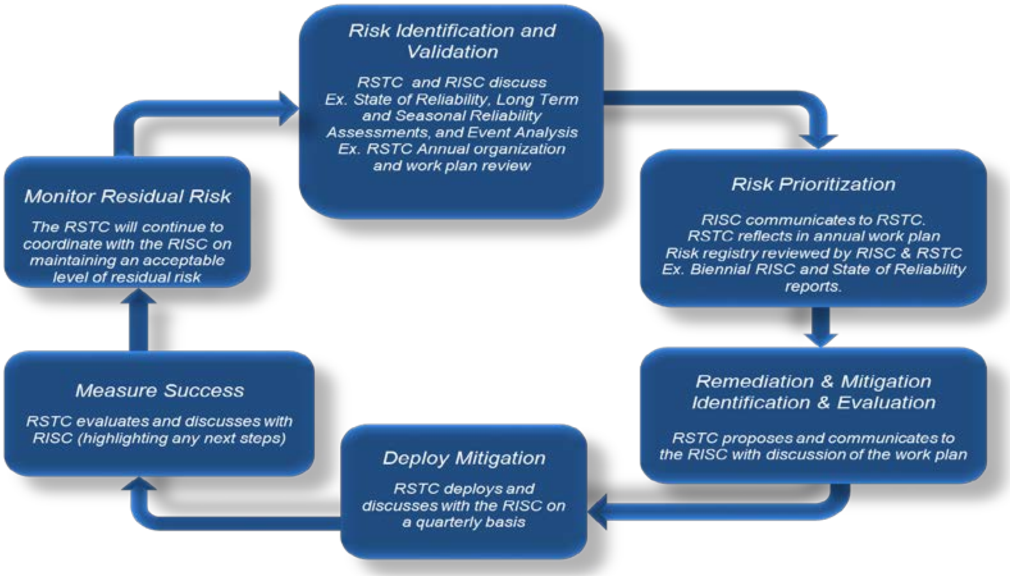

Figure 2: RSTC/RISC Coordination within the Risk Framework

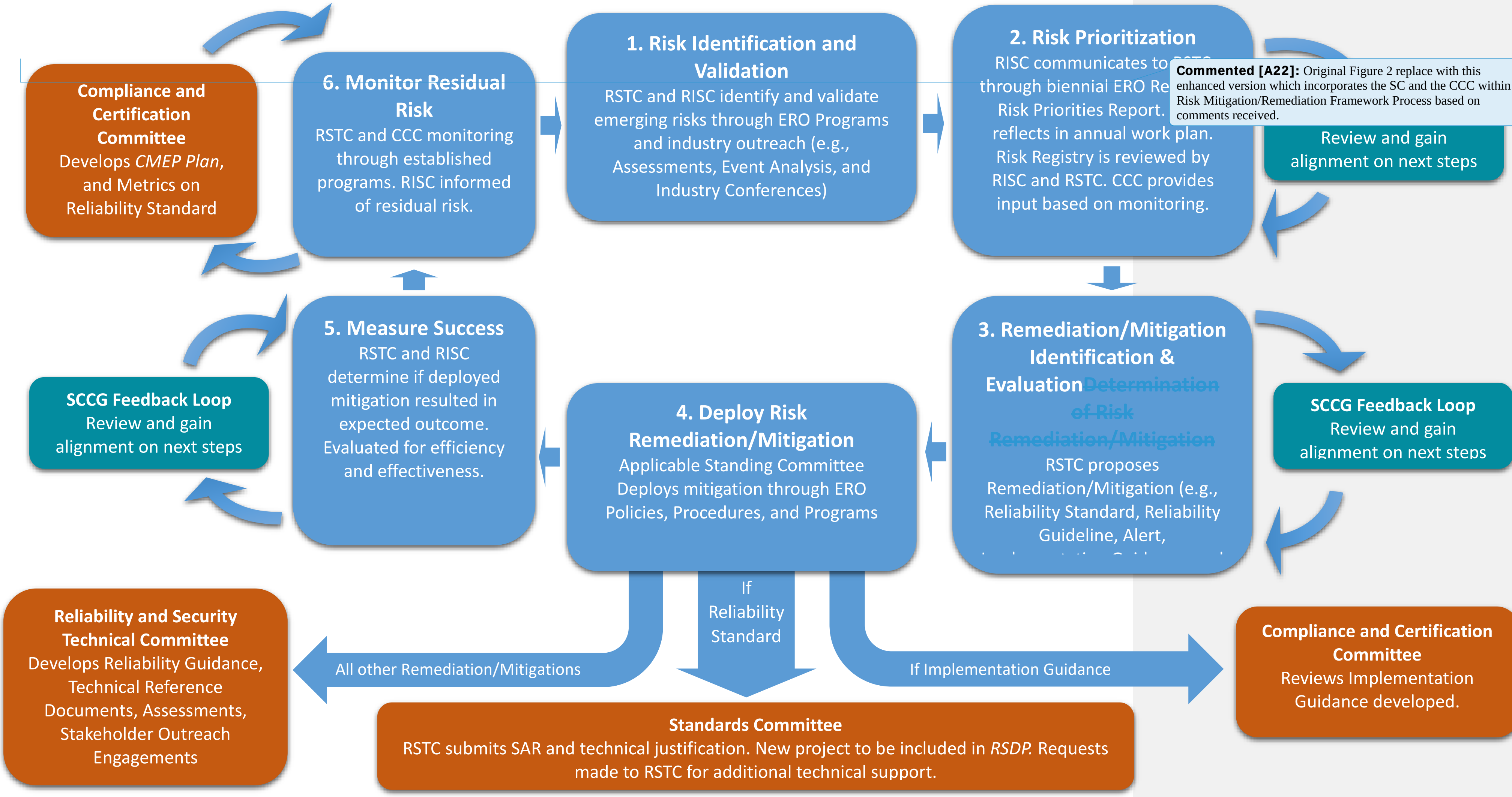

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Figure 2: RSTC, RISC. SC. aAnd CCC Coordination within the Risk Framework

1. **Risk Identification and Validation** is completed by the RSTC and RISC as they review the annual State of Reliability Report, Long-Term and Seasonal Reliability Assessments, Event Analysis records and with a joint review the biennial RISC Report incorporating prioritized risks into the RSTC's subgroup's work plans. Further, the RSTC coordinates with the RISC on long-term risks and mitigations. In this way, risks determined by monitoring the ongoing performance of the bulk power system and those identified by scanning the horizon. The risk registry will be maintained by the RISC and RSTC to determine if an inherent nature of a risk changes over time, and consider removing risks or adding others.

2. **Reliability Risk Prioritization** is completed collaboratively between the RSTC and RISC on an annual basis. Ongoing activities are calibrated, and newly identified risks are prioritized. The SCCG will serve as a coordination point to ensure broad alignment across the Standing Committees.

3. **Remediation & Mitigation Identification & Evaluation**~~**Remediation & Mitigation Identification & Evaluation**~~ activities to address the risks are assigned to the appropriate RSTC subgroups accounting for changing needs across the BPS. They create the ERO Policies, Procedures and Programs to address the risks. Frequent communications ensures coordination of ongoing risk prioritization. RSTC will provide updates to the RISC on the subgroup activities being taken on a quarterly basis. The SCCG will serve as a coordination point to ensure broad alignment across the Standing Committees.

4. **Deploy Mitigations** by putting ERO Policies, Procedures and Programs into effect. Depending on the Risk Remediation/Mitigation activities selected, the RSTC, SC, and CCC will be assigned certain activities. If Implementation Guidance is identified, the CCC will be assigned to review the developed guidance. If a Reliability Standard is identified, the RSTC (or identified stakeholder) will need to submit a SAR to the SC and that project is to be included in the annual Reliability Standards Development Plan. For all other mitigation/remediation activities, the RSTC will be responsible for developing remediation/mitigation.

5. **Measure Success** of the strategies/plans which are jointly evaluated for effectiveness, highlighting next steps. RSTC will measure success using its annual performance measurement activities (e.g., State of Reliability Report, Long-Term Reliability Assessment, and Event Analysis). RSTC will provide updates to the RISC on the actions being taken on a quarterly basis.

6. **Residual Risk** is monitored in coordination between the RSTC coordinates and RISC towards maintaining an acceptable level of residual risk. The CCC will be responsible for measuring the effectiveness of Reliability Standard developed, as well as residual risk, and report back to the RISC through its Compliance and Enforcement Implementation Plan and specific metrics used to measure effectiveness. The SCCG will serve as a coordination point to ensure broad alignment across the Standing Committees.

Commented [A23]: NRECA

Commented [A24]: Described the enhanced interaction between RISC, RSTC, CCC, and SC based on new Figure 2.

