NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Reliability Issues Steering Committee

Report on Resilience

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RELIABILITY | ACCOUNTABILITY




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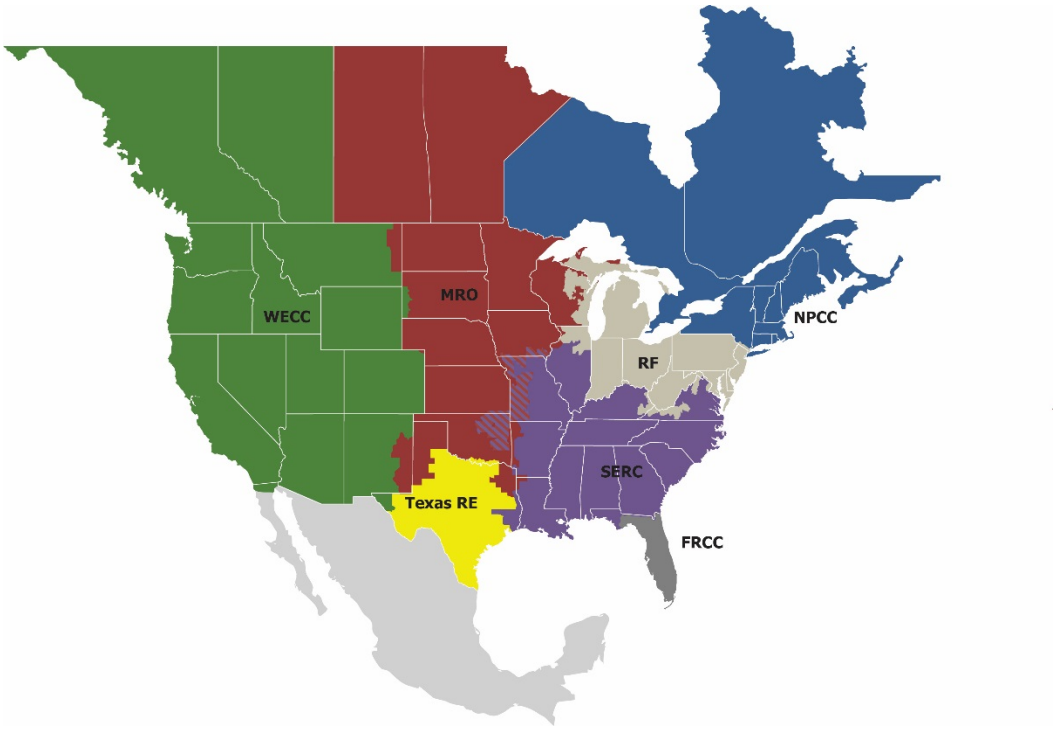
Preface

The vision for the Electric Reliability Organization (ERO) Enterprise, which is comprised of the North American Electric Reliability Corporation (NERC) and the seven Regional Entities (REs), is a highly reliable and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

The North American BPS is divided into seven RE boundaries as shown in the map and corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Region while associated Transmission Owners/Operators participate in another.



FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

Executive Summary

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.[1] 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 framework for resilience and examine resilience in today's environment. At the November 2017 NERC Board Meeting, Board Chair, Mr. Roy Thilly commented that, "Resilience is already built into what NERC does, and NERC is not looking to expand scope but rather to examine resilience more closely. The NERC Board requested that the RISC report back with a framework on how to think about resiliency in the context of reliability."

In accordance with the NERC Board's directive, the RISC has 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 Federal Energy Regulatory Commission (FERC) have continued evaluating the relationship of resilience and reliability. This report summarizes the results of the RISC's examination of resilience, including the RISC Resilience Framework.

Since its inception and consistent with section 215 of the FPA, NERC has focused on the grid's ability to withstand and manage event impacts, and respond to emerging issues and risks to ensure the Reliable Operation of the BPS.[2] Resilience is a performance characteristic of the Reliable Operation of the BPS and a critical part of ERO Enterprise activities. Per its statutory mission, NERC has an essential leadership role in identifying and mitigating evolving and emerging risks to reliability. Further, as a learning industry, NERC supports sharing of lessons learned and monitors system performance to identify evolving and emerging risks. Through its subject authority over Bulk Electric System (BES) reliability and its reliability programs, NERC can identify and share ways industry can increase resiliency of the BES to resist anticipated threats.

In particular, NERC must develop and enforce Reliability Standards for Reliable Operation on the BES of the BPS and conduct periodic assessments of the reliability and adequacy of the BPS in North America. For more than 50 years, "reliability" for the BPS has been defined to consist of two fundamental and aspirational concepts:

- **Adequacy** is the ability of the electric system to supply the aggregate electrical demand and energy requirements at the end-use customers **at all times**,[3] taking into account scheduled and reasonably expected unscheduled outages of system elements.
- **Operating reliability** (formerly titled Security) is the ability of the electric system to **withstand sudden disturbances** such as electric short circuits or unanticipated loss of system components.

