North American Transmission FORUM

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EPRI

Understanding the Definition of Resilience (Companion Document)

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Versioning

Version History

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11/03/2022	1.0	Initial version

Review and Update Requirements

- Review: every three years
- Update: as necessary

Contents

Introduction and Purpose

This document is a supplement to the NATF/EPRI definition of resilience. This additional explanation helps improve consistency in application. Because there is no one-size-fits-all scope and applicability of resilience, this definition provides the framework for implementing resilience programs and related activities.

This document is not intended to prescribe the only methods to accomplish resilience activities and should not be taken as a checklist or list of requirements. The intent is to promote a common understanding and vernacular.

Importance of Documented Procedures

Because resilience defies a black-and-white determination across all entities, the importance of written documentation cannot be over-emphasized. Each entity should clearly document their application of the definition and augment that with examples. When processes and work practices are not written down, work may not be executed consistently and knowledge transfer may not occur. In addition, quality of results will vary, effective internal controls cannot be established, and continuous improvement is very difficult. Organizations that rely on unwritten institutional knowledge may find that processes are not sustainable when personnel change.

Processes change over time as (1) new knowledge and tools become available, (2) personnel and requirements change, and (3) the organization recognizes ways to improve. Documents should be kept updated accordingly.

Background

In early 2022, NATF and EPRI, through their Resilience Steering Group, began an initiative to review and update the NATF/EPRI definition of transmission resilience. The approach to that work included:

- Review of current NATF/EPRI definition (from 2017)
- Review other definitions within the electricity-subsector industry and related government entities
- Identify gaps in the current definition
- Identify commonalities in other definitions
- Identify suggested revisions or suggest adoption of another entity's definition if it meets the need

2017 NATF/EPRI definition:

Transmission system resilience is defined as the ability of the system and its components (i.e., both the equipment and human components) to minimize damage and improve recovery from non-routine disruptions, including high impact, low frequency (HILF) events, in a reasonable amount of time.

The 2017 definition was five years old when the review and update initiative began. Now, more information and resilience learnings are available to advise development of an improved definition.

In addition, the 2017 NATF/EPRI definition was limited to transmission resilience. While transmission entities are a special focus, especially for NATF, we recognize that limiting the definition in this manner is not optimal. Many electricity subsector entities include business units beyond transmission, including generation, distribution, or both. In addition, many entities approach resilience holistically, so an overall definition for the electricity sub-sector is desired to align with and realize efficiencies from that approach.

On a positive note, the NATF/EPRI definition was found to be aligned with the DOE definition. Therefore, by including improvements to the current definition that augment and do not change its intent substantively, continued alignment with the DOE definition is achieved.

After the data gathering and review stage, the following improvements were agreed upon:

1) Expand to a holistic definition for electricity sub-sector
2) Because of the complexities in defining resilience broadly, augment the definition with supporting information. (Hence, the development of this companion document.) In addition to expounding on the complexities in the definition, the supporting information highlights specific issues or concerns for transmission system resilience that would be of interest to NATF members.
3) Include “anticipate,” “absorb,” and “adapt,” since situational awareness, robustness, and flexibility are important in responding to, withstanding, and recovering from current and evolving hazards.
4) Change "improve recovery" to “recover.” The prior wording introduced some ambiguity, so the simpler phrase (recover), conveys the important idea. Also, since recovery should be orderly and not purely driven by time, the new definition does not include an element of expedited recovery. It is an inherent goal for electricity sub-sector entities that recovery occur as safely and quickly as possible.
5) Seek broad industry adoption of the new definition, as appropriate.

Reference Appendix 1: Public Definitions of Resilience from Electric Industry and Related Government Entities for the public definitions of resilience that were reviewed and used as the basis for determining improvements to the NATF/EPRI definition. The recurring use of “anticipate,” “absorb,” “adapt,” “recover,” and “disruption” was noted in the suite of definitions.

The result of this review of definitions and consideration of improvement opportunities is an updated NATF/EPRI definition of resilience described in the following sections.

Definition of Resilience

NATF and EPRI have developed a succinct definition of resilience that provides a common framework and understanding for our members and the industry:

> The ability of the system and its components (both equipment and human) to 1) **prepare** for, 2) **anticipate**, 3) **absorb**, 4) **adapt** to, and 5) **recover** from non-routine disruptions, including high impact-low frequency (HILF) events, in a reasonable amount of time
>
> Where:
>
> 1) **Prepare** involves both longer-term mitigation strategies (e.g., system hardening, sparing strategies/acquisition) and shorter-term preparations (e.g., reconfigurations, staging)
> 2) **Anticipate** provides situational awareness before and during an event
> 3) **Absorb** requires inherent robustness of the system and supporting processes during an event
> 4) **Adapt** entails flexibility and scalability of the system and supporting processes during an event
> 5) **Recover** relates to response and recovery activities during an event

The balance of this companion document expounds on the implications and application of this definition.