III. Risk Mitigation from Likelihood and Severity Perspective

From a likelihood and impact perspective, the ERO Policies, Procedures, and Programs above overlap based on the specifics of each risk being mitigated. In addition, there are a host of additional activities that work together to manage risks, such as engagement with the reliability ecosystem, (e.g. Forums, professional organizations (IEEE-PES, CIGRE, etc.), and government). A combination can be used towards gaining industry action, setting the stage for standards as well as addressing a risk while a standard is being developed. Likelihood and impact have a bearing when a Reliability Standard is required. Figure 3 provides an illustration that is representative of the principles:

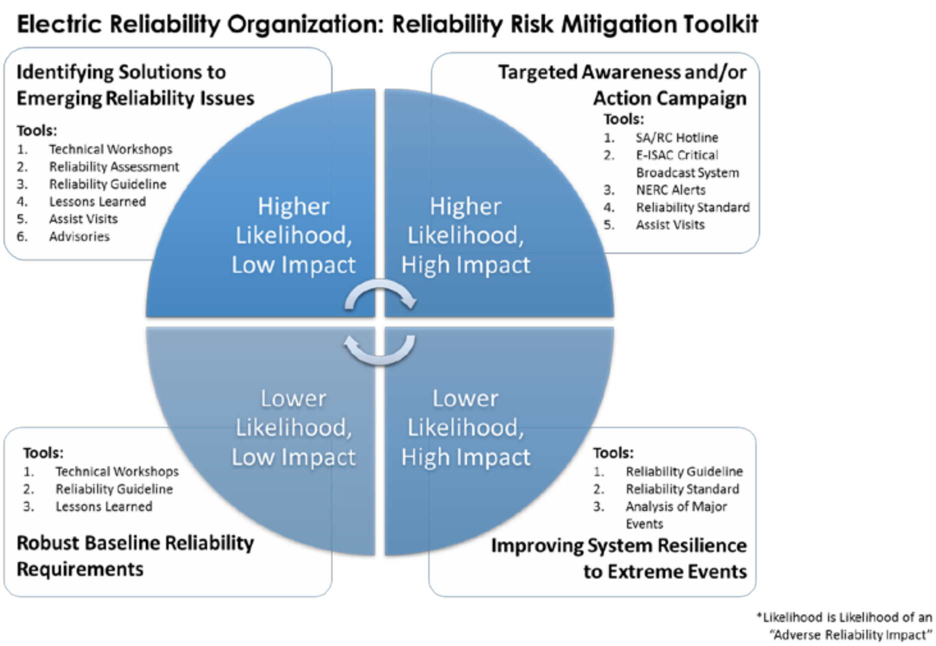

Figure 3: ERO Reliability Risk Mitigation Portfolio

Commented [A25]: This addresses NRECA's comments on Figure 4. Their concern is addressed in Figure 3

"there is concern that, where extremely valuable tools like assist visits and "Technical Engagement" are applicable across the risk spectrum (high impact and low impact), the figure may not fully represent such value. To ensure that these critical elements are recognized, when using the model, we request that NERC consider clarifying that the tools are agile and cumulative e.g., listed tools may be applicable and available to address issues across the risk spectrum."

IV. Resilience Impact on Risk Management

In August 2017, the Department of Energy (DOE) issued a Staff Report to the Secretary on Electricity Markets and Reliability (DOE Grid Report) regarding reliability and resilience in light of the changing energy environment. One recommendation in the DOE Grid Report stated that NERC should consider adding resilience to its mission and broadening its scope to address resilience. In response to the DOE report and NERC assessments, the NERC Board of Trustees (NERC Board) directed the Reliability Issues Steering Committee (RISC) to develop a model for resilience and examine resilience in today's environment.

In accordance with the NERC Board's directive, the RISC worked with NERC stakeholders to reexamine the meaning of resilience in today's changing environment and how resilience impacts NERC activities. Meanwhile, the DOE and FERC have continued evaluating the relationship of resilience and reliability.

In November of 2018, the NERC Board accepted the RISC's Report, titled "Reliability Issues Steering Committee Resilience Report." This report summarizes the results of the RISC's examination of resilience, including the RISC Resilience Model.

Commented [A26]: Flows better

NERC has developed, filed with FERC, and later updated a definition of the adequate level of reliability (ALR) along with a technical report to guide Reliability Standards development, Reliability Assessments, guideline development, data collection, system analysis and standing committee work. In particular, the ALR, or design basis of the system, is defined as the state that design, planning, and operation the BES will achieve when five ALR performance objectives are met.[5] Each objective addresses Reliable Operation of the BES over four time frames:

1. **Steady state:** the period before a disturbance and after restoration has achieved normal operating conditions
2. **Transient:** the transitional period after a disturbance and during high-speed automatic actions in response
3. **Operations response:** the period after the disturbance where some automatic actions occur and operators act to respond
4. **Recovery and system restoration:** the time period after a widespread outage through initial restoration rebounding to a sustainable operating state and recovery to a new steady state

Further, there is a need to development of additional metrics that measure impacts from emerging risks (e.g. energy sufficiency and transmission/generation operating technology security). These metrics can inform industry on the extent of the condition, level of risk, and relative success of their mitigation.

Commented [A27]: NPCC

~~In November of 2018, the NERC Board accepted the RISC's Report, titled "Reliability Issues Steering Committee Resilience Report." This report summarizes the results of the RISC's examination of resilience, including the RISC Resilience Model.~~

V. Incorporating Risk Adds a Critical Dimension to the ERO's Mission

Application of ERO Policies, Procedures and Programs provides a multi-dimensional approach to address risks. Namely, some of these approaches can be put in place swiftly, while others require industry collaborative action which can take more time. Further, there are time considerations on the speed of the ERO Policies, Procedures and Programs deployment, as well as the speed at which a risk should be addressed. Figure 4 provides a risk time horizon perspective. The application of mitigation approaches in this Framework are not meant to be static. There are risks, however, that include dynamic forces outside the ERO or risks may not be fully within the ERO's purview. This can and will influence the timing and impact of risks.

Commented [A28]: TAPS

[5] **The ALR Performance Objectives are as follows:**

1. The BES does not experience instability, uncontrolled separation, Cascading, or voltage collapse under normal operating conditions and when subject to predefined Disturbances.
2. BES frequency is maintained within defined parameters under normal operating conditions and when subject to predefined Disturbances.
3. BES voltage is maintained within defined parameters under normal operating conditions and when subject to predefined Disturbances.
4. Adverse Reliability Impacts on the BES following low probability Disturbances (e.g., multiple contingences, unplanned and uncontrolled equipment outages, cyber security events, and malicious acts) are managed.
5. Restoration of the BES after major system Disturbances that result in blackouts and widespread outages of BES elements is performed in a coordinated and controlled manner.

The ALR also lists two assessment objectives for purposes of assessing risks to reliability:

1. BES transmission capability is assessed to determine availability to meet anticipated BES demands during normal operating conditions and when subject to predefined Disturbances.
2. Resource capability is assessed to determine availability to the Bulk Electric System to meet anticipated BES demands during normal operating conditions and when subject to predefined Disturbances.

The ERO Policies, Procedures and Programs deployed are largely dependent on the likelihood that a given risk would impact reliability. For example, reliability issues that have occurred are generally more likely than those that have not occurred, and risks/issues that have occurred are generally more likely to occur again.

Therefore, the ERO Policies, Procedures and Programs used to mitigate risks that have occurred may be different than those used to mitigate longer-term issue that haven't impacted reliability yet. For instance, after analysis of major and/or off-normal events, depending on the potential impacts and reoccurrence likelihood, strong action can be taken by the ERO with nearly immediate response by issuing up to three levels of NERC Alerts, Assist Visits, followed by Reliability Guidelines, technical conferences, and enhancement of Reliability Standards.

Generally, industry action to address medium to high impact and likelihood risks employs Reliability Standards which provide the highest certainty of risk mitigation. Following Reliability Standards is mandatory and provides a high value by creating comfort and certainty for interconnected organizations of expectations and roles, ensuring that the adequate level of reliability will be maintained. In the end, following the Reliability Standards is an outcome of good industry reliability performance.

High-Impact, Low-Frequency-type risks generally do not have a historical record of technical information. Longer-term risks can be difficult to quantify—therefore, much of the work the ERO can do is to assemble industry experts and stakeholders to agree on and validate what the reliability risk is and how it should be considered and addressed within the ERO Policies, Procedures and Programs, including the full reliability ecosystem. These risks require more collaborative effort and more time towards developing technical references, convening industry stakeholders, and conducting independent reliability assessments to determine the best way to mitigate the risk.

The ERO's risk-based approach is fundamental to the success of its mission to ensure the reliability and security of the BES in North America.

