

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Technical Rationale and Justification for TPL-008-1

Project 2023-07 Transmission Planning
Performance Requirements for Extreme
Weather

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RELIABILITY | RESILIENCE | SECURITY



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Table of Contents

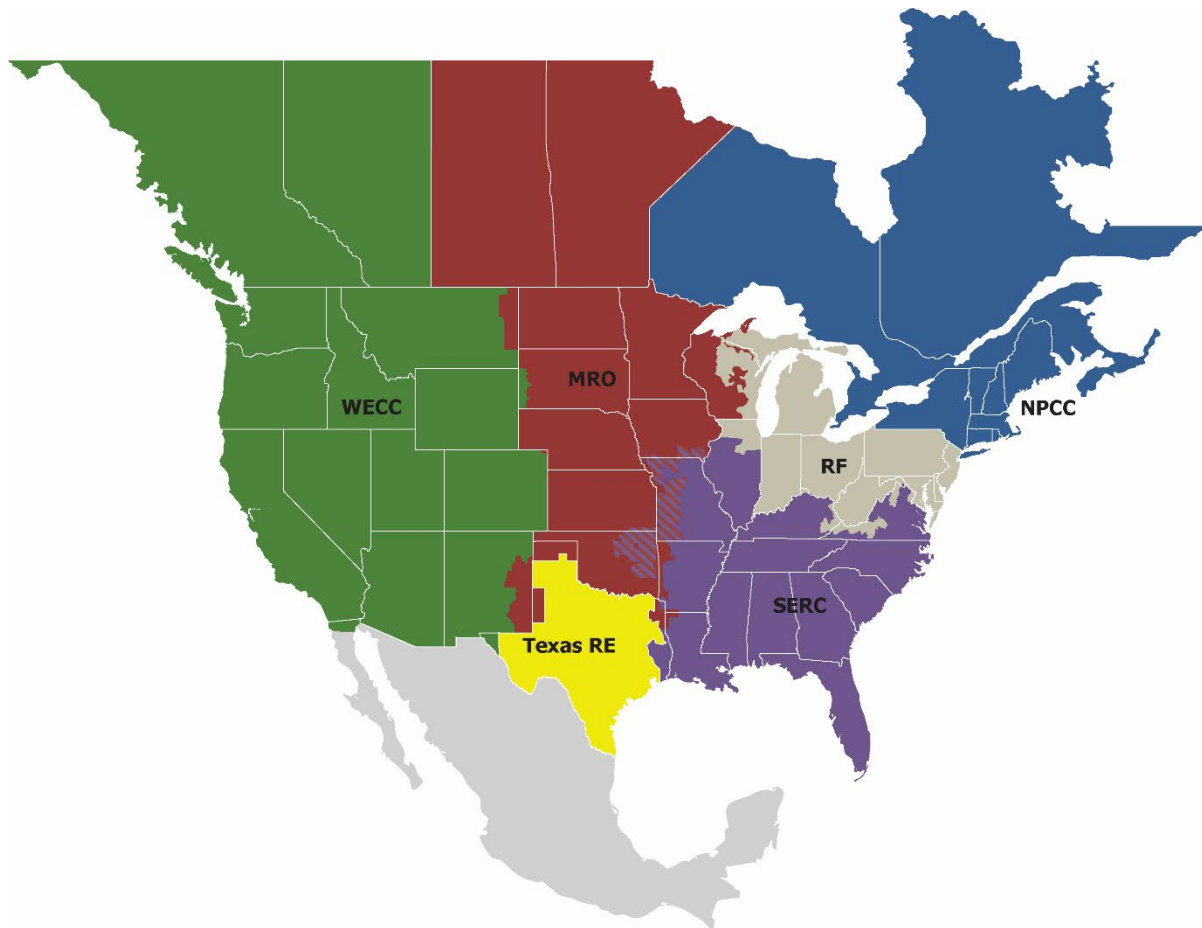
Preface	iii
Introduction	iv
Defined Terms	5
TPL-008-1 Standard.....	6
Requirement R1	7
Requirement R2	8
Requirement R3	9
Requirement R4	10
Requirement R5	11
Requirement R6	12
Requirement R7	13
Requirement R8	15
Requirement R9	17
Requirement R10	18
Requirement R11	19

Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, 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.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown on the map and in the corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



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

Introduction

This document explains the technical rationale and justification for the proposed Reliability Standard TPL-008-1. It provides stakeholders and the ERO Enterprise with an understanding of the technology and technical requirements in the Reliability Standard. This Technical Rationale and Justification for TPL-008-1 is not a Reliability Standard and should not be considered mandatory and enforceable.

Background

On June 15, 2023, FERC issued FERC Order No. 896 that acknowledges the “challenges associated with planning for extreme heat and cold weather events, particularly those that occur during periods when the Bulk-Power System must meet unexpectedly high demand. Extreme heat and cold weather events have occurred with greater frequency in recent years and are projected to occur with even greater frequency in the future. These events have shown that load shed during extreme temperatures result in unacceptable risk to life and have extreme economic impact. As such, the impact of concurrent failures of Bulk-Power System generation and transmission equipment and the potential for cascading outages that may be caused by extreme heat and cold weather events should be studied and corrective actions should be identified and implemented.”¹

Therefore, the Commission directed in FERC Order No. 896 to develop a new or modified Reliability Standard to address a lack of long-term planning requirement(s) for extreme heat and cold weather events. Specifically, FERC directed NERC to develop modifications to Reliability Standard TPL-001-5.1 or a new Reliability Standard, to require the following: (1) development of benchmark planning cases based on major prior extreme heat and cold weather events and/or meteorological projections; (2) planning for extreme heat and cold weather events using steady state and transient stability analyses expanded to cover a range of extreme weather scenarios including the expected resource mix's availability during extreme heat and cold weather conditions, and including the wide-area impacts of extreme heat and cold weather; and (3) development of corrective action plans that mitigate any instances where performance requirements for extreme heat and cold weather events are not met.

¹ N. Am. Elec. Reliability Corp., 183 FERC ¶ 61,191 (2023) (FERC Order), Final Rule. [eLibrary](#) | [File List \(ferc.gov\)](#)

Defined Terms

The Standard Drafting Team (SDT) defined one term to be added to the NERC Glossary of Terms to make the requirements easier to read and understand.

Extreme Temperature Assessment

Documented evaluation of future Bulk Electric System performance for extreme heat and extreme cold temperature benchmark events.

The definition of Extreme Temperature Assessment was developed by the SDT to limit wordiness throughout the requirements.

TPL-008-1 Standard

The FERC Order No. 896 directed NERC to submit a new Reliability Standard or modifications to Reliability Standard TPL-001-5.1 to address the concerns pertaining to transmission system planning for extreme heat and cold weather events that impact the Reliable Operation of the Bulk-Power System.

The SDT developed TPL-008-1 to address the FERC directive and determined that a new Reliability Standard was the cleanest way to address all directives versus modifying Reliability Standard TPL-001-5.1. While the TPL-008-1 standard pulls in similar requirements, this allows industry to have one standard that focuses on extreme heat and extreme cold weather benchmark planning analysis requirements.

Requirement R1

Requirement R1 was drafted to allow Planning Coordinator(s) (PC) and its Transmission Planner(s) (TP) within the PC's footprint to coordinate each entity's individual and joint responsibilities when completing the Extreme Temperature Assessment. The purpose of this requirement is to have the PC and its TPs identify their individual and joint responsibilities for the following activities: selecting the extreme heat and cold benchmark temperature events, developing and maintaining modeling data, having acceptable criteria, identifying Contingencies, performing steady state and transient stability analyses, developing Corrective Action Plans (CAPs) for Table 1 P0 and P1 Contingencies, evaluating and documenting possible actions for Table 1 P2, P4, and P7 Contingencies, and providing study results to any functional entity who have a reliability related need.