[1] https://www.energy.gov/sites/prod/files/2017/08/f36/Staff%20Report%20on%20Electricity%20Markets%20and%20Reliability_0.pdf.

[2] Reliable Operation of the BPS is defined in section 215 of the Federal Power Act (FPA) as, "operating the elements of the bulk-power system within equipment and electric system thermal, voltage, and stability limits so that instability, uncontrolled separation, or cascading failures of such system will not occur as a result of a sudden disturbance, including a cybersecurity incident, or unanticipated failure of system elements." 16 U.S.C. §824o(a)(4). As discussed in section 215 of the FPA, the BPS and NERC's jurisdiction, "does not include facilities used in the local distribution of electric energy." 16 U.S.C. §824o(a)(1).

[3] For example, many times industry designs capacity reserve margins so sufficient resources are available to meet a Loss of Load Probability (LOLP) criteria of 1-day-in-10 years. Capacity reserve margins (which do not directly consider potential energy limitations) are thus not planned to levels that ensure the system has the resources to supply aggregate electrical demand at all times, but to an agreed upon design level. This is part of the resilient design of the BPS, whereby sufficient resources have been constructed to meet a 1-day-in-10 years criteria, thus reducing the likelihood of not meeting aggregate electrical demand requirements. In the event that resources are insufficient, emergency procedures are in place to support restoration.

A resilient BPS should provide an Adequate Level of Reliability (ALR).[4] Resilience is a critical aspect of reliability of the BPS and central to NERC's mission. Based on its analysis of resilience, the RISC has determined that:

1. Resilience has consistently been, and should continue to be, a central component of NERC's mission to "assure the effective and efficient reduction of risks to the reliability and security of the grid;"
2. The National Infrastructure Advisory Council (NIAC) Framework for establishing Critical Infrastructure Goals (NIAC Framework) serves as an appropriate framework for resilience as refined by the RISC and further informed by NERC's FERC-filed definition of what constitutes the ALR of the BES;
3. NERC currently engages in a broad array of activities in support of resilience, as demonstrated by the RISC Resilience Framework's mapping of NERC activities to aspects of resilience, and as called for in NERC's Reliability Standards;
4. NERC should continue pursuing activities to further support a resilient and reliable BPS, as illustrated by standing committee suggestions to the RISC and NERC's workshop on gas infrastructure risk;
5. NERC, in conjunction with industry stakeholders, should expand reliability assessment activities to support the development of a model or metrics to measure the resilience and energy security of the BPS;
6. NERC standing committees should work to develop additional guidance around achievement of both resilience and energy security, focusing on flexible design approaches and timely recovery processes for differing threats; and
7. NERC should continue to work with the North American Generator Forum, North American Transmission Forum (NATF), the Electric Power Research Institute, and other industry partners to facilitate sharing of industry practices and experiences related to addressing resilience issues as well as performing needed research and development activities.

[4] *See,* Chapter 2 for discussion of NERC's definition of the ALR, as filed with FERC on an informational basis. The ALR is available at https://www.nerc.com/pa/Stand/Resources/Documents/Adequate_Level_of_Reliability_Definition_(Informational_Filing).pdf

Introduction

The electric sector is in the midst of unprecedented evolution in both the pace and magnitude of change. This evolution is driven by a number of factors, including economics, new technology, public policy priorities, and customer expectations. The changing resource mix, for example, is altering the operational characteristics of the BPS. NERC's reliability assessments have identified and analyzed the manner in which the generation resource mix has been evolving from a fleet that primarily relies on coal, hydro, and nuclear generation to one with increasing levels of non-synchronous and natural gas-fired resources. Non-synchronous generation fueled by the sun and wind introduces greater diversity to the resource mix and is independent from traditional fuel transportation systems, although these resources may be challenged by fuel uncertainty. With the discovery of new drilling technologies, natural gas-fired generation has become a predominant conventional resource addition as older plants retire. These resources may also introduce uncertainty as they can be susceptible to fuel interruptions due to the nature of fuel procurement and gas transport capacity in some areas in North America. Similarly, inverter-based resources introduce new opportunities and potential new vulnerabilities in the form of resource tripping or blocking during some disturbances. Battery storage is also increasingly being considered as an alternative to meet system and local needs. On the cyber and physical security front, the landscape grows ever more complex as the electric sector confronts an expanding array of malicious threats and actors. Working with stakeholders, NERC and the ERO Enterprise must continue to assure the effective and efficient reduction of risks to BPS reliability and security as the industry undergoes rapid transformation. This focus is necessary to ensure that the electric sector continues to evolve with sufficient levels of resilience which is critical for Reliable Operation of the BPS.

The RISC is an advisory committee reporting to the NERC Board that provides front-end, high-level leadership for issues of strategic importance to BPS reliability. The RISC advises the NERC Board, NERC Standing Committees, NERC staff, regulators, REs, and industry stakeholders to establish a common understanding of the scope, priority, and goals for the development of solutions to address these issues. Every two years, RISC produces the *ERO Reliability Risk Priorities Report*.[5] In performing these activities, the RISC provides a framework for steering, developing, formalizing, and organizing recommendations to help NERC and industry effectively focus their resources on the critical issues needed to best improve the reliability of the BPS.