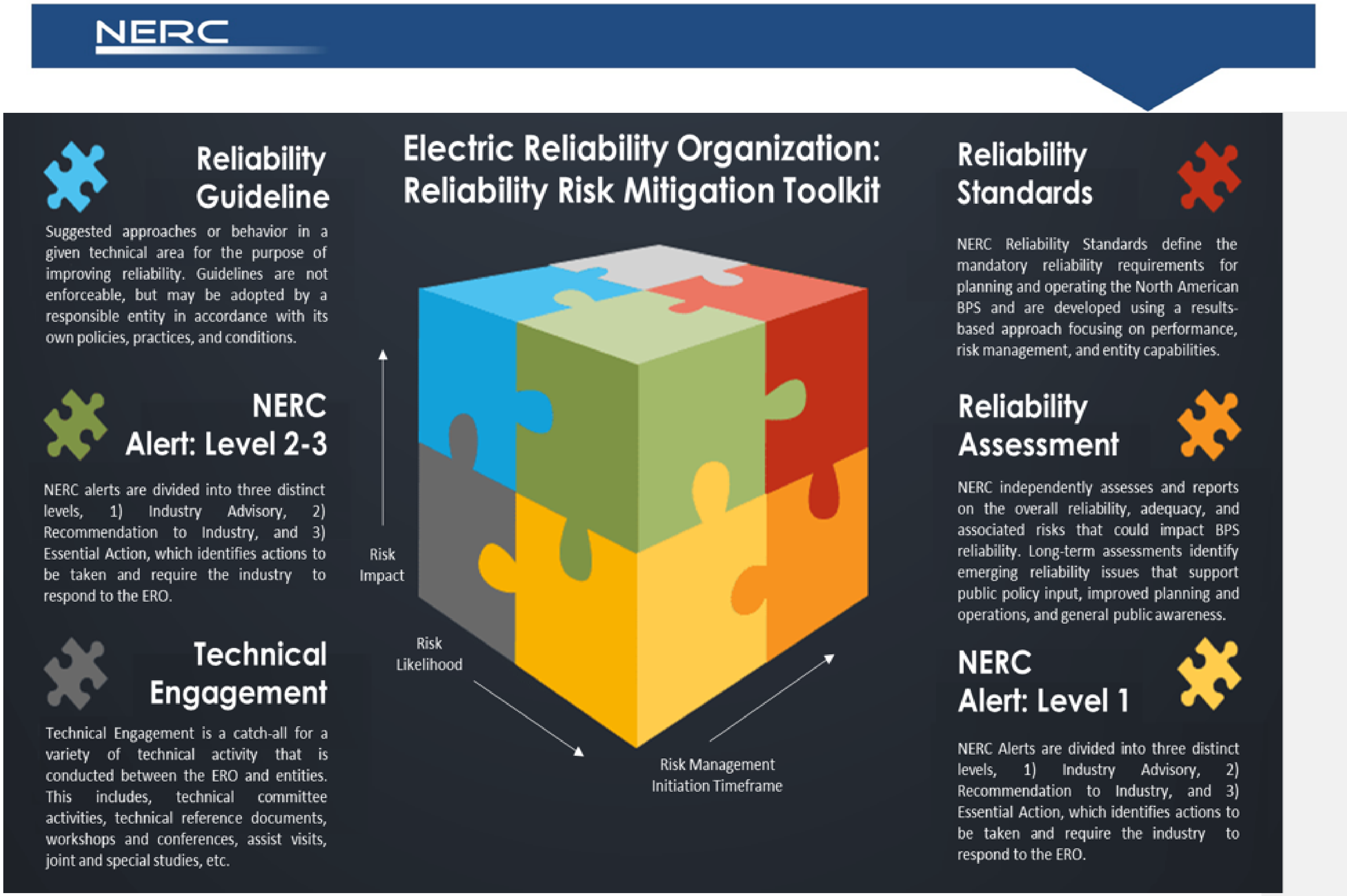

Figure 4: Risk Time Horizon

MRC Policy Input-October 2020
Risk Framework Comment Response Matrix

Comment	Response
CEA 1. NERC should ensure any framework to address risk allows appropriate flexibility in risk identification and management activities. 2. The Whitepaper could more clearly define where new or modified programs or efforts to implement any of the framework would be required, and the expected timelines and prioritization for doing so.	1. Added *"Does the mix of mitigations vary based on jurisdictional or regional differences?"* in risk prioritization section 2. Added expected time lines for registry development (2nd quarter of 2021)
EEI 1. EEI recommends clarifying the concepts of risk identification and risk validation, including addressing the need for a technical justification to support an identified risk 2. EEI suggests that those who recommend mitigation adequately support the basis for selecting the particular approach to mitigation over the other available tools.	1. Added subsections in the Risk Identification and Validation. 2. Added the call for a template like the SAR to provide a basis of the risk and potential mitigations in Risk Identification and Validation. 3. Enhanced Figure 2 to include the Standards Committee, Compliance and Certification Committee, and the Standing Committee Coordinating Group.
Federal Utilities and Federal Power Marketing Administrations (Sector 4) 1. Ensure that the process identified in the whitepaper on The Framework to Address Known and Emerging Reliability and Security Risks is flexible enough to deal with new unexpected risks.	1. Added: "*From-time-to-time risks are identified and validated which require an accelerated industry attention. The ERO risk framework can support quick implementation industry of awareness and mitigation activities*."
ISO/RTO Council (IRC) 1. The IRC generally supports the NERC Framework to Address Known and Emerging Reliability and Security Risks. The document indicates how NERC working with the RISC/RSTC and stakeholders collect, evaluate and then prioritizes risks that need to be mitigated or monitored; the MRC and stakeholders have been supportive of development of such a document.	1. Added Standards Committee to the Remediation & Mitigation Identification/ Evaluation feedback loop in Figure 1 2. Enhanced Figure 2 to include the Standards Committee, Compliance and Certification Committee, and the Standing Committee Coordinating Group.
NAGF 1. **Remediation and Mitigation Identification and Evaluation:** The NAGF believes that prior to the development of mitigation activities, the risk tolerance level needs to be defined for each risk and then remediation/mitigation plans can be developed accordingly. Input from the NERC resources, stakeholders, industry experts, and external parties such as	1. Added **Remediation and Mitigation Identification and Evaluation**: *"Further, the risk tolerances needs to balanced against potential impacts so that the remediation/ mitigation plans can be developed accordingly."* 2. Added **Measurement of Success:** : *A partnership between the ERO leadership and both the RISC/RSTC will enable input from the*

Comment	Response
the NAGF are important to help ensure the success of remediation/ mitigation activities. 2. **Measurement of Success:** The NAGF agrees with the need to evaluate the effectiveness of mitigation activities against the defined risk tolerance/residual risk. The NAGF believes the Trades and Forums working together could provide measures and evaluations of the effectiveness. 3. **Monitor Residual Risk**: The NATF agrees with the need to periodically monitor risks that achieve acceptable risk levels	*ERO program areas, industry Forums and trade associations to provide additional context in the measurement of success*. 3. Added **Monitor Residual Risk**: *The ERO, working with its industry partners, technical committees, stakeholders and forums, would determine if the residual risk was acceptable of if additional mitigations required* 4. Enhanced Figure 2 to include the Standards Committee, Compliance and Certification Committee, and the Standing Committee Coordinating Group.
NRSRC No Comments	
NPCC 1. Augmenting the explanation of the Reliability Standards, Assurance, and Enforcement process to summarize the Compliance Oversight Process that identifies high risk areas for registered entities' that focuses on improving their individual performance. 2. Expanding the communications feedback loop to more explicitly include industry stakeholders not directly involved in either the RISC or RSTC efforts. 3. Inclusion of cost-effectiveness analysis to the framework when considering the type and/or depth of remediation and mitigation of identified risks. 4. Increased coordination of the identified risk mitigation activities with Canadian entities and other industry partners. 5. Appropriate ERO committees work to develop risk metrics for transmission security and energy sufficiency, and to examine the risk balance provided by the current definition of an adequate level of reliability to re-affirm the industry's risk appetite and risk tolerance.	1. Added: *Regional Entities review the risks each individual registered entity may have, and identify which Reliability Standards they wish to focus on based on these risks. This risk-based approach enables focus on the most important risks to reliability, and review of the controls in place to address them for each individual organization* 2. In Figure 1, Added stakeholders in Deploy Mitigation communications feedback loop 3. Added: *When reviewing the type and/or depth of remediation and mitigation, a form of cost-effectiveness analysis may be considered to understand impacts and potential burdens. This analysis can then be compared to potential impacts of the risk.* 4. Added: *These mitigations would be coordinated with Canadian, industry partners and stakeholders.* 5. This is more around a specific risk set metric development, and the need to update the ALR. Added the call for a template like the SAR to provide a basis of the risk and potential mitigations in Risk Identification and Validation. Added subsections in the Risk Identification and Validation. Added **Remediation and Mitigation Identification and Evaluation**: *"Further, the risk tolerances needs to balanced against potential impacts so that the remediation/ mitigation plans can be developed accordingly."*

Comment	Response
	Added **Monitor Residual Risk**: *The ERO, working with its industry partners, technical committees, stakeholders and forums, would determine if the residual risk was acceptable of if additional mitigations required* Added in **Resilience Impact on Risk Management**: *Further, there is a need to development of additional metrics that measure impacts from emerging risks (e.g. energy sufficiency and transmission/generation operating technology security). These metrics can inform industry on the extent of the condition, level of risk, and relative success of their mitigation.* Enhanced Figure 2 to include the Standards Committee, Compliance and Certification Committee, and the Standing Committee Coordinating Group.
Coop 1. Provide additional explanation on how NERC utilizes data and information gathered as a result of compliance monitoring and enforcement activities; 2. The proposed framework relies heavily on the membership and expertise of its participants, e.g., the RSTC and the RISC. Both are committees with membership that changes over time, and risk identification and prioritization efforts include elements of subjectivity, which can make risk trending difficult. The addition of documented criteria and processes would address these realities and provide significant benefits for risk trending over time. 3. As experience is gained with the risk framework and associated processes, the ERO Enterprise should consider several potential areas for enhancement. a. Additional clarity regarding how identified risks will be managed through the risk registry versus other methods (potentially through a heat map); b. Addition of roles and responsibilities for the management of the risk registry and decision making regarding acceptable residual risk and appropriate mitigation activities; and	1. Added in **Reliability Standards, Assurance, and Enforcement:** *Information and data gathered as a result of compliance monitoring and enforcement activities can inform about the effectiveness of a Reliability Standard or the need for enhancements. At a high level, this recommendation can be passed on through the Standards Development process for consideration*. 2. Last paragraph on page 3 and first paragraph on page 4 covers this already. 3. Added a. "*and heat maps*" on page 5 b. *"That said, criteria and other related processes should be developed for determining risk severity, likelihood, and mitigation activity effectiveness*" on page 8 c. Considered as "Stakeholders" in the Figure 1 4. Added: *"The risk registry will be maintained by the RISC and RSTC to determine if an inherent nature of a risk changes over time, and consider removing risks or adding others"* on page 10 5. This is already covered in Figure 3 6. Enhanced Figure 2 to include the Standards Committee, Compliance and Certification

Comment	Response
c. Additional clarity regarding how the ERO enterprise integrates into the risk framework its ongoing engagement with stakeholders, such as the ESCC, NATF, NAGF, EPRI, government partners, and trade organizations, as well as stakeholder involvement outside of these groups. 4. Clearly describe how the holistic review of the identified risks, risk register, and the inherent risk identified, and overall risk register maintenance is performed when the inherent nature of an identified risk changes over time. 5. To ensure that these critical elements are recognized, when using the model, we request that NERC consider clarifying that the tools are agile and cumulative e.g., listed tools may be applicable and available to address issues across the risk spectrum.	Committee, and the Standing Committee Coordinating Group.
Merchant Electricity Generator Called out in NAGF	
SM-TDU 1. Comments include: a. What is not apparent from the process steps are specifics about how the collaborative process will work and decisions made, as the Framework steps are implemented. This is particularly true for the identification and prioritization steps. b. It would be helpful if the Framework paper detailed how management versus monitored risks would work within the Risk Framework process. c. The Framework model appears to assume that all identified reliability and security risks will fall under the purview of the ERO and be completely mitigated by the ERO. This is simply not the case. 2. NA 3. There are process steps inclusive to the six steps, that need to be added and documented. Already mentioned are the validation/prioritization triage group, a process for distinguishing items outside of the ERO's purview and transparency considerations for each validated risk. Moreover, the MRC pre-meeting call identified the need for more detail on the formation and responsibilities for developing and maintaining the Risk Register, with which we agree.	1. Response: a. Not going to detailed processes behind each box. These can be developed once the framework is finalized. Added*: Each of these steps will require process development, including stakeholder engagement, validation/triage approaches, residual risk monitoring, ERO's level of purview over a risk, etc. These processes will be developed once the framework has been finalized* b. Added a foot note that clarifies that mitigate = management c. Added a question under mitigation: *Is the risk fully or partially within the purview of the ERO?* In addition, afterward added, *"The ERO remains responsible for risks to the reliable and secure operation of the BES. Risk mitigation should still be followed by the ERO no matter which organization takes on activities."* 2. NA 3. See 1.a above 4. Response: a. Add: *"Once the ERO, NERC Committees, Forums, or industry subject matter experts identify and validate a risk, it is critical that the corresponding recommendation for mitigation describe, explain, and provide support for the basis for selecting the*

Comment	Response
4. Included: a. Much like Standard Authorization Requests (SARs) can be offered by ERO Staff or the general public, the same would be true for risk consideration requests. b. SM-TDUs believe it would be valuable to include the CCC with respect to mitigation decisions because this is an area that they have specific experience with and can provide valuable input. c. Currently, the model does not include dynamic forces outside of the ERO. As mentioned earlier there are risks that are not (completely) included in the purview of the Figure 4 model that can and will impact the timing and impact of risks.	*particular approach to mitigation. A template will be created, that mirrors the Standards Authorization Request template, that requires an explanation of the risk and approach(es) for mitigation."* b. Updated Figure 1 *c.* Added: "*The application of mitigation approaches in this Framework are not meant to be static. There are risks, however, that include dynamic forces outside the ERO or risks may not be fully within the ERO's purview. This can and will influence the timing and impact of risks."* *d.* Enhanced Figure 2 to include the Standards Committee, Compliance and Certification Committee, and the Standing Committee Coordinating Group.