General Explanation of the Definition

The definition of resilience strives to cover the important aspects of resilience while not prescribing how to be resilient. Common terminology and understanding of resilience principles is important. However, it is recognized that electricity sub-sector entities employ various implementation techniques, depending on what is best for them, considering many factors, such as the threats most likely to impact their respective systems. For specific resilience-related practices information, refer to the Transmission Resilience Maturity Model (TRMM) [1].

Furthermore, the definition focuses on more severe, non-routine events that have not been experienced historically, as described in the NATF Bulletin - Resilience Learnings (NATF-BLTN-002)[1] [2]. The intent is not to ignore the importance of resilience to all disruptions, but to recognize the special considerations for dealing with larger impact, longer-duration events for which an entity has limited experience.

Most definitions of resilience focus on the timeframes of the resilience trapezoid[2] [3]. The NATF/EPRI definition of resilience goes further and covers all time horizons (e.g., long-term planning, operations planning, and real-time operations [4]). The time horizon(s) covered by each element of the definition, as shown in Figure 1, are important to fully understand what each element encompasses.

For example, the first element, “Prepare,” not only covers the timeframe for responding to an impending or active event, it also covers the vital preparations that take much longer to implement, such as system hardening and robust planning of sparing strategies. Those longer-term preparations also include readying your processes and workforce.

Another departure from the timeframes of the resilience trapezoid, is the NATF/EPRI definition’s recognition that almost instantaneously after an event, recovery activities begin. Figure 1 shows the full overlap of “Recover,” “Adapt,” and “Absorb” elements. While “Anticipate” starts before the event, it also works in parallel with those other elements in real-time to maintain situational awareness during response to the event. All four elements, working in concert, are necessary to successfully bring the system back to a stable operating state.

[1] This document is only available to NATF members

[2] The resilience trapezoid covers the operational timeframes for detecting and responding to an event, adapting to and mitigating the event, and returning the system to an acceptable state.

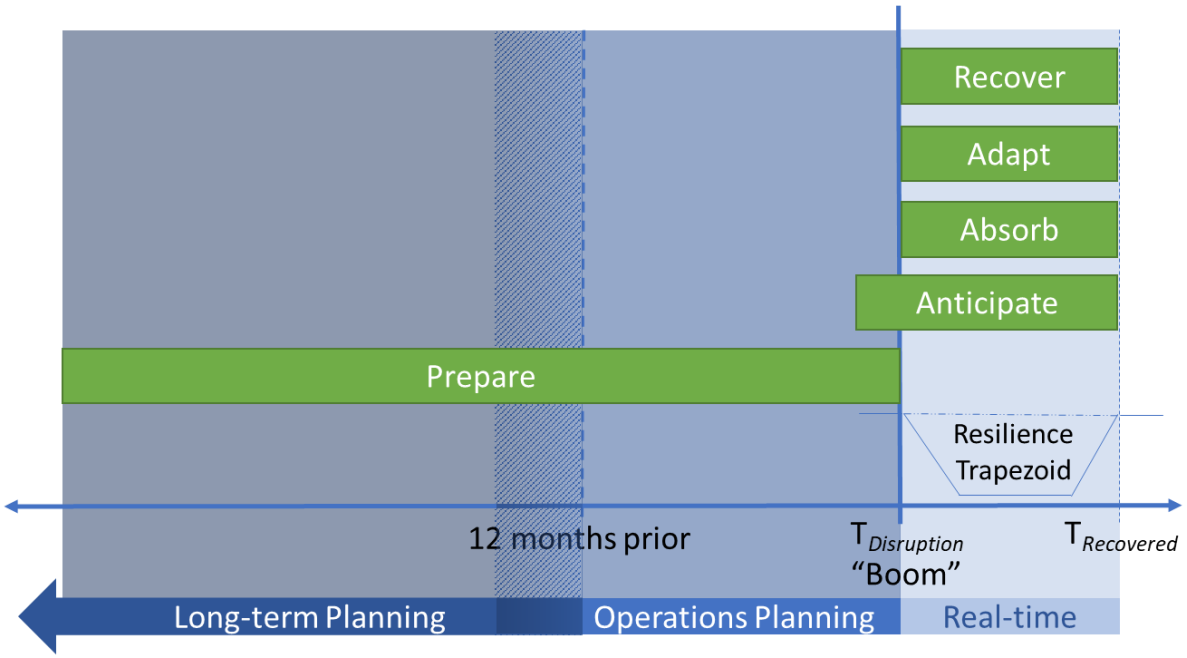

Figure 1. Time horizons for the elements of the definition

The NATF/EPRI definition is all-encompassing and not specific to any one threat or event. Through its five interrelated elements, the definition conveys the important long-term activities as well as the activities leading up to and after a disruption[3] that are necessary to limit impacts to the system and end-users. The intent is to safely complete restoration and recovery in an efficient, deliberate, and timely manner.