In August 2017, the DOE issued the *DOE Grid Report* regarding reliability and resilience in light of the changing energy environment. One recommendation stated that NERC should consider adding resilience to its mission statement and work with its members to broaden its ways of addressing resilience.[6] On November 9, 2017, in response to the DOE report and NERC assessments, the NERC Board directed the RISC to develop a framework examining resilience, its definition, and NERC activities contributing to resilience.

Pursuant to the Board's directive, the RISC developed a Resilience Framework based on the NIAC Framework and further informed by NERC's, FERC-filed definition of the ALR. Relying on these prior activities, the RISC prepared a Resilience Framework mapping ERO Enterprise activities to four outcome-based abilities of resilience: (1) robustness; (2) resourcefulness; (3) rapid recovery; and (4) adaptability. The RISC then requested NERC Standing Committee feedback, to assist with its subsequent evaluation of whether NERC should take additional steps to address key elements of BPS resilience. At the same time, the RISC monitored NERC's Natural Gas Workshop held on July 10, 2018 and focused on evaluating solutions to potential resilience issues associated with fuel adequacy and assurance presented by increasing dependence on natural gas-fired generation.

While NERC's reexamination of resilience was underway, on October 10, 2017, the DOE submitted a proposed rule to FERC on grid reliability and resilience pricing. NERC and other stakeholders provided comments in that proceeding. On January 8, 2018, FERC issued an order terminating the DOE's proposed rule and initiating a new proceeding to

[5] https://www.nerc.com/comm/RISC/Related%20Files%20DL/ERO-Reliability-_Risk_Priorities-Report_Board_Accepted_February_2018.pdf.
[6] https://www.energy.gov/sites/prod/files/2017/08/f36/Staff%20Report%20on%20Electricity%20Markets%20and%20Reliability_0.pdf.

define and examine resilience. FERC's proposed definition of resilience was based on the NIAC Framework, and FERC asked whether resilience was addressed by existing operating procedures, Regional Transmission Operator/Independent System Operator (RTO/ISO) planning processes, and NERC Reliability Standards. RTO/ISO comments were filed on March 9, 2018, and reply comments were filed by NERC and other stakeholders on May 9, 2018. Consistent with the RISC's findings, NERC's comments focused on resilience as an element of Reliable Operation of the BPS. NERC explained that reliability encompasses aspects of resilience of the BPS consistent with NERC's statutory mission, the definition of the ALR, and NERC activities. NERC's comments also presented the RISC Resilience Framework.[7] These issues were addressed once more in testimony given by James Robb, president and chief executive officer of NERC, and Mark Lauby, senior vice president and chief reliability officer of NERC, during FERC's 2018 Reliability Technical Conference.[8] Mr. Lauby's testimony at the resilience panel stated, "[a]s the ERO, a highly reliable and secure grid is at the heart of our vision and the very foundation of the ERO Enterprise. NERC, and the Regional Entities, which make up the ERO Enterprise, work with industry every day to identify risks to reliability, prioritize actions, and implement mitigation strategies."[9]

This report presents the RISC's findings in response to the NERC Board's directed evaluation of resilience and summarizes relevant regulatory proceedings.

[7] *See, Comments of NERC in Response to Grid Reliability and Resilience Pricing NOPR*; *and* NERC Reply Comments on FERC Grid Resilience Proceeding (for NERC comments in FERC Docket Nos. RM18-1-000 and AD-18-7-000 respectively).

[8] *See,* https://www.ferc.gov/CalendarFiles/20180731083512-Robb,%20NERC.pdf (providing James Robb's testimony); *and* https://www.ferc.gov/CalendarFiles/20180731083852-Lauby,%20NERC.pdf (providing Mark Lauby's testimony).

[9] https://www.ferc.gov/CalendarFiles/20180731083852-Lauby,%20NERC.pdf, at p. 1.

Chapter 1: The RISC's Commitment to Evaluate Resilience

Overview of the NERC Board's Directive to Evaluate Resilience

The *DOE Grid Report* was issued after the Secretary of the DOE requested a grid study to examine the evolution of wholesale electricity markets, compensation for resilience in wholesale energy and capacity markets, and baseload power plant retirements. The report asserted that a combination of market and policy forces, including low natural gas prices, low electricity growth, environmental regulations, and increased variable renewable energy penetration have accelerated the closure of a significant number of traditional baseload power plants. In addition, the report noted that: (1) bulk power reliability is adequate today, but long-term concerns about baseload retirements require further study; (2) markets recognize and compensate reliability, but more work is needed to understand resilience across a variety of scenarios; and (3) growing natural gas interdependence still needs to be addressed.