North American Generator Forum
RSTC Update

Allen D. Schriver, P.E.
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and
COO North American Generator Forum
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December 15, 2020

NAGF Mission

The NAGF mission is to promote the safe, reliable operation of the generator segment of the bulk electric system through generator owner and operator collaboration with grid operators and regulators.

Agenda

- **NERC Standard Drafting Teams**
  - **PRC-005**
  - **Cold Weather**

- **Collaboration With NATF**
  - **PRC-027**
  - **Supply Chain**

- **IRPWG/IEEE P2800**

NERC Standard Drafting Teams

- NERC Project 2019-04: Modifications to PRC-005-6
  - The NAGF does not support the expanded scope of the SAR v1 to include protective functions inside other control systems for BES elements. NERC, Standard Drafting Team representatives and the NAGF discussed the NAGF comments in detail, thus providing additional insights and education for all participants.

- NERC Project 2019-06: Cold Weather
  - The NAGF discussed concerns with a Standard Drafting Team representative again noting the Reliability Guideline: Generating Unit Winter Weather Readiness states in Assumptions 2, BAs and Market Operators should consider strategies to start-up and dispatch to minimum load prior to anticipated severe cold weather units that are forecasted to be needed for the surge in demand, since keeping units running through exceptional cold snaps can be accomplished much more reliably than attempting start-up of offline generation during such events.

NAGF Collaboration With NATF

- PRC-027-1: Coordination of Protection Systems
  - NAGF and NATF collaborating to revise NATF Protection System Coordination documentation to incorporate guidance for PRC-027-1. The team finalized the draft document which will be very useful for generators coordinating protection information with transmission entities. The tables that address current-based protection, line protection owned by the generator, and other generator protection functions summarize the exchange of data for PRC-027 as well as other protection standards that have data sharing requirements. This effort is focused on improving cyber security, and assisting entities with compliance.

- Supply Chain
  - NAGF continues to be actively engaged with the NATF and other industry organizations to provide a streamlined, effective, and efficient industry-accepted method for entities to assess supplier cyber security practices. This approach will reduce the burden on suppliers and provide entities with more information effectively and efficiently.

NAGF

➢ IRPWG/IEEE P2800

- Reliability Guideline: EMT Modeling and Simulations
  - Goal: Provide industry with clear guidance and recommendations for use of EMT models and performing EMT simulations.

- Reliability Guideline: BESS and Hybrid Plant Performance, Modeling, Studies
  - Goal: Provide industry with clear guidance and recommendations for BESS and hybrid plant performance, modeling, and studies.

- NAGF working on Whitepaper: Using BPS-Connected Inverter-Based Resources and Hybrid Plant Capabilities for Frequency Response

- Modeling
  - NAGF recommends members read the NERC WECC Modeling Report . The NAGF also requests that GOs work with their respective TPs and PCs if they have questions related to confirming the models are correct. It is through this collaboration the industry can successfully ensure that system studies can correctly and accurately analyze the stability and reliability of the system.

Q & A

NAGF

the power to make a difference

Thank you!

www.GeneratorForum.org

To: NERC Reliability and Security Technical Committee (RSTC)

From: Roman Carter (Director – Peer Reviews, Assistance, Training and Knowledge Management)

Date: November 10, 2020

Subject: NATF Periodic Report to the NERC RSTC – December 2020

Attachments: NATF External Newsletter (October 2020)

The NATF interfaces with the industry as well as regulatory agencies on key reliability, resiliency, security, and safety topics to promote collaboration, alignment, and continuous improvement, while reducing duplication of effort. Some examples are highlighted below and in the attached October NATF external newsletter, which is also available on our public website: www.natf.net/news/newsletters.

Response to COVID-19 Challenges

The NATF continues to work with members and industry partners on responding to the epidemic. A particulary successful endeavor is our ongoing collaboration with NERC, the U.S. Department of Energy (DOE), and the Federal Energy Regulatory Commission on the epidemic/pandemic response plan resource. As noted in the newsletter, version 3 of the resource was issued in August.

NATF-NERC Leadership Meeting

NATF and NERC leadership meet periodically to discuss collaborative work and industry topics. These periodic meetings are an opportunity for the two organizations to identify risks, prioritize actions, and implement mitigation strategies; advance initiatives that support reliability and security; and enhance our working relationship.

The most recent meeting was held on October 9. Discussions included facility ratings, grid security emergencies, and supply chain.

Supply Chain Executive Order (NERC, DOE Requests)

The NATF has been supporting members with Executive Order 13920 *Securing the United States Bulk-Power System*. For example, NATF staff conducted discussions with NERC staff and offered guidance to NATF members to ensure quality responses to the NERC *Recommendation to Industry: Supply Chain Risk III*. In addition, NATF staff submitted comments to the DOE regarding its July 8 request for information.

Update on Pilot Collaborations with NERC, RF, and SERC

The NATF, along with ReliabilityFirst and SERC, hosted an industry-wide special webinar on "Identifying and Managing Potential Compromise of Network Interface Cards" on October 22, 2020. The webinar was part of the pilot collaboration among the NATF, RF, and SERC focused on mitigation practices that entities can employ on their systems, equipment, and networks to reduce risk introduced via the supply chain.

The 265 attendees heard presentations from the NATF, RF, SERC, NERC, FERC, and NATF member-company subject-matter experts on the following topics:

- Overview of NATF-ERO Collaboration Pilot
- NATF Supplier Cyber Security Assessment Model – How Entity Mitigation Fits In
- NERC/FERC Joint Staff White Paper on Supply Chain Vendor Identification
- Regional Entity Perspectives on Responding to Supply Chain Compromise Risk
- NATF Member SME Perspectives/Experiences with Supply Chain Compromise Mitigation

In the facility ratings collaboration, the NATF has conducted an initial baseline survey of member implementation status of key practices in the "NATF Facility Ratings Practices Document," published in June 2020, and is preparing reports for its members. A summary report will be provided to the ERO in early 2021.

North American Transmission Forum External Newsletter

October 2020

Transmission Resilience Maturity Model: Helps Utilities Improve Resilience

In October, the inaugural version (1.0) of the Transmission Resilience Maturity Model (TRMM) was released publicly on the TRMM website. In addition to access to the TRMM tool, the website provides overview and background information, FAQs, a suite of supporting documentation, and more.

The TRMM (developed jointly by the NATF, the Pacific Northwest National Laboratory, the Electric Power Research Institute, and the U.S. Department of Energy) is a free, easy-to-use tool, with supporting documentation, designed for electric transmission system utilities to evaluate and benchmark the relative maturity of their transmission resilience programs. The model can help identify gaps and prioritize actions and investments to improve the resilience of transmission systems.

The draft model was piloted by five NATF member companies in 2020, and improvements based on lessons learned were incorporated into version 1.0. The NATF envisions incorporating aspects of the TRMM as additional service offerings for members, including facilitated self-assessments, metrics, and targeted assistance.

To obtain a passphrase for the tool, please register here. Contact us at trmm@natf.net with any questions.

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Virtual Peer Reviews

Consistently rated as one of the NATF's most value-added product offerings, peer reviews typically involve on-site evaluations of a member company's procedures, practices, and processes by a group of subject-matter experts from other NATF members (peers).

Substantial value and benefit come from the face-to-face engagement, which facilitates foundations of trust, teamwork, and candor—all fundamental tenets to ongoing program success. For these reasons, conducting peer reviews on-site at the host company remains the overall preference.

The COVID-19 pandemic, however, has continued to impact what we considered to be "normal" business. To ensure staff and member safety, support peer review business continuity, and continue to provide value during this time, the NATF has developed alternative approaches, including a "virtual" peer review option for our members. While not identical to an on-site offering, a virtual peer review will employ many of the same, effective, and proven peer review practices. Virtual peer reviews will be executed using available host and peer resources via web conferences.

Face-to-face peer reviews will remain the NATF's preference and standard practice. We are cautiously optimistic in resuming peer reviews on-site as soon as practical, hopefully beginning sometime in 2021. However, upcoming peer reviews will be carefully evaluated leveraging governmental (e.g., U.S. CDC) and World Health Organization guidance, industry/member/individual risk tolerances, and peer review host preferences.

***

NATF Posts Revision Process for Supply Chain Criteria and Questionnaire

The NATF has posted the "Revision Process for the Energy Sector Supply Chain Risk Questionnaire and NATF Cyber Security Criteria for Suppliers" for industry use.

The purpose of this process is to facilitate periodic reviews and modifications of the NATF "Energy Sector Supply Chain Risk Questionnaire" (Questionnaire) and the "NATF Cyber Security Criteria for Suppliers" (Criteria), which were developed for industry-wide use to drive consistency of information obtained from suppliers of bulk power system hardware, software, and services.