Detailed Explanations of the Definition's Five Elements

Element 1 - Prepare

Prepare: *longer-term mitigation strategies (e.g., system hardening, sparing strategies/acquisition) and shorter-term preparations (e.g., reconfigurations, staging)*

Some of the most important activities to support resilience occur well before an event, often years in advance. This is the only element of the definition where there is time to make major additions and changes to the system and its supporting processes. In this timeframe, there is time for identification, assessment, and mitigation of risks via capital investments and other extensive initiatives. For example, longer-term preparation for potential events allows time for system hardening, redesign, acquisition of spare parts, workforce training/drills, and other projects or initiatives that have longer lead times. Longer-term preparation is covered by Domain 2 (Risk Identification, Assessment, and Management) of reference [1].

As shown in Figure 1, the "Prepare" element of the definition spans a large timeframe, from multiple years into the future (i.e., the long-term planning horizon, just discussed) up to, but not including real-time operations (i.e.,

[3] Disruptions refer to the events that may impact and disturb your system.

the operations planning horizon). In the latter timeframe (operations planning horizon), there is limited time to position the grid for the impacts. Therefore, the effective implementation of shorter-term planning relies heavily on the effectiveness of longer-term planning and robust, well-executed plans. Flexibility and scalability of those plans are key in managing the range of resilience event impacts. See Element 5 for more information on response and recovery.

Shorter-term preparations involve using the resources you already have or can engage quickly in the limited time available to prepare for potential impacts. For example, shorter-term preparation for potential or impending events includes things such as system reconfigurations, strategic outages, and staging of equipment and resources. Shorter-term preparation is covered by Domain 4 (Event Response and Recovery) of reference [1].

In addition, it is important that lessons learned from disruptive events, both real and staged during drills and exercises, are incorporated into these planning activities. This feedback loop ensures continuous improvement of an entity's resilience posture.

Element 2 - Anticipate

Anticipate: *situational awareness (before and during an event)*

Situational awareness is embedded throughout the NERC Reliability Standards and in a dedicated guideline on the topic [5] which demonstrates its importance. However, it is even more important before, during, and after a resilience event because the consequences can be novel and extreme.

Refer again to Figure 1, which shows the timeframe for this element of the definition includes a portion of the operational planning timeframe and all of real-time operations. It is important to have as much advance notice of an impending event as possible, and perhaps even more important to be aware of conditions as the event unfolds and as response and recovery activities are executed.

Situational awareness provides an understanding of the current resilience landscape, based on awareness and analysis of both real-time and near real-time intelligence, from internal and external sources. This is accomplished, in part, by monitoring key aspects of potential threats and vulnerabilities and the risks those present. It also includes monitoring the inventory and status of assets and equipment – including spare transmission assets and equipment needed to support resilience program activities (e.g., light vehicles, service vehicles, and communication equipment). Situational awareness further includes information on workforce resources (e.g., available primary response staff, backup staff, and available contractor support). Situational awareness concepts are covered by Domain 3 (Situational Awareness) of reference [1].

Element 3 - Absorb

Absorb: *inherent robustness of the system and supporting processes during an event*

The NERC Reliability Issues Steering Committee (RISC) Report on Resilience [6] defines robustness as "the ability to absorb shocks and continue operating." In other words, to absorb means to be able to take a "hit" while minimizing the impacts of the event on the system. Therefore, the timeframe for this element of the definition is limited to the time after the disruption, as seen in Figure 1. However, that inherent robustness of the system starts with long-term planning in Element 2 - Prepare. The ability of the system to absorb shocks/hits while limiting impacts is determined by the activities and projects in the preparation phase. Things such as redundancies, backups, hardening schemes, and sparing strategies build system robustness and the ability of the system to absorb shocks from a disruptive event, continue to operate, and positions an entity for the best results during an event.

Element 4 - Adapt

Adapt: *flexibility and scalability of the system and supporting processes during an event*

Similar to the discussion above on Element 3 - Absorb, being able to adapt during an event is an important tool for entities that begins with the preparation phase. That advance planning is integral to building in and leveraging adaptability to manage a disruptive event as it unfolds. Equally important is having skilled, trained personnel to take advantage of the capability of the system and supporting plans to adapt on the fly.