One recommendation stated that NERC should consider including resilience as an explicit part of its mission, stating "NERC should consider adding resilience components to its mission statement and develop a program to work with its member utilities to broaden their use of emerging ways to better incorporate resilience."

After reviewing the report and its recommendations, the NERC Board directed the RISC to reexamine resilience and its definition, propose a resilience framework, review NERC's ongoing activities and their contributions to resilience, and make recommendations for any additional actions.

Chapter 2: RISC Evaluation of Resilience and Development of the Resilience Framework

In response to the NERC Board's directive, the RISC initiated activities to examine resilience in today's environment, leveraging prior efforts to address resilience. Through its analysis of the issues, the RISC determined that resilience is an existing and central component of NERC's mission, created a model for Reliable Operation of the BPS, and developed the NERC Resilience Framework.

The RISC Resilience Framework is presented in **Table 2.1** as the culmination of these efforts and a tool supporting NERC activities in favor of resilience. In particular, the RISC Resilience Framework is intended to:

1. Develop a common understanding and definition of the key elements of BPS resilience;
2. Understand how these key elements of BPS resilience fit into the existing ERO framework; and
3. Evaluate whether there is a need to undertake additional steps, within the ERO framework, to address these key elements of BPS resilience beyond what is already in place and underway in connection with ongoing ERO Enterprise operations, including work being undertaken by each of the NERC standing committees.

Leveraging Prior Efforts Addressing Resilience

The RISC determined that it should begin developing a NERC Resilience Framework by building on prior efforts addressing resilience, including the NIAC Framework. As a result, the RISC Resilience Framework relies on the NIAC Framework as a credible source for understanding resilience, which breaks down resilience into four outcome-focused abilities: (1) robustness; (2) resourcefulness; (3) rapid recovery; and (4) adaptability.

The RISC Resilience Framework is based on the NIAC Framework, with additions in red proposed by the RISC based on standing committee feedback in March of 2018. Four outcome-based abilities of resilience are included as follows:

- **Robustness** – the ability to absorb shocks and continue operating
- **Resourcefulness** – the ability to detect and manage a crisis as it unfolds
- **Rapid recovery** – the ability to get services back as quickly as possible in a coordinated and controlled manner and taking into consideration the extent of the damage
- **Adaptability** – the ability to incorporate lessons learned from past events to improve resilience

In particular, the RISC modified the NIAC Framework to include the ability to detect crises (such as cyber incidences or equipment failure modes) within the scope of resourcefulness and to ensure rapid recovery is performed in a coordinated and controlled manner as provided in the ALR.

Resilience as an Existing and Central Component of NERC's Mission

While developing the Resilience Framework, the RISC determined that resilience is an existing and central component of NERC's mission to support Reliable Operations of the BPS. The RISC's May 2018 presentation to the Member Representatives Committee (MRC) detailed the RISC's evaluation of resilience as a key aspect of NERC's mission.
As provided in section 215 of the Federal Power Act, NERC develops Reliability Standards based on what is necessary to achieve an ALR for Reliable Operations. When FERC certified NERC as the ERO, it ordered that a definition of the ALR be submitted to FERC. NERC accordingly developed, filed, and later updated a definition of the ALR[10] along with

[10] https://www.nerc.com/pa/Stand/Resources/Documents/Adequate_Level_of_Reliability_Definition_(Informational_Filing).pdf.

a technical report[11] to guide Reliability Standards development, Reliability Assessments, and standing committee work. In particular, the ALR is defined as the state that design, planning, and operation the BES will achieve when five performance objectives are met.[12]

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 to a sustainable operating state and recovery to a new steady state

These periods of time generally correspond to the four outcome-based abilities of the NIAC Framework and FERC's proposed definition of resilience. (See **Chapter 3** below for discussion of that proceeding). NERC must develop and enforce Reliability Standards on the BES for Reliable Operation of the BPS as well as assess reliability and adequacy of the BPS in North America.[13]

The ALR provides granularity of NERC's definition of BPS reliability which consists of two fundamental concepts that encompass aspects of resilience:

- **Adequacy** is the ability of the electric system to supply the aggregate electrical demand and energy requirements at the end-use customers **at all times**, taking into account scheduled and reasonably expected unscheduled outages of system elements.
- **Operating reliability** is the ability of the electric system to **withstand sudden disturbances** such as electric short circuits or unanticipated loss of system components.[14]

As stated in the companion technical report to the definition of ALR:

[11] https://www.nerc.com/pa/Stand/Resources/Documents/Adequate_Level_of_Reliability_Definition_(Informational_Filing).pdf (including with the informational filing at FERC as Exhibit B).

[12] 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.

[13] Section 215 of the FPA specifically does not authorize the ERO to develop standards related to adequacy and safety.

[14] Adequacy assumes a certain level of forecast demand distribution does not cover all events that may occur. System are design cover a level of probabilistic service interruption (i.e. 1 event in 10 years) considering the distribution of louds and outages.