Consistent with the NATF's open, collaborative, and consensus-based approach, modifications via this process will be made with consideration of input from across industry and will include adding, deleting, or modifying individual questions in the Questionnaire or individual criterion in the Criteria as well as adding, deleting, or modifying mappings to security frameworks (e.g., SOC2, ISO27001, etc.).

Learn more at https://www.natf.net/industry-initiatives/supply-chain-industry-coordination.

***

Coordination and Support Aspects Added to Epidemic/Pandemic Resource

The *Epidemic/Pandemic Response Plan Resource* has been updated to include details on cross-sector coordination, prioritized requests for government support, and misinformation.

The resource—which focuses on planning/preparedness, response, and recovery activities for a severe epidemic/pandemic—was jointly developed by the NATF, the North American Electric Reliability Corporation, the U.S. Department of Energy, and the Federal Energy Regulatory Commission to help utilities create, update, or formalize their epidemic/pandemic-response plans in response to the COVID-19 pandemic.

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Redacted Operating Experience Reports

Since our last newsletter, we have posted three reports to our public site for members and other utilities to use internally and share with their contractors to help improve safety, reliability, and resiliency.

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For more information about the NATF, please visit www.natf.net.

Agenda Item 6
Reliability and Security Technical
Committee Meeting
December 16, 2020

Energy Storage System: Lessons Learned Defining Design

Action

Information

Summary

The presentation will provide an overview of the APS McMicken Incident. The valuable lessons learned derived from this incident should be a key component in driving design improvements based on the concerns and response capabilities of the fire services. The presentation will cover these best practices in risk mitigation.

Ensuring Energy Adequacy with Energy-Constrained Resources

Action
Information

Background
Unassured fuel supplies1 including the timing and inconsistent output from variable renewable energy resources, fuel location, and volatility in forecasted load can result in insufficient amounts of energy on the system to serve electrical demand and ensure the reliable operation of the bulk power system throughout the year.

Summary
This ERO Enterprise developed a whitepaper (Attachment 1) to explore the shortcomings of the application of historical capacity analysis to the grid transformation being experienced through North America. Based on this review, 11 questions are presented. The timeframes that impact energy adequacy, the potential Reliability Standard implications, the types of analysis required, and next steps.

The ISO/RTO Council (IRC) reviewed an earlier version of the whitepaper, considered the timeframes, and developed responses to the questions while grouping similar topics for the sake of efficiently prioritizing what work should be considered sooner rather than later (See Attachment 2).

[1] Some examples are: lack of firm gas transportation, pipeline maintenance or disruption, compressor station failures, emission limitations on fossil fuels. All resources have some degree of fuel uncertainty due to unavailability including coal (onsite stock-piles can be frozen) and nuclear (during some tidal conditions affecting cooling intake).

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Ensuring Energy Adequacy with Energy-Constrained Resources

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RELIABILITY | RESILIENCE | SECURITY

What is the issue?

- Sufficient amounts of energy are needed to meet the energy needs of the end-use consumer
- Historically, industry ensured energy requirements solely though capacity and reserve margins (with adjustment to hydro)
- The Grid Transformation (from RISC) is resulting in a system that has a higher level of energy uncertainty, regardless of fuel type
- The focus needs not to be fuel type, but energy adequacy
- The current tools, rules of thumb, and approaches were not designed to ensure energy adequacy with the types of resources in the transformed grid

Energy Adequacy in 3 Timeframes

- Mid-to-long term planning (1-5 year timeframe)
  - Ensure that resources are planned that can provide options to obtain sufficient and flexible energy resources
  - Review tools, rules-of-thumb and processes to support the need for these energy resources
- Operational planning (1 day to 1 year)
  - Ensure sufficient resources are available and able to provide energy to meet demand and off-set ramping requirements
  - Electrical energy production needs to reflect status of energy availability given the uncertainties
- Operations (0-1 day)
  - Ensure sufficient amounts of capacity, energy, and ramp flexibility are available from available resources

Risk Mitigation Toolkit:

Reliability Guidelines, Reliability Assessments, and Technical Engagement are being used by the ERO to address risks to reliability

Electric Reliability Organization: Reliability Risk Mitigation Toolkit

Reliability Guideline

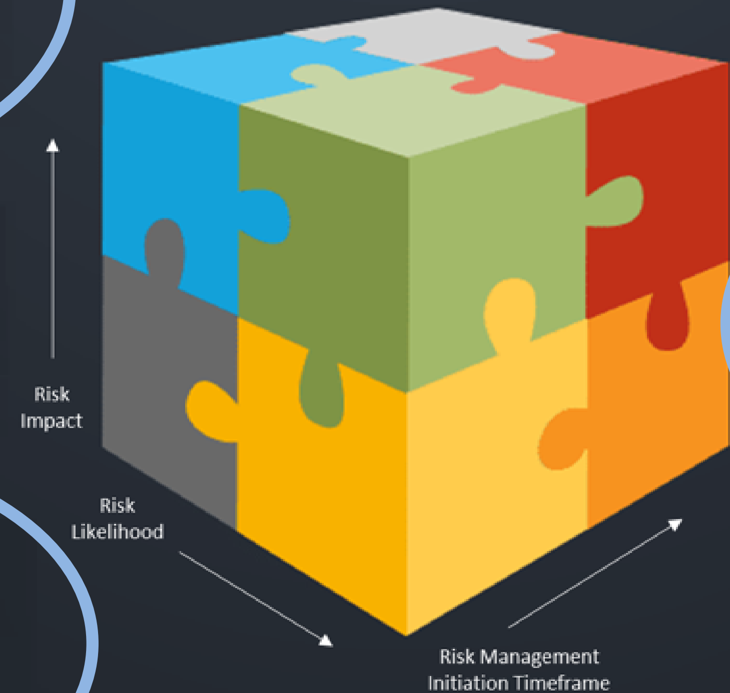
Suggested approaches or behavior in a given technical area for the purpose of improving reliability. Guidelines are not enforceable, but may be adopted by a responsible entity in accordance with its own policies, practices, and conditions.

NERC Alert: Level 2-3

NERC alerts are divided into three distinct levels, 1) Industry Advisory, 2) Recommendation to Industry, and 3) Essential Action, which identifies actions to be taken and require the industry to respond to the ERO.

Technical Engagement

Technical Engagement is a catch-all for a variety of technical activity that is conducted between the ERO and entities. This includes, technical committee activities, technical reference documents, workshops and conferences, assist visits, joint and special studies, etc.



Reliability Standards

NERC Reliability Standards define the mandatory reliability requirements for planning and operating the North American BPS and are developed using a results-based approach focusing on performance, risk management, and entity capabilities.

Reliability Assessment

NERC independently assesses and reports on the overall reliability, adequacy, and associated risks that could impact BPS reliability. Long-term assessments identify emerging reliability issues that support public policy input, improved planning and operations, and general public awareness

NERC Alert: Level 1

NERC Alerts are divided into three distinct levels, 1) Industry Advisory, 2) Recommendation to Industry, and 3) Essential Action, which identifies actions to be taken and require the industry to respond to the ERO.

What MUST We Do?

- Define Adequate Studies
- Require Adequate Studies
- Take action for all time horizons
- Energy Adequacy

Standard Requirement

Common underlying risk is the increased used of just-in-time delivery of fuel

- A NERC *reliability guideline* was recently drafted on fuel assurance and fuel-related reliability risk analysis
- A Standard Authorization Request developed for cold weather operation (Operational Planning and Operational timeframe)
- Study is needed mid-to-long-term planning horizon so impacts understood
- Can industry agree on a planning and operating design basis' that will ensure energy sufficiency (e.g. 1 event in 10 years, solar drought impacts)?

11 Questions Asked

- Understanding energy adequacy, and by extension, fuel availability compared to capacity requires advanced consideration of multiple technologies and concepts
- Eleven Questions asked in the whitepaper
- Independent Service Operators (ISOs)/Reliability Transmission Organizations (RTOs) Council (IRC) has considered an earlier version of the whitepaper that did not include the “Standard Requirement” section
- Evaluated each of the eleven questions against the three time frames

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ISO/RTO Council Review

- A **common theme** was developed for each set of ISO/RTO responses
- The IRC **grouped and prioritized** the eleven questions. Two higher priority categories were identified
  - 1, 4, 8, 9: “Energy Adequacy and Flexibility for Evolving Resource Mix”
  - 10, 11: “Gas Delivery Security”
- The groupings provide a means to continue with a more detailed analysis. The IRC recommends that the **remaining topics** would be **addressed later** or as they tangentially relate to the existing groupings

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High Priority Areas of Focus 1

- Energy Adequacy and Flexibility for Evolving Resource Mix
  - As the mix of resources trends toward more renewable energy, primarily with variable and intermittent supplies of fuel (e.g. sunshine, wind, and water), maintaining a balanced power system will require a more flexible approach to energy and capacity adequacy in order to maintain operational awareness.
  - Traditionally, peak-hour capacity can be solved in an isolated case that ignores all other hours, but in a limited energy situation, the utilization of system resources affects the availability during peak hours.
  - Generator flexibility is gaining importance as load ramps begin to stress the existing infrastructure.

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High Priority Areas of Focus 1 (cont.)