To adapt means to adjust to changes or new conditions. In this context, adaptability can be described by two aspects: 1) flexibility and 2) scalability. Flexibility implies that the system and its supporting plans and processes are not rigid, and adjustments can be made when dealing with disruptive events in real-time. Building in flexibility includes tactics such as decision trees, alternate steps (or paths), and ability to achieve steps in various orders. Scalability implies that planning has considered more severe scenarios and has built in provisions for amplifying base plans to accommodate more critical and long-lasting conditions. An example would be a base plan for fuel supplies that contains contracts for up to a 2-week disruption and is augmented with emergency provisions for multiple providers for longer durations.

Because there are so many variations in possible disruptive events, it is unreasonable to assume planning can take into consideration all scenarios. Therefore, the ability of the system and supporting processes to adapt is imperative in responding to the full spectrum of potential events.

Element 5 - Recover

Recover: *response and recovery from an event*

Response and recovery are the best understood elements of the definition. System restoration is covered by the NERC EOP standards and is a cornerstone for operating entities in managing disruptive events. As such, entities have a long history of documenting, drilling, and executing these plans. However, going beyond historical events to contemplate non-routine, extreme resilience events is critical to integrate the necessary flexibility and scalability for responding to the wide range of potential extreme events and their impacts. Drills and exercises are an important tool in training personnel and identifying improvement opportunities for responding to these high impact but infrequent scenarios. Response and recovery is covered by Domain 4 (Event Response and Recovery) of reference [1].

Utilities learn new lessons from every event, leading to continuous improvement opportunities, including resilience-specific improvements, for example, in training and exercises, restoration and recovery activities, and new tools and technologies. These lessons should be supplied to those responsible for preparation activities to plan for and complete improvements.

Summary

Resilience is an important and complex topic. This companion document supplements the definition to improve the understanding of resilience.

The new definition is not a major deviation from the 2017 NATF/EPRI definition nor other definitions used in industry. However, resilience definitions have traditionally focused primarily on the response and recovery timeframe. In contrast, this definition highlights the need to also focus on the longer-term resilience planning aspects. In addition, the definition emphasizes the importance of considering larger-impact, longer-duration events for which an entity has limited experience.

While not prescribing specific approaches, the new definition and this companion document promote a common understanding of resilience throughout the industry. Consequently, this helps organizations and the entire industry plan for and address the challenges of resilience.

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Appendix 1: Public Definitions of Resilience from Electric Industry and Related Government Entities

NATF/EPRI (2017)	Transmission system resilience is defined as the ability of the system and its components (i.e., both the equipment and human components) to minimize damage and improve recovery from non-routine disruptions, including high impact, low frequency (HILF) events, in a reasonable amount of time.
NIAC (2010)	Infrastructure resilience is the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to and/or rapidly recover from a potentially disruptive event [7].
Presidential Policy Directive 21 – Critical Infrastructure Security and Resilience (2013)	The term "resilience" means the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents [8].
DOE (2017)	The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them [9].
IEEE Technical Report PES-TR65 (2020) and FERC Docket No. AD18-7-000 (2018)	The 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 [10].
NERC RISC Report on Resilience (2018)	The RISC Resilience Framework, informed by the NIAC Framework and NERC's definition of the Adequate Level of Reliability (ALR), provides an appropriate definition of resilience in today's environment [6]. • The RISC Resilience Framework is based on the NIAC Framework • ALR provides granularity of NERC's definition of BPS reliability which consists of two fundamental concepts that encompass aspects of resilience: adequacy and operating reliability

NERC's Severe Impact Resilience Task Force (2012)	The ASIS SPC.1-2009 standard on Organizational Resilience says, "Resilience is the ability of an organization to resist being affected by an event or the ability to return to an acceptable level of performance in an acceptable period of time after being affected by an event" [11].
NARUC (current)	The ability of the system to anticipate, absorb, recover from, and adapt to disruptive events, particularly high-impact, low-frequency events [12].
NARUC (2013)	Robustness and recovery characteristics of utility infrastructure and operations, which avoid or minimize interruptions of service during an extraordinary and hazardous event [13].
EIS Council	Resilience is the ability to withstand, adapt to changing conditions, and recover positively from shocks and stresses. Resilient infrastructure will therefore be able to continue to provide essential services, due to its ability to withstand, adapt and recover positively from whatever shocks and stresses it may face now and in the future [14].
Idaho National Labs (INL) (2021)	The resilience of an EEDS is described as a characteristic of the people, assets, and processes that make up the EEDS and its ability to identify, prepare for, and adapt to disruptive events (in the form of changing conditions) and recover rapidly from any disturbance to an acceptable state of operation [3].