Simply stated, the ALRTF's goal is to develop a definition of ALR that encompasses NERC's responsibility to ensure reliable planning and operation of the BES, along with the obligation to assess the capability of the BES. The definition identifies and defines Reliability Performance Objectives that drive what system planners and operators do on a day-to-day basis to ensure that the BES is reliable and defines Reliability Assessment Objectives that identify risks to system reliability that alert system planners and operators so appropriate actions can be taken…

ALR is clearly not a single value or outcome or state; rather, ALR is an outcome of a multi-dimensional effort to identify Reliability Performance and Assessment Objectives and then achieve outcomes that will support reliable operations. This multi-dimensional effort is reflected in NERC's current and evolving body of reliability standards, which work together to establish a portfolio of performance outcomes, risk reduction, and capability-based reliability standards that are designed to achieve an in-depth defense against an inadequate level of reliability. Other NERC programs, such as industry alerts; reliability assessments; event analysis; education; the compliance with and enforcement of reliability standards, are designed to work in concert with reliability standards to support reliable operation. Each of these activities should be driven by the goal of consistently achieving an adequate level of reliability. [15]

The RISC's Model for Reliable Operation of the BPS

Leveraging the NIAC Framework and the NERC ALR, the RISC created a model depicted in **Figure 2.1** below that illustrates and enables measurement of system performance, or resilience, and provides an understanding of the elements needed to support the Reliable Operation of the BPS. Measuring the profile represented in this model provides relative characteristics of system performance, identifies areas where improvements may be desired, post events, and measures the success from system improvements. Some of the key areas that lend themselves for measurement are robustness, amplitude, degradation, recovery, and recovery state.

[15] *Supra*, n. 11, at pp. 1-2.