- Specific items from white paper:

1. What flexibility is required to balance volatility in resource and load uncertainty through multiple operating horizons and seasons of the year?
   - High Impact in Operations Planning and Operations timeframe, but better evaluated in Mid-Long Term Planning timeframe.
   - The volatility of variable resources in the Operations timeframe have a high impact in areas with high penetration, already requiring greater flexibility

4. How should the fuel availability / energy adequacy of battery or long-duration storage be evaluated?
   - Gaps in all 3 timeframes, but lower impact currently, due to lower penetration
   - Should be addressed due to projected higher penetration which is still evolving in different regions
   - Seasonal differences of renewable resources will require evaluation to properly define storage requirements (e.g. snowstorms that eliminate the output of solar panels)

8. Are there new tools needed to address not only the traditional capacity adequacy, but energy adequacy and meeting reliable operational requirements?
   - Gaps across all 3 timeframes
   - New products and tools are needed, including different ramp products for Ops Planning and Operations timeframe

9. Could strategically overbuilding a similar technology (i.e. solar) augmented by either storage or some portion of the firm capacity fleet (albeit operating at low capacity factors only when needed) provide for a resilient and reliable transition?
   - Gaps in all 3 timeframes
   - This logically extends and adds another level of complexity the question on flexibility required to balance volatility (#1)
   - Daily and seasonal variability of renewable resources should be considered when determining capacity values of the installed resources

High Priority Areas of Focus 2

- Gas Delivery Security
  - Maintaining system balance in cooperation with a limited energy set of resources will require some level of controllability with the remaining fleet, which will most likely be gas fired generation.
  - The variability of the renewable resources will likely change how gas is utilized, requiring a higher precision of understanding to determine if the existing system is capable to serve the changing needs (e.g. larger swings of gas demand due to higher overall gas generation ramp rates and shorter periods of online time, burning 24 hours of gas in 8 hours instead of 16)
  - Forces external to power system operators may influence gas delivery security, such as policies and procedure developments from FERC, NAESB, natural gas pipeline companies, or other entities

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High Priority Areas of Focus 2 (cont.)

- Specific items from white paper

10. How should fuel availability through long-term fuel contracts (commodity plus transportation capacity) and on-site storage (e.g. oil, coal and reservoir-based hydro) be incorporated as part of the analysis, looking at a simultaneous demand on transportation capabilities over an extended period?
    - Could be High impact, however ISOs are across spectrum on gaps
    - Additional modeling for fuel security event (e.g. DoE North American Energy Resilience Model (NAERM))
    - Consider the unique characteristics of each operating region
11. How should gas pipeline disruption scenarios be modeled, realizing that individual gas pipeline design and gas generator interconnections vary, which result in different impacts to the generator and the Bulk Power System.
    - Could be High impact, however ISOs are across spectrum on gaps
    - NERC EGWG Reliability Guideline provides foundation
    - Next steps – studies under NERC umbrella, such as a system-wide hydraulic study, or region-specific studies, but in the context of balancing against variability of renewable resources in terms of energy and ramping capability utilizing the existing infrastructure (e.g. assessing the sustainability of increased ramping on existing infrastructure)

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IRC Recommended Path Forward

- The path that starts with the white paper and ends with a long-term secure power system in all areas, with **varying degrees of challenges** in all aspects of Energy Adequacy, involves **several diverse disciplines** and a **considerable coordination effort**
- While **all** of the questions will need to be addressed, along with other areas of concern that are discovered as work moves forward, the **groupings** provided by the IRC provide a **starting point** for an initial effort
- Focus should be on how to integrate the developing **limited and variable energy resources**, which will **influence** the gas pipeline services required by gas fired resources to **balance** the variability
- Developing and implementing the proper **metrics**, **tools** and **operating procedures/protocols** in these key areas first is critical

NERC Next Steps (1-2)

1. Coordinate energy assurance activities with industry working groups
2. Subject matter experts should be assembled to develop:
   a. Technical foundation for the three time horizons
   b. Ways to identify the levels of energy that are required to meet the operational needs
   c. Tool specifications needed to incorporate energy considerations into planning, operational planning and operations assessments

NERC Next Steps (3-5)

3. Engage industry R&D organizations (EPRI, DOE, Natural Resources Canada, National Laboratories, etc.) to validate the technical foundation(s) and development of the tool(s) and methods.
4. Coordinate studies and plans with adjacent Balancing Authorities to identify enhanced collaborative regional support.
5. Create a Standard Authorization Request to enhance existing or create new Reliability Standards to address fuel assurance and resulting energy limitations for the planning timeframe

Questions and Answers

Ensuring Energy Adequacy with Energy-Constrained Resources

Problem Statement

Unassured fuel supplies[1] including the timing and inconsistent output from variable renewable energy resources, fuel location, and volatility in forecasted load can result in insufficient amounts of energy on the system to serve electrical demand and ensure the reliable operation of the bulk power system throughout the year.

Background

Electricity is fundamental to the quality of life for over 330 million people in North America. Electrification continues apace as new applications are developed for use in advanced technologies. For example, advanced computing now permeates every aspect of our economy, and policy makers are seeking to electrify transportation and heating in order to decarbonize the economy. The bulk power system is undergoing an unprecedented change requiring rethinking the way in which generating capacity, energy supply, and load serving needs are understood.

Historically, analysis of the resource adequacy of the bulk power system focused on capacity over peak time periods. Assessment of resource adequacy focused on capacity reserve levels compared to peak demand because resources were generally dispatchable and, except for unit outages and de-rates, were available when needed. Reserve margins were planned so that deficiency in capacity to meet daily peak demand (Loss of Load Expectation (LOLE) or Loss-of-Load Probability (LOLP)) occurred no more than one-day-in-ten-years.[2] Reserve margins are calculated from probabilistic analysis using generating unit forced outage rates based on random equipment failures derived from historic performance. The targeted level has historically been one event-in-ten-years, based on daily peaks (rather than hourly energy obligations). Additional insights were traditional gained by also calculating Loss-of-Load-Hours (LOLH) and expected unserved energy (EUE) based on the mean-time-to-repair (MTTR) unit averages. Review and clarification of such traditional metrics is needed to understand their assumptions, and put forward additional meaningful measures that support key aspects of capacity and energy delivery.

A key assumption in this analysis has been that fuel is available when capacity is required to provide the requisite energy. This is not surprising as generally fuel availability was assured with either long-term fuel contracts (commodity plus transportation capacity), on-site storage (e.g. oil, coal and reservoir-based hydro), or with required periodic and predictable fuel replacement (e.g. nuclear). With diverse, dispatchable resource technologies, capacity from other technologies could mitigate impacts if fuel for one resource type became unavailable.

[1] Some examples are: lack of firm gas transportation, pipeline maintenance or disruption, compressor station failures, emission limitations on fossil fuels. All resources have some degree of fuel uncertainty due to unavailability including coal (onsite stock-piles can be frozen) and nuclear (during some tidal conditions affecting cooling intake).

[2] The method determining planning reserve margins historically was based on only one data point (or hour) which is the peak load of the day. The inability to meet this single hour peak was considered an event for one day.

However, this framework is changing. Transitioning from coal and nuclear resources to wind, solar, gas that is dual fueled, and hybrid resources creates a more complex scenario wherein fuel assurance and forward energy supply planning becomes increasingly important. Generating capacity alone is not sufficient to ensure the reliable operation of the bulk power system. Policy efforts to increase the contribution of renewable energy has resulted in a higher emphasis on the 'on call' availability of capacity to supply energy to serve net demand. Production flexibility from these balancing resources has already become important and will become critically important in the future. Operational uncertainty is increasing due to the types of, and conditions under which, energy, and by implication, fuel, is available or acquired. Examples of these uncertainties are resources solely dependent on the availability of wind and solar, which are similar to run-of-river hydro plants in that they have no energy storage capabilities and are completely dependent on real time weather conditions. These also include distribution level resources and flexible load programs which may introduce additional volatility into energy forecasts.

Layered into this uncertainty, in some areas natural gas fueled resources may, depending on the contract for fuel acquisition,[3] be subject to fuel curtailment or interruption during peak fuel demands. Additionally, gas pipeline design and how gas generators interconnect with the pipeline can vary, which can result in significantly different impacts to the generator and the Bulk Electric System (BES) under gas pipeline disruption scenarios. Further, in some areas, variable energy resources require that there are sufficient flexible energy resources available to quickly respond to off-set ramping requirements. In addition, the impacts can be mitigated with the supply and geographical diversity from renewable and smaller distributed resources. However, these uncertainties are already causing many system operators to consider scheduling, optimization and commitment of resources over a multi-day timeframe. Replacing the existing generation fleet with energy limited resources requires industry to consider both capacity requirements and energy, and by extension fuel, availability. Even if sufficient capacity is available, a level of certainty in the delivery of fuel is required to ensure that energy is available to support demand.

Further, as demonstrated in California, when solar becomes a significant resource, the flexibility of the natural gas system (generating plant ramping capability plus pipeline flexibility to support needed ramp rates) also becomes a key planning consideration. This issue came into focus with the limitations placed on the Aliso Canyon natural gas storage facility causing operational challenges to ensure adequate pipeline pressure was available to support the late afternoon ramp. Provision of fuel flexibility will remain a concern as solar generation grows, at least until large scale electric storage or other solutions are available to attenuate the fuel draw requirements to support steep ramp rates.

Understanding energy adequacy, and by extension, fuel availability compared to capacity requires advanced consideration of multiple technologies and concepts. For example:

1) What flexibility is required to balance volatility in resource and load uncertainty through multiple operating horizons and seasons of the year?
2) Should emergency procedures be revised to reflect current fleet structure and operating needs?
3) When and how should demand response be considered when assessing fuel availability and energy adequacy?

[3] Contracts here should be considered in the broadest sense. Namely, beyond just firm/interruptible gas, but logistics of gas and fuel oil acquisition, transportation and delivery in a timely fashion to address emerging and projected energy requirements.

4) How should the fuel availability / energy adequacy of battery or long-duration storage be evaluated?
5) Does there need to be common practices on how Effective Load Carrying Capability (ELCC)[4] or other useful metrics are determined?
6) Does there need to be common planning practices for how forced outages are incorporated into resource adequacy analysis?
7) How does the availability of the interconnection's import transfer capability factor into the resource adequacy analysis?
8) Are there new tools needed to address not only the traditional capacity adequacy, but energy adequacy and meeting reliable operational requirements?
9) Could strategically overbuilding a similar technology (i.e. solar) augmented by either storage or some portion of the firm capacity fleet (albeit operating at low capacity factors only when needed) could provide for a resilient and reliable transition?
10) How should fuel availability through long-term fuel contracts (commodity plus transportation capacity) and on-site storage (e.g. oil, coal and reservoir-based hydro) be incorporated as part of the analysis, looking at a simultaneous demand on transportation capabilities over an extended period?
11) How should gas pipeline disruption scenarios be modeled, realizing that individual gas pipeline design and gas generators interconnections vary, which result in different impacts to the generator and the Bulk Power System?