Requirement R2

Requirement R2 describes the need to select foundational weather data necessary for the creation of benchmark planning cases. Specifically, extreme hot and cold temperatures experienced during benchmark events are assumed to be outside the ranges used as the basis of planning cases studied under Reliability Standard TPL-001-5.1. Since temperature levels and associated weather conditions affect load levels, generation performance, and transfer levels, the selection of benchmark events is critical to ensuring the Extreme Temperature Assessment appropriately evaluates probable System conditions.

The SDT determined that the extreme heat and extreme cold temperatures selected must have a verified statistical basis based on weather data from credible sources. However, because there are many factors to consider in selecting benchmark events (e.g., temperature magnitude, duration of the event, geographical area impacted, etc.) the SDT is not in a position to provide that statistical basis or determine the appropriateness of any specific event. Therefore, to ensure consistency across regions, it is necessary for the ERO to have the responsibility for determining the suitability of benchmark events to represent probable future conditions. The ERO will maintain a library of benchmark events and develop a process to incorporate additional events proposed by responsible entities. Responsible entities will then have access to vetted benchmark weather data in a format that can be incorporated into benchmark planning cases.

Since any region can experience temperatures that are higher or lower than normal, each responsible entity must select at least one case that includes hotter temperature assumptions and one case that includes colder temperature assumptions. While it is understood that, for example, one region may typically experience hotter summers and milder winters than another region, both a hotter than average summer and a colder than average winter could result in reliability concerns. Therefore, the requirement is for at least one case specific to extreme heat and at least one case specific to extreme cold conditions to be studied for the Extreme Temperature Assessment.

Requirement R3

Requirement R3 aligns with directives in FERC Order 896, emphasizing the importance of coordinating the development of benchmark planning cases amongst impacted responsible entities, where the scope of extreme temperature event studies will likely cover large geographical areas exceeding smaller individual planning areas. Rather than attempting to define study boundaries, the SDT instead focused on developing language that ensures Planning Coordinators establish a process that ensures coordination of temperature-dependent variables with other affected entities based upon the selected benchmark temperature events.

NERC already defines “Wide Area” as “The entire Reliability Coordinator Area as well as the critical flow and status information from adjacent Reliability Coordinator Areas as determined by detailed system studies to allow the calculation of Interconnected Reliability Operating Limits.” Reliability Coordinator Areas can be geographically very large – for example the Reliability Coordinator West (RCW) region extends from the Pacific Northwest to the southern borders of California and Arizona. Thus, defining coordination requirements based on these boundaries may not accurately capture weather events and system impacts at a sufficiently granular level. In addition, it is recognized that electrical boundaries such as those defining the Eastern/Western/ERCOT interconnections limit the potential for events in one area to affect reliability in another.

The SDT considered comments from the industry expressing concerns regarding the necessity to coordinate among all impacted Planning Coordinators in developing benchmark planning cases for various extreme temperature benchmark temperature events. Recognizing that coordination among all impacted Planning Coordinators may not be necessary to ensure reliability within an individual planning area, the SDT revised Requirement R3 to require each Planning Coordinator to develop and implement a process for coordinating the development of benchmark planning cases among adjacent impacted Planning Coordinator(s), Transmission Planner(s), and other designated study entities, within the same Interconnection. The SDT believes this change balances the need to ensure the planning cases capture impacts to/from entities affected by the same benchmark weather event, while recognizing that reliability will not be impacted by system changes far removed from the individual planning area.

Requirement R4

The SDT revised Requirement R4 to require the responsible entity to use data consistent with Reliability Standard MOD-032 for developing and maintaining benchmark planning cases that include seasonal and temperature dependent adjustment for Load, generation, Transmission and transfers representing System conditions based on selected benchmark events. This aligns with directives in FERC Order 896, paragraph 30, emphasizing the requirement of developing both benchmark planning cases and sensitivity study cases. Requirement R4 is consistent with how Reliability Standard TPL-001-5.1 cross-references Reliability Standard MOD-032, which establishes consistent modeling data requirements and reporting procedures for the development of planning horizon cases necessary to support analysis of the reliability of the interconnected System.