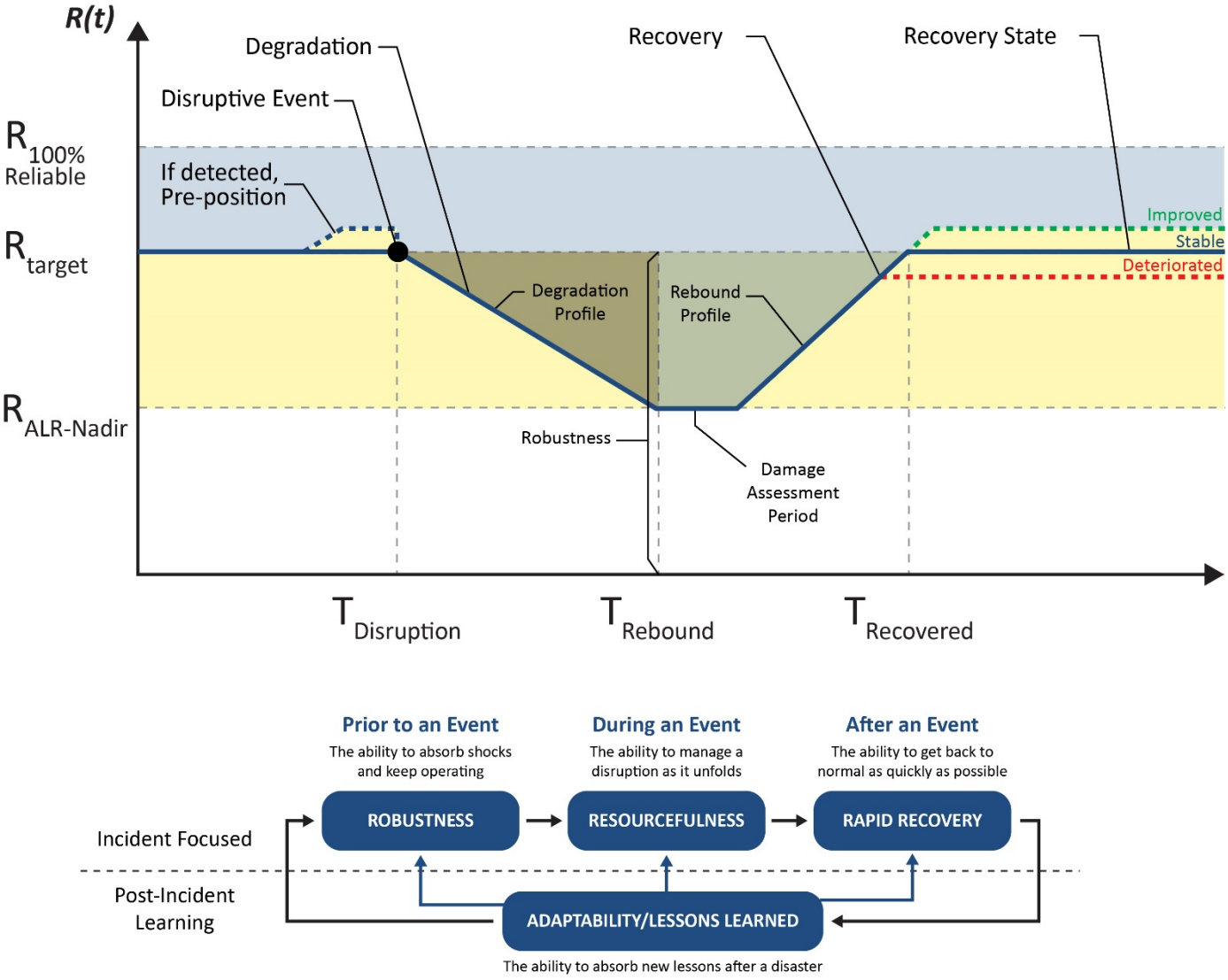


Figure 2.1: RISC's Model for Reliable Operation of the BPS

The RISC Resilience Framework as a Tool to Support Resilience

Relying on the NIAC Framework, NERC ALR, and the RISC Model described above, the RISC prepared a NERC Resilience Framework to map current ERO Enterprise activities to the four outcome-based abilities of the NIAC Framework. By bringing together the concepts in the refined NIAC Framework and NERC's definition of the ALR, the RISC has arrived at an overall NERC-specific Resilience Framework. The RISC Resilience Framework reflects the realization that Reliable Operation varies and is a function of time.

Recognizing that the BPS cannot withstand all potential events, an adequate level of reliability must be provided so that the system can be reliably operated even with degradation in reliability due to an event. Further the system must have the ability to rebound or recover when repairs are made, or system conditions are alleviated. The resulting RISC Resilience Framework provides guidance on how resilience fits into NERC's activities and how additional activities might further support resilience of the grid. The RISC Resilience Framework underscores NERC's longstanding focus on aspects of resilience and emphasis on reexamining the issue in the face of the changing resource mix.

Table 2.1 provides the RISC Resilience Framework and the associated NERC activities that support the NIAC outcome-based abilities.[16]

Table 2.1: RISC Resilience Framework

NIAC Resilience Constructs[17]	Key Programs and Activities	Specific Efforts\Tools

Robustness—The ability to continue operations in the face of disaster. In some cases, it translates into designing structures or systems to be strong enough to take a foreseeable punch. In others, robustness requires devising substitute or redundant systems that can be brought to bear should something important break or stop working.
 	
Robustness also entails investing in and maintaining elements of critical infrastructure so that they can withstand low probability but high consequence events.
	• Reliability and Emerging Risk Assessments
	• Risk, Event and Performance Monitoring
	• Technical Committee work, including special projects
	• Mandatory Reliability Standards
	• Reliability Guidelines and technical reference documents
	• System Operator Certification and Credential Maintenance
	• System Operator Training
	• E-ISAC information sharing programs
		• Alerts
		• State of Reliability Report
		  ▪ GADS
		  ▪ TADS
		  ▪ DADS
		  ▪ Protection system misoperations
		  ▪ TEAMS
		  ▪ FR Performance
		• Long-Term Reliability Assessment
		• Key Reliability Standards:
		  ▪ TPL (Extreme)
		  ▪ EOP
		  ▪ Blackstart Restoration
		  ▪ Personnel Credentials
		  ▪ GridEx
		• Security conferences and information sharing (e.g. GridSecCon)
		• Supply Chain Security
		• Security Practices

Resourcefulness—The ability to skillfully detect and manage a disaster as it unfolds. It includes identifying options, prioritizing what should be done both to control damage and to begin mitigating it, and communicating decisions to the people who will implement them.	• Situational Awareness and Industry Coordination • Government Coordination • Cross-Sector Information Sharing • Mandatory Reliability Standards/Functional Model	• BPSA information sharing tools and processes • E-ISAC information sharing tools and processes • Formation of a Crisis Action Team to support industry and governmental coordination • GridEx

[16] Other activities are ongoing with industry and governmental entities, such as NATF and the DOE. Coordination can help support effectiveness and avoid gaps or duplicative efforts.

[17] Those items in red indicate NERC additions to the NIAC framework that includes the ability to detect (such as cyber incidences or equipment failure modes), or ensure rapid recovery includes that it is performed in a coordinated and controlled manner per the ALR.

Table 2.1: RISC Resilience Framework		
NIAC Resilience Constructs[17]	**Key Programs and Activities**	**Specific Efforts\Tools**
Resourcefulness depends primarily on people, not technology.	• Reliability Guidelines and technical reference documents • System Operator Certification and Credential Maintenance • System Operator Training	• Standards requirements ▪ Reliability Coordinators ▪ Transmission Operators ▪ Communications
Rapid recovery—The capacity to get things back to normal as quickly as possible after a disaster in a coordinated and controlled manner and taking into consideration the extent of the damage. Carefully drafted contingency plans, competent emergency operations, and the means to get the right people and resources to the right places are crucial.	• Situational Awareness, Industry Coordination • Government Coordination • Cross-Sector Information Sharing • Reliability Guidelines and technical reference documents • System Operator Certification and Credential Maintenance • System Operator Training	• Support for Electric Sector Coordinating Council activities • BES simulation • System restoration coordination
Adaptability—The means to absorb new lessons that can be drawn from a catastrophe. It involves revising plans, modifying procedures, and introducing new tools and technologies needed to improve robustness, resourcefulness, and recovery capabilities before the next crisis.	• Reliability and Emerging Risk Assessments • Event Analysis • Event Forensics • Reliability Guidelines and technical reference documents • System Operator Certification and Credential Maintenance • System Operator Training • Periodic Review	• Technical Committee Recommendations • Reliability Guidelines • Lessons Learned • Event Analysis, Investigations • Audit Recommendations • Reliability Assessments • State of Reliability Report • Annual BES Security Assessment • BES Security Metrics • Training • BES simulation • Emergency operations