Three Timeframes

Faced with transformation, grid operators must plan for energy adequacy requirements that need to be planned and available over three timeframes:

1. When undertaking **mid- to long-term planning** for resources to support the system in the one-to-five-year timeframe, ensure that sufficient amounts of energy are planned such that sufficient options are available to acquire needed energy to meet demand and flexibility requirements for reliably operating the bulk power system throughout all seasons of the year. Review of traditional approaches and metrics is required to put forward advances needed to support energy sufficiency. This includes considering fuel contract types, dual-fuel requirements, hybrid resource requirements, projected emission limitations, early unit retirements, forced outage uncertainty, and scenario analysis of wind, solar and water droughts, etc. under normal and N-1 scenarios.
2. When evaluating the **operational planning** timeframe (1 day to 1 year), ensure that sufficient units are available with the ability to provide the needed energy both to meet demand and off-set potential ramping requirements. Electrical energy production measurements need to reflect contracts in place, dual-fuel available, unit maintenance, fuel (e.g. LNG) levels, barge and other transportation requirements for short-term turnaround to re-supply. Fuel assurance must insure that energy is available for defined scenarios. The operational planning timeframe includes forecasting of variable renewable resources, the forward scheduling, optimization and commitment of power system resources to produce the needed energy to meet forecasted demand, which in turn leads to the scheduling, optimization, and commitment of the required fuel availability.

[4] ELCC results in a derating factor that is applied to a facility's maximum output (Pmax) towards its expected capacity value.

3. When evaluating the **operations** timeframe (0-1 day), provide situational awareness of energy adequacy to ensure sufficient amounts of energy and ramp flexibility are available from existing resources given contract status, start-up time, unit maintenance, dual fuel availability, etc. and are scheduled to be on-line to cover potential system contingencies, including ramping requirements while meeting real-time demand.

Standard Requirement

One common underlying risk is the increased use of just-in-time delivery of fuel. More specifically, challenges are mounting from the single points of failure caused by the penetration of wind, solar and natural gas with increased uncertainties due to unexpected interruptions of fuel delivery. This could be a result of the sun not shining or blocked by snow and ice, the wind not blowing (or blowing too much, or extremely cold or hot), and natural gas becoming unavailable (due to contract type, equipment failure or pipeline maintenance or failure). A NERC reliability guideline was recently drafted on fuel assurance and fuel-related reliability risk analysis. The goal is to begin considering design basis and potentially strengthening the Reliability Standards.

This need is increasingly becoming apparent as extreme weather has resulted in deficits in energy (rather than capacity). For example, in January 2019, temperature dipped below design basis for wind turbines, resulting in the need for quick action by the Reliability Coordinators (RCs), Transmission Operator (TOPs) and Balancing Authorities (BAs). Similarly, a 2019 report by FERC and NERC staff on the event of January 17, 2019 when cold weather resulted in a number of gas-fired units to become unavailable resulting again in energy deficits and the quick action to meet energy needs. As recommended in the FERC-NERC report, a Standard Authorization Request (SAR) towards writing a standard that ensures the ability to provide energy is communicated by Generator Operators (GOs) to the RC, TOP and BAs during Winter timeframes when local forecasted cold weather conditions are expected to limit BES generator unit performance or availability is being reviewed with industry.

These single points of failure require study by industry towards understanding impacts, and putting in place plans to address them. Namely, enhancement to existing NERC Reliability Standards (e.g. Transmission System Planning Performance Requirements or TPL-001-4) is needed to require the relevant entities to address the critical risks to reliability for planned and extreme events design basis.

For example, study of the loss of a large gas pipeline is already called for extreme event(s) in the transmission planning Reliability Standard TPL-001-4, but more scenarios for planning and extreme events are needed to represent the loss of solar, wind, water, and gas (e.g. not just the total loss of a pipeline, but partial loss of gas availability) resources for suitable periods of time (e.g. energy deficiency scenarios), towards understanding their impacts on the reliable operation of the bulk power. This would be demonstrated by entities performing assessments ensuring that they understand the risks. Further, corrective action plans should be in place to mitigate impacts from agreed upon planned event design basis, and an evaluation of possible actions designed to reduce the likelihood or mitigate the consequences and adverse impacts from agreed upon extreme event(s).

The scenarios belonging in planned events versus extreme events requires the development of an agreed upon design basis identifying what risks/impacts are acceptable, and which are not and require mitigation. The resulting Reliability Standard should provide certainty of risk mitigation and expected reliability performance across industry when the system is planned, and would be a companion to the operational Reliability Standard mentioned above currently being considered by industry. Rather than a burden, these enhancements would provide certainty of risk mitigation between organizations and throughout the interconnections thereby ensuring an Adequate Level of Reliability for the bulk electric system is maintained.

Analysis Requirements[5]

The ability to model and address fuel limitations or shortages in BPS planning is a critical part of system planning and operations. Therefore, there is a need for improved models as well as required data and information to support this planning to ensure the continued reliable operation of the BPS.

- **Identify Energy Limitations and Constraints:** Every generator has some level of energy limitation. For example, solar resources are limited by the availability of the sun's irradiance; hydro-resources are limited by the amount of water stored behind dams or run-of-river capacity; natural gas resources are limited by the transport capability of the pipeline system under normal and outage conditions as well as response capability; dual fuel resources are limited by the amount of on-site back-up fuel plus replenishment capability, and coal resources are limited by frozen or wet coal. All resources are limited by forced outages (and partial outages) due to thermal stresses, equipment failure, and, in some cases, emission allowances and discharge water temperature values. For all fossil-fire resources, energy limitations can also be experienced due to emission limitations which are expected to increase over time. In addition, transmission maintenance that limits energy delivery and market rules that might reserve limited-energy resources for a later time.
- **Identify the tools needed**: For the planning, operational planning, and operations time horizons, tools and methods are needed that can identify the right mix of resources to ensure sufficient amounts of energy are available to serve demand, meet ramping requirements at all times, and ensure the required energy can be delivered from the source to the end user. In addition, in organized markets, market-based incentives or rules, tariff changes, and other market tools need to be investigated. For example, some jurisdictions have evolved to performing 8,760 stochastic simulations to assess hourly levels risk. In addition, some jurisdictions also have established locational, flexible, capability, and performance requirements into their resource adequacy programs. Review of existing tools and methods already developed, identification of any gaps, and providing guidance in their use will support creation of systems that will have sufficient amounts of energy for the reliable operation of the bulk power system.
- **Loss-of-Load Assessment:** The system must be planned (in both planning time horizons) to provide a set of options to the operator so sufficient amounts energy are available for the reliable operation of the bulk power system throughout all seasons of the year. Energy limitations need to be incorporated into the electric power resource adequacy models to more accurately estimate the key adequacy metrics, such as Loss-of-Load Expectation (LOLE), Loss-of-Load Hours (LOLH), and Expected Unserved Energy (EUE). As the applications of electricity grows in North America,

[5] NERC currently has an in-house project to complete a Composite Reliability Study (assessment) of two Planning Coordinator footprints that aims to incorporate the requirements detailed in this section. This pilot project will use NERC staff and existing tools to achieve a probabilistic, rather than a deterministic assessment to assess adequacy of deliverable resource energy. The pilot should identify specific input data needed for similar industry studies.

the value of lost load will further increase and, as result, the value of energy assurance to serve load will also grow in importance. Further, as micro-grid developments increase, assessment of contributions to reliability, and consequences on energy adequacy need to be more fully understood. An important feature of integrating these suggested analyses with existing tools is the ability to incorporate operational solutions into the planning models For example incorporation of demand response, voltage reduction, and public appeals would be valuable. By recognizing cross-energy sector study results from the energy limitations, such as fuel or pipeline infrastructure limitations into probability-based resource adequacy models, an accurate representation of risk can be quantified and then translated into risk-based planning solutions. Cross-energy sector studies should include agreed upon study criteria between the sectors on what it means to be reliable and implications on resilience.[6] This is important as one sector may have a view of reliability that does not translate into other dependent sectors. For example, should sustaining the loss of a large gas storage field be considered a credible event impacting reliability that should be addressed by both the gas and electric sectors? Additionally, agreed upon contingencies impacting fuel transportation or severe weather event scenarios that impact multiple energy sectors require agreement. This analysis can be used for all time frames, incorporating more granular information as the system approaches the operations timeframe.

Appropriate reliability metrics and criteria for the three time frames must be developed, as the degree of uncertainty in the assumptions varies across each of them. Study is needed to determine if the same or different metrics are needed when the three time frame assumptions have varying risk profiles.

Next Steps

Advancing these concepts with industry requires discussions with appropriate NERC technical committees. This document should be forwarded to these committees for their consideration and incorporation into their work plans. In addition, the following actions should be initiated:

1. Coordinate developments of energy assurance activities with industry working groups.
2. Subject matter experts should be assembled (e.g. task forces or working groups) to develop:
   a. the technical foundation for the three time horizons
   b. ways to identify the levels of energy that are required to meet the operational needs
   c. the tool specifications needed to incorporate energy considerations into planning, operational planning and operations assessments
3. Engage industry R&D organizations (EPRI, DOE, Natural Resources Canada, national laboratories, etc.) to validate the technical foundation(s) and development of the tool(s) and methods.
4. Coordinate studies and plans with adjacent Balancing Authorities to identify enhanced collaborative regional support.
5. Create a Standard Authorization Request to enhance existing or create new Reliability Standards to address fuel assurance and resulting energy limitations for the planning timeframe.

[6] See the Reliability Issues Steering Committee's Report on Resilience.

IRC EGCTF Energy Security Review

Executive Summary

The ISO/RTO Council Electric Gas Coordination Task Force (IRC EGCTF) has reviewed the Energy Security whitepaper (Ensuring Energy Adequacy with Increasing Fuel Constrained Availability) drafted by NERC in 2019. Throughout the course of the review, the IRC EGCTF collected responses from each member for each planning time horizon, and then grouped specific topics, based on areas of overlap and synergies between topic areas.

The IRC ECGTF is in alignment that the two groupings of topics to prioritize and engage in further industry discussion at this time are (1) Energy Adequacy and Flexibility for Evolving Resource Mix, questions 1, 4, 8, and 9 below, and (2) Gas Delivery Security, questions 10 and 11 below.