As per Order 896, paragraph 94, it is clarified that resource adequacy benchmarks are not within the scope of TPL-008-1. The intent of the standard is to evaluate benchmark events where sufficient generation is available to supply load. However, under an extreme heat or extreme cold temperature condition, there may be instances where the benchmark planning cases and/or sensitivity cases may not have sufficient available generation to supply the load. In these scenarios, it may be acceptable for the responsible entity to revise the model to reduce the projected load, or include reasonable projections of future resources, to achieve a solution for the benchmark planning case and evaluate future Bulk Electric System performance for extreme temperature events.

Requirement R5

Requirement R5 was drafted to require each responsible entity to set the criteria needed for limits that will be used to evaluate the steady-state voltage and thermal results from the Extreme Temperature Assessment. The establishment of these criteria allows auditors to compare the results of the assessment with the established criteria.

Requirement R6

Requirement R6 was drafted to require the responsible entity to have the criteria or methodology used in evaluating the Extreme Temperature Assessment analysis to identify instability, uncontrolled separation, or Cascading within an Interconnection. Adequate and thorough criteria should be built into the Extreme Temperature Assessment to help identify instability, uncontrolled separation, and Cascading conditions. The establishment of these criteria allows auditors to compare the results of the assessment with the established criteria.

Requirement R7

This requirement addresses directives in FERC Order No. 896 to define a set of Contingencies that responsible entities will be required to consider when conducting wide-area studies of extreme heat and cold weather events. FERC's preference to rely on established Contingency definitions, "[w]e believe that it is necessary to establish a set of common contingencies for all responsible entities to analyze. Required contingencies, such as those listed in Table 1 of Reliability Standard TPL-001-5.1 (i.e., category P1 through P7), establish common planning events that set the starting point for transmission system planning assessments," was also considered by the SDT. It is necessary to establish a set of common Contingencies for all responsible entities to analyze. Requiring the study of predefined Contingencies, such as those listed in Table 1, will ensure a level of uniformity across planning regions, considering that extreme heat and cold weather events often exceed the geographic boundaries of most existing planning footprints. Defining the Contingencies in Table 1 consistently with Table 1 of Reliability Standard TPL-001-5.1 meets FERC's preference for commonality.

If feasible, all Contingencies or Planning Events listed in Table 1 should be considered for evaluation by the responsible entity; however, the language affords flexibility in identifying the most appropriate Contingencies. As such, the responsible entity should implement a method and establish sufficient supporting rationale to ensure Contingencies that are expected to produce more severe System impacts within its planning area are adequately identified. It is noted that since the benchmark planning cases are developed from the extreme temperature benchmark events, they already represent extreme System conditions and thus not all Contingencies from Reliability Standard TPL-001-5.1 Table 1 are included in the TPL-008-1 Table 1 for assessment. The Events included in TPL-008-1 Table 1 represent the more likely Contingencies to occur.

The SDT finds it reasonable to exclude P3, P5 and P6 Contingencies from the Extreme Temperature Assessment. The following discusses the rationale for excluding these Contingencies for TPL-008-1:

1. Excluding P3 and P6 Contingencies:

Part of the decision stems from the complexity of P3 and P6, which involve multiple element outages triggered by multiple Contingencies, with System adjustments allowed between them. Consequently, the occurrence likelihood of P3 and P6 could be even lower compared to P2, P4, and P7 Contingencies. Moreover, aligning with the directives set forth in FERC Order 896, which emphasizes the importance of incorporating derated generation, transmission capacity, and the availability of generation and transmission in the development of benchmark planning cases, it becomes imperative for responsible entities to consider potential concurrent or correlated generation and transmission outages and/or derates within relevant benchmark planning cases. This ensures that the benchmark planning case accurately reflects System conditions under extreme temperatures, with generation and transmission derates and/or outages already factored. Therefore, the SDT believes excluding P3 and P6 is justified, as generation and transmission derates and/or outages are already accounted for within the benchmark planning cases.