Chapter 3: Resilience Proceedings by Governmental Authorities

Overview of the Proceedings and Initial Comments

On October 10, 2017, following the DOE Grid Report, the DOE submitted a proposed rule on grid reliability and resilience pricing to FERC. On January 8, 2018, FERC issued an order terminating the DOE's proposed grid resilience pricing rule and initiating a new proceeding to examine resilience.[18] FERC proposed to define resilience as, "[t]he ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."[19] FERC based its proposed definition on the NIAC framework. In addition, FERC asked whether existing operating procedures, RTO/ISO planning process, and NERC Reliability Standards address resilience and whether they should be modified to better address resilience.[20]

Initial RTO/ISO comments were filed with FERC on March 9, 2018. Reviewing RTO/ISO comments, the RISC noted:

- Most RTOs/ISOs generally appeared to have perspectives on reliance that were consistent with FERC's proposed definition of resilience and the (then draft) RISC Resilience Framework;
- Most RTOs/ISOs commented that their planning processes take into account reliability and resilience;
- RTO/ISO comments did not indicate a gap in relation to the RISC's discussions; and
- Several RTOs/ISOs highlighted regional concerns and the value of interregional coordination, NERC Reliability Standards, and resource diversity.

NERC's Reply Comments in FERC's Resilience Proceeding

On May 9, 2018, NERC and other stakeholders filed reply comments in the proceeding. Consistent with the RISC's evaluation of resilience, NERC's comments focused on resilience as an element of Reliable Operation of the BPS and as related to the ALR of the BES. NERC explained that reliability encompasses aspects of resilience of the BPS, consistent with section 215 of the FPA and NERC's obligation to develop Reliability Standards supporting Reliable Operation of the BPS. NERC described how elements of resilience are incorporated into NERC's definition of the ALR.

NERC's comments also summarized activities under Reliability Standards, Reliability Assessments, Event Analysis, Situational Awareness, and the Electric-Information Sharing Analysis Center (E-ISAC) in support of resilience of the BPS. For example, NERC's comments highlighted that, as recognized by RTOs/ISOs in the proceeding, NERC Reliability Standards incorporate resilience by supporting robustness, resourcefulness, rapid recovery, and adaptability. These Reliability Standards relate to the BPS's capability to withstand disturbances in anticipation of potential events, manage the system after an event, and/or prepare to restore or rebound after an event. For example, NERC has developed the following:

- Reliability Standard TPL-001-4 (*Transmission System Planning Performance Requirements*): regarding planning performance requirements in anticipation of potential events;
- Reliability Standard EOP-004-3 (*Event Reporting*): requiring that entities report disturbances and events threatening reliability;
- Reliability Standard EOP-005-2 (*System Restoration from Blackstart Resources*): requiring preparation for system restoration from Blackstart resources;
- Reliability Standard EOP-006-2 (*System Restoration Coordination*): requiring that plans and personnel be prepared to support system restoration after an event;

[18] *Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures*, *Grid Resilience in Regional Transmission Organizations and Independent System Operators*, 162 FERC ¶ 61,012 (2018) ("Order").
[19] Order, P 23.
[20] Order, P 27.

- Reliability Standard EOP-011-1(*Emergency Operations*): requiring operating plans to mitigate emergencies;
- Reliability Standard CIP-006-6 (*Cyber Security – Physical Security of BES Cyber Systems)*: requiring a physical security plan in support of protecting BES Cyber Systems;
- Reliability Standard CIP-008-5 (*Cyber Security - Incident Reporting and Response Planning*): requiring plans to address reportable cyber security incidents;
- Reliability Standard CIP-014-2 (*Physical Security*): pertaining to physical security; and
- Reliability Standard TPL-007-1 (*Transmission System Planned Performance for Geomagnetic Disturbance Events*): on planning to withstand a predefined level of geomagnetic disturbances.[21]

Other Reliability Standards codify obligations to implement lessons learned and thereby adapt after an event. See, for example:

- Reliability Standard TPL-007-1 (*Transmission System Planned Performance for Geomagnetic Disturbance Events*): requiring corrective action plans if a geomagnetic disturbance vulnerability assessment concludes that the system does not meet certain performance requirements;
- Reliability Standard PRC-004-5 (*Protection System Misoperation Identification and Correction*): requiring a corrective action plan after Protection System Misoperations or declaration explaining why corrective action plans are beyond the entity's control or would not improve BES reliability;
- Reliability Standard PRC-006-3 (*Automatic Underfrequency Load Shedding*): requiring a corrective action plan where the automatic underfrequency load shedding ("UFLS") design assessment determines that the UFLS program does not meet certain performance characteristics; and
- Reliability Standard PRC-016-1 (*Remedial Action Scheme Misoperations*): regarding corrective actions to avoid future remedial action scheme misoperations.[22]

In addition to Reliability Standards, NERC's comments described Reliability Assessments and Event Analysis on issues impacting resilience, such as NERC's 2017 *Special Reliability Assessment: Potential Bulk Power System Impacts Due to Severe Disruptions on the Natural Gas System* and *Alert 1200 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report.* NERC also highlighted activities by the E-ISAC such as GridEx and the Cybersecurity Risk Information Sharing Program. Finally, NERC described work being completed by the RISC to reexamine resilience and potential additional NERC activities in support of resilience.[23]

Third Party Comments on FERC's Resilience Proceeding

A wide variety of third party comments were filed in the latest FERC proceeding, reflecting the diversity of issues affecting resilience. The RISC reviewed these comments as part of evaluating resilience pursuant to the NERC Board's directive. Reviewing third party comments, the RISC observed that:

- Comments widely recognized NERC activities in support of resilience;
- Several commenters underscored FERC's limited jurisdiction over the electric and natural gas distribution systems;
- Many commenters highlighted regional differences impacting resilience;
- Several comments highlighted the role of transmission infrastructure in resilience; and

[21] *See*, NERC Complete Set of Reliability Standards, *available at*, https://www.nerc.com/pa/Stand/Reliability%20Standards%20Complete%20Set/RSCompleteSet.pdf (last updated Feb. 15, 2018) (providing the full set of NERC Reliability Standards).
[22] *Id.*
[23] *Supra* n. 7.

- Comments presented varying perspectives on the extent to which reliance on natural gas-fired generation is impacting or could impact resilience of the BPS.

Chapter 4: Standing Committee Feedback

As mentioned above, the RISC requested NERC standing committee feedback regarding activities addressing resilience. In particular, the RISC requested input from the Compliance and Certification Committee (CCC), Critical Infrastructure Protection Committee (CIPC), Operating Committee (OC), Personnel Certification and Governance Committee, Planning Committee (PC), and Standards Committee (SC) on the RISC Resilience Framework.

The RISC requested that these committees comment on:

1. The committee's views on how BPS resilience is currently being addressed within the scope of the committee's responsibilities; and
2. Any additional activities the committee believes should be undertaken.

All committees supported the Resilience Framework. Standing committee comments underscored that resilience is an existing concept, reflected within the definition of the ALR as well as definitions of Reliability, Adequacy, and Security. The CCC, CIPC, OC, PC, and SC also suggested additional activities that might support resilience. Some additional activities included, for example, revisions to standards process templates and training materials, enhanced communication of NERC's ongoing resilience and risk mitigation efforts, additional compliance monitoring focus on standards supporting resilience, and additional focus on areas that might impact resilience. The RISC will review these suggestions as input to the 2019 ERO Reliability Risk Priorities Report for potential 2020 implementation.

Chapter 5: Conclusion

NERC's activities, since its inception, have focused on the ability to withstand events, manage event impacts, and respond to emerging issues and risks to ensure the Reliable Operation of the BPS. As the ERO, NERC must identify new and emerging risks to reliability. Resilience is an existing part of NERC's statutory mission to assure the effective and efficient reduction of risks to the reliability and security of the grid. The RISC's examination of resilience demonstrates NERC has consistently considered aspects of resilience as part of what contributes to reliability. While a system able to withstand impacts from all risks is a difficult and costly goal to realize, it is feasible and imperative to establish an adequate level of reliability that gives due consideration to cost efficiency and effectiveness. A balance is achieved by coupling the ability to withstand impacts to certain design levels with resilience measures that are meant to mitigate risks to reliability and maintain Reliable Operation of the BPS. By leveraging industry expertise, informed by sound technical analysis and support by the ERO Enterprise, NERC fosters a learning environment to identify and mitigate risks in pursuit of improved reliability. The ERO Enterprise's continued leadership role is essential to maintaining a focus on conventional risk, while anticipating emerging risks during a period of revolutionary change in the electricity sector.

The RISC Resilience Framework, informed by the NIAC Framework and NERC's definition of the ALR, provides an appropriate definition of resilience in today's environment. This definition is consistent with FERC's proposed definition in pending regulatory proceedings. The RISC Resilience Framework demonstrates how various NERC activities support resilience by mapping NERC activities across the ERO Enterprise that are driven towards supporting the ALR and a resilient system. These activities include Reliability Standards, reliability assessments, event analysis, GridEx, and the E-ISAC work. As described in this report, the ERO should continue pursuing activities that support resilience.