> Questions 10 and 11 - which are more closely aligned with the IRC EGCTF core charter focus of gas-electric coordination.
>
> Questions 1, 4, 8 and 9 – which are all related to energy adequacy and flexibility related to an evolving resource mix. From an IRC EGCTF charter applicability perspective, there is a correlation back to gas electric correlation in that gas fired resources will need to be part of the flexibility solution in conjunction with energy adequacy for an evolving resource mix.

Energy Security Review Key Topic Summary

The following is summary level review of the topics and questions presented in the whitepaper with common themes in each planning timeframe.

Question 1: What flexibility is required to balance volatility in resource and load uncertainty through multiple operating horizons and seasons of the year?

- **Mid to Long Term Planning (1-5 years) Timeframe:** This is something that should be assessed by RTOs/ISOs, and although there aren't many examples of this currently in place, most report examples of approaches that are being considered to identify flexibility requirements as part of a long term plan.
- **Operational Planning (1 day to 1 year) Timeframe:** RTOs/ISOs all have Operations Planning and Operations processes/tools for addressing resource and load uncertainty in the day-ahead / real-time operations timeframes.
- **Operations (0-1 day) Timeframe:** RTOs/ISOs all have Operations Planning and Operations processes/tools for addressing resource and load uncertainty in real-time operations.

Question 2: Should emergency procedures be revised to reflect current fleet structure and operating needs?

- **Mid to Long Term Planning (1-5 years) Timeframe:** RTOs/ISOs should be responsible for revising emergency procedures.
- **Operational Planning (1 day to 1 year) Timeframe:** RTOs/ISOs have processes in place for periodic review and revision of emergency procedures as needed
- **Operations (0-1 day) Timeframe:** RTOs/ISOs have processes in place for periodic review and revision of emergency procedures as needed

Question 3: When and how should demand response be considered when assessing fuel availability / energy adequacy?

- **Mid to Long Term Planning (1-5 years) Timeframe:** Many RTOs/ISOs include some form of Demand Response (DR) in the analysis of fuel availability and/or energy adequacy in the mid- to long-term planning timeframe. There are varying forms of DR, each with its own set of considerations.
- **Operational Planning (1 day to 1 year) Timeframe:** There are two opposing points of view in the operational planning timeframe regarding DR. Some RTOs/ISOs account for DR in some form, and others do not. Those who do not, go further to assert that DR should not be considered.

- **Operations (0-1 day) Timeframe:** In the Operations Timeframe, there are three main classifications of DR treatment. The first is to not account for DR. The second only uses DR as an emergency or abnormal action. The third includes DR as a normal course of resource dispatch.

Question 4: How should the fuel availability / energy adequacy of battery or long-duration storage be evaluated?

- **Mid to Long Term Planning (1-5 years) Timeframe:** Inclusion of storage is in varying stages of adoption across the different regions, which should be addressed by ISOs/RTOs. Evaluation of energy limitations for storage resources is still evolving in different regions based on their relative rates of storage penetration.
- **Operational Planning (1 day to 1 year) Timeframe:** There is minimal inclusion of storage in the Operational Planning timeframe. Evaluation of energy limitations for storage resources is still evolving in different regions based on their relative rates of storage penetration.
- **Operations (0-1 day) Timeframe:** RTOs/ISOs have some existing measures to account for storage when committing and dispatching resources in the operations timeframe. Evaluation of energy limitations for storage resources is still evolving in different regions based on their relative rates of storage penetration.

Question 5: Does there need to be common practices on how Effective Load Carrying Capability (ELCC) or other useful metrics are determined?

- **Mid to Long Term Planning (1-5 years) Timeframe:** ELCC is viewed as an industry accepted practice and RTOs/ISOs perform analysis with variations to meet specific operating or market needs.
- **Operational Planning (1 day to 1 year) Timeframe:** ELCC is generally not applicable with a few RTOs/ISOs considering forced outage rates in analysis for this medium time horizon.
- **Operations (0-1 day) Timeframe:** RTOs/ISOs generally do not feel that this is applicable for the operations timeframe.

Question 6: Does there need to be common planning practices for how forced outages are incorporated into resource adequacy analysis?

- **Mid to Long Term Planning (1-5 years) Timeframe:** RTOs/ISOs generally incorporate historical or seasonal forced outage rates from relevant system resources into resource adequacy analysis performed by internal planning or resource adequacy groups.

- **Operational Planning (1 day to 1 year) Timeframe:** RTOs/ISOs generally incorporate actual forced outage rates for specific times of the year and specific outage conditions into outage planning analysis.
- **Operations (0-1 day) Timeframe:** RTOs/ISOs generally agree that common planning practices are not applicable in the operations timeframe, although some RTOs/ISOs are including an analysis in the determination of daily capacity requirements.

Question 7: How does the availability of the interconnection's import transfer capability factor into the resource adequacy analysis?

- **Mid to Long Term Planning (1-5 years) Timeframe:** Some type of assumption(s) are generally made when analyzing import transfer capability factor (interchange) for resource adequacy. These assumptions vary from using normal transfer limits and long-term transactions, historical data and averaging, and conservative assumptions or limitations to prevent overreliance on the external systems support.
- **Operational Planning (1 day to 1 year) Timeframe:** Conservative assumptions are used to ensure reliability and address the variability during this period.
- **Operations (0-1 day) Timeframe:** In the Operations timeframe, import transfer capability is treated similar or the same as other resources when determining resource adequacy or the ability of a Control Area to meet load. In addition to the processes and procedures that define interchange 24/7/365 multiple members mentioned emergency purchases as a means to utilize transfer capability.

Question 8: Are there new tools needed to address not only the traditional capacity adequacy, but energy adequacy and meeting reliable operational requirements?

- **Mid to Long Term Planning (1-5 years) Timeframe:** New tools are/will be needed to address these requirements. Most RTOs/ISOs are either looking for, or are working on developing, models, tools and applications to serve these growing needs. The need to use common terminology in the different regions, to describe the challenges/energy limitations that affect certain resources (such as batteries, renewables, hybrids, demand response) is a common theme, which would help drive development of the appropriate tools.
- **Operational Planning (1 day to 1 year) Timeframe:** There is no commonality among RTOs/ISOs in the Operational Planning Timeframe. It seems logical that assessments in this Timeframe could be improved with the incorporation of additional tools, and leveraging tools developed in the planning horizon could be a logical first step. A process is being developed for a new set of day-ahead products that will address ramping needs and uncertainty that can occur between day-ahead and real-time markets.

- **Operations (0-1 day) Timeframe:** There is no commonality among most of the RTOs/ISOs in the Operations Timeframe. It seems logical that assessments in this Timeframe could be improved with the incorporation of additional tools, and leveraging tools developed in the planning horizon could be a logical first step.

Question 9: Could strategically overbuilding a similar technology (i.e. solar) augmented by either storage or some portion of the firm capacity fleet (albeit operating at low capacity factors only when needed) could provide for a resilient and reliable transition?

- **Mid to Long Term Planning (1-5 years) Timeframe:** This could be a potential benefit under specific scenarios; however there have been little studies performed that explore this option. Resource Adequacy-focused working groups in the ISOs' regions would likely provide the best forum for further engagement of such discussions. Operations Planning/Operations type studies should be included in the analysis for the longer term planning resource portfolios (Dispatch/Operations Planning simulations should be performed).
- **Operational Planning (1 day to 1 year) Timeframe:** This question is more appropriate for the Mid- to Long-term Planning Timeframe than it is the Operational Planning Timeframe. This could be a potential benefit; however there have been little studies performed that explore the benefits in the Operational Planning Timeframe. New tools/procedures may need to be considered for managing a combination of these resources in the closer in timeframes, when deployed into the operating capacity.
- **Operations (0-1 day) Timeframe:** This question is more appropriate for the Mid- to Long-term Planning Timeframe than it is the Operations Timeframe. While this could be a potential benefit, the performance requirements, as well as the duration under study for that performance, should be defined in advance. New tools/procedures may need to be considered for managing a combination of these resources in the closer in timeframes, when deployed into the operating capacity.

Question 10: How should fuel availability through long-term fuel contracts (commodity plus transportation capacity) and on-site storage (e.g. oil, coal and reservoir-based hydro) be incorporated as part of the analysis, looking at a simultaneous demand on transportation capabilities over an extended period?

- **Mid to Long Term Planning (1-5 years) Timeframe:** Some RTOs/ISOs have shown interest in natural gas availability. At least one RTO/ISO has shown interest in on-site fuel storage for black start resources. Many RTOs/ISOs believe these analyses should be handled by RTOs/ISOs resource adequacy or other long-term planning groups. Aspects of this fuel availability question were addressed in the NERC Gas/Electric Reliability Guidelines.

- **Operational Planning (1 day to 1 year) Timeframe:** Some RTOs/ISOs conduct surveys of fuel inventories and firm/non-firm contract status, one of which incorporates fuel availability into operational (day-ahead) planning. Aspects of this fuel availability question were addressed in the NERC Gas/Electric Reliability Guidelines.
- **Operations (0-1 day) Timeframe:** Some RTOs/ISOs are explicitly incorporating fuel supply into intra-day operations. Aspects of this fuel availability question were addressed in the NERC Gas/Electric Reliability Guidelines.

Question 11: How should gas pipeline disruption scenarios be modeled, realizing that individual gas pipeline design and gas generators interconnections vary, which result in different impacts to the generator and the Bulk Power System?

- **Mid to Long Term Planning (1-5 years) Timeframe:** Most, if not all, RTOs/ISOs analyze some kind of gas supply disruption but not every member models the full, detailed pipeline configuration.
- **Operational Planning (1 day to 1 year) Timeframe:** Several RTOs/ISOs look to NERC EGWG Reliability Guidelines to develop gas pipeline contingencies but most are not currently analyzing gas supply disruptions. Several express interest in providing a medium-term projection/outlook of risks.
- **Operations (0-1 day) Timeframe:** Several RTOs/ISOs use NERC EGWG Reliability Guidelines to coordinate with gas generator owners and pipeline operators, especially for developing contingencies. However, contingencies seem to be managed through standard emergency procedures. Several members would like to develop or improve short-term outlooks for fuel availability risk