2. Excluding P5 Contingencies:

After consideration of comments were received, the SDT removed P5 Contingency (Delayed Fault Clearing due to failure of non-redundant component of a Protection System). This is because while some categories of Contingencies may be assessed in a straightforward approach, category P5 events often require a significant level of engineering analysis (including protection and/or control analysis). These analyses are sensitive to the System topology and expected dispatch. As the planning benchmark cases are developed for TPL-008-1 that represent System conditions that are different than the typical summer or winter peak conditions, the development of category P5 events is expected to be a significant burden. Since these events only require evaluations of possible mitigations (and not CAPs), violations resulting from these events are

unlikely to result in significant transmission System investment. Furthermore, any violations resulting from category P5 events may be mitigated by eliminating and addressing the single point of failure included in the event definition. Thus, the evaluation of possible actions is unlikely to result in further insight beyond the general reliability improvements associated with eliminating single points of failure.

Some, but not all, items to consider when developing the rationale for selecting Contingencies are:

- Past studies,
- Subject matter expert knowledge of the responsible entity's System (to be supplemented with data or analysis), and
- Historical data from past operating events.

Requirement R8

Requirement R8 was drafted to provide clarity on the following:

1. Frequency of the Extreme Temperature Assessment (Assessment):

Due to significant level of data collection and coordination between the Planning Coordinator(s) and Transmission Planner(s) for the potential wide-area extreme cold or extreme heat benchmark events, as well as the need to document the assumptions and study results, the SDT opined that performing and completing of the Assessment once every five calendar years is a reasonable timeframe to allow responsible entities to coordinate, prepare, perform and document the Assessment study results. To the extent that responsible entities want to perform more than one set of Assessment for an extreme heat and extreme cold benchmark event, they can do so, but the minimum requirement is once every five calendar years to perform and complete one set of Assessment.

2. What planning study cases are required?

The Requirement R8 includes the following minimum number of assessments to complete the Extreme Temperature Assessment and address FERC 896 directives per paragraph 111 that “direct NERC to require in the proposed new or modified Reliability Standard that responsible entities perform both steady state and transient stability (dynamic) analyses in the extreme heat and cold weather planning studies”. In addition, Requirement R8 also addresses FERC 896 directives per paragraph 124 that “require the use of sensitivity cases to demonstrate the impact of changes to the assumptions used in the benchmark planning case”. Requirement R8 also addresses FERC directives per paragraph 124 that sensitivity cases “should consider including conditions that vary with temperature such as load, generation, and system transfers.” Since the benchmark planning case(s) already include System conditions under extreme heat or extreme cold events, the sensitivity analysis is to include, at a minimum, changes to one of the assumptions in generation, loads or transfers. Since the minimum requirement includes changes to one of these conditions, the PCs and the TPs can include further sensitivity assessments to change more conditions if they choose to do so.

The following provides the minimum number of assessments required to complete the Extreme Temperature Assessment for the benchmark planning cases, as well as for sensitivity assessments.

Type of Extreme Temperature Assessment	Extreme Cold Temperature Event	Extreme Heat Temperature Event	Total
Benchmark Planning Case Analysis	A minimum of one extreme cold benchmark planning case assessment	A minimum of one extreme heat benchmark planning case assessment	Total Minimum: Two benchmark planning case assessments
Sensitivity Analysis	A minimum of one sensitivity study case for one of the following: <ol style="list-style-type: none"> 1. Changes in generation availability, or 2. Changes in load level (real and reactive), or 	A minimum of one sensitivity study case for one of the following: <ol style="list-style-type: none"> 1. Changes in generation availability, or 2. Changes in load level (real and reactive), or 	Total Minimum: Two sensitivity cases analysis

Type of Extreme Temperature Assessment	Extreme Cold Temperature Event	Extreme Heat Temperature Event	Total
	3. Changes in transfer level	3. Changes in transfer level	
Total			A minimum total of four assessments to complete the Extreme Temperature Assessment

3. What are the types of power flow related analyses?

There are two types of power flow related analyses: a steady-state and a stability analysis that are applied for the minimum of four planning study cases as identified in the above table. This requirement is to satisfy FERC Order 896 directive paragraph 111.

Requirement R9

FERC Order 896 identifies a deficiency in the existing Reliability Standard TPL-001-5.1 where “planning coordinators and transmission planners are required to evaluate possible actions to reduce the likelihood or mitigate the consequences of extreme temperature events but are not obligated to develop corrective action plans” (§139).

Given potential severe consequences of extreme cold and extreme heat events, FERC Order 896 raises the bar and “directs NERC to require in the new or modified Reliability Standard the development of extreme weather corrective action plans for specified instances when performance standards are not met” (§152).

Due to higher likelihood of P0 and P1 planning events, performance requirements for P0 and P1 Contingencies are held to a higher performance standard, and Corrective Action Plans (CAPs) are required to address performance deficiencies for P0 and P1 Contingencies in the Extreme Temperature Assessments.

Furthermore, having a CAP requirement for P0 and P1 contingencies aligns with ensuring resilience during future extreme cold and extreme heat events, when the transmission System is required to be P1-secure (using contingency analysis, voltage stability and transient stability).

Given that a P0 planning event represents a continuous System condition without any system disturbances, the SDT opined that load shedding should not be considered as a CAP. However, the SDT has determined that load curtailment may be considered for a P1 Contingency as a CAP where load shed is allowed to prevent system-wide failures and ensuring the continued operation of essential services under a critical P1 Contingency in the extreme heat and cold temperature events. The SDT also emphasizes that other alternative solutions, other than firm load curtailment, are evaluated in higher priorities. In the event that firm Load shed is included in the CAP for a P1 contingency, the responsible entity shall document the alternative(s) considered, as mentioned in Requirement R9, and notify the applicable regulatory authorities or governing bodies responsible for retail electric service issues.

Requirement R10

The requirement for responsible entities to assess and document possible actions designed to reduce the likelihood or mitigate the consequences of System instability, uncontrolled separation, or Cascading failures during P2, P4, and P7 Contingencies is in response to directives outlined in FERC Order 896.

The P2, P4, and P7 Contingencies involve multiple element outages resulting from a single event, making them relatively less likely to occur compared to P0 and P1 Contingencies but potentially causing more severe system impacts. Considering both the likelihood of these Contingencies and the fact that the Extreme Temperature Assessment already addresses low-probability System conditions, the SDT determined that no Corrective Action Plan is required for P2, P4, and P7 Contingencies. However, due to their potential severity resulting from single-Contingency multiple element outages, the SDT believes it is appropriate for responsible entities to at least evaluate and document possible mitigation actions to reduce the likelihood or mitigate the consequences and adverse impacts. The biggest benefit from the evaluation and documentation of the mitigating actions is it allows an entity to see where major problems exist that they may need to be addressed; and, if a project shows up on enough issues, it may encourage a fix to be implemented without it being strictly called for from the standard. Not requiring CAPs for these contingencies but requiring the evaluation is a compromise from having CAPs for all studied issues.

Requirement R11

The requirement for responsible entities to share Extreme Temperature Assessment results aligns with directives in FERC Order 896, emphasizing coordination and sharing of study findings. It ensures collaboration among stakeholders and timely dissemination of critical information to entities with reliability-related needs. This fosters a collective understanding of reliability concerns identified in wide-area studies, thereby enhancing overall grid reliability.