

**NERC**

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

# Technical Rationale and Justification for TPL-008-1

Project 2023-07 Transmission Planning  
Performance Requirements for Extreme  
Weather

March 2024

**RELIABILITY | RESILIENCE | SECURITY**



3353 Peachtree Road NE  
Suite 600, North Tower  
Atlanta, GA 30326  
404-446-2560 | [www.nerc.com](http://www.nerc.com)

# Table of Contents

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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 .....	14
Requirement R9 .....	16
Requirement R10 .....	17
Requirement R11 .....	18

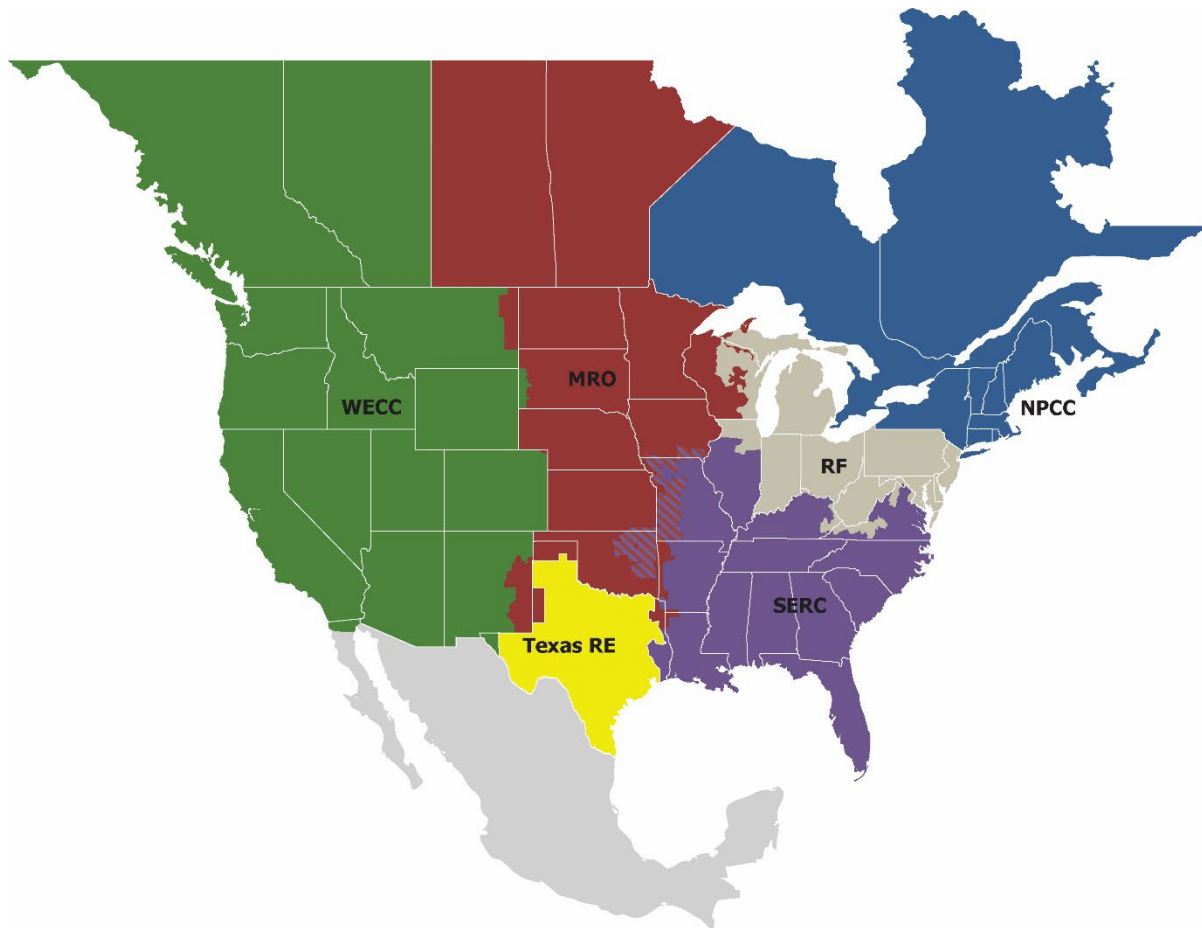
# Preface

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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.



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

# Introduction

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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.”<sup>1</sup>

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.

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

## Defined Terms

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The drafting team 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 Transmission System performance for extreme heat and extreme cold temperature benchmark events.

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

## **TPL-008-1 Standard**

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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 drafting team 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 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

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Requirement R1 was drafted to allow Planning Coordinator (PC) and Transmission Planner(s) (TP) within the PC's footprint, to sync up regarding their individual and joint responsibilities when performing the required studies. This will assist entities with clarity on who will complete the other respective requirements within the TPL-008-1 Reliability Standard.

## Requirement R2

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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 TPL-005-1.1. 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 Standard Drafting Team (SDT) determined that the extreme heat and 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

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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.

Requirement R3, Part 3.1 addresses directives in FERC Order 896, paragraph 50, to consider the wide-area impacts of extreme heat and cold weather and define the wide-area boundaries in transmission planning studies. Additionally, Requirement R3, Part 3.2 addresses directives in FERC Order 896, paragraph 124, which requires the use of sensitivity cases to demonstrate the impact of changes to the assumptions used in the benchmark planning case(s). Specifically, paragraph 124 emphasizes the importance of including conditions that vary with temperature such as load, generation, and system transfers.

## Requirement R4

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The Extreme Temperature Assessment requires System models, developed in accordance with the MOD-032 standard, for conducting steady state power flow and stability analysis. This aligns with directives in FERC Order 896, emphasizing the requirement of both steady state and transient stability analysis be conducted for extreme heat and cold weather events as part of transmission planning studies. 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.

## Requirement R5

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Requirement R5 was drafted to require each responsible entity to set the criteria needed for limits that will be used to evaluate the voltage 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

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This requirement addresses directives in FERC Order No. 896 for responsible entities to perform both steady state and transient stability (dynamic) analyses to ensure that the system has been thoroughly assessed for instability, uncontrolled separation, and Cascading in both the steady state and the transient stability realms.

Adequate criteria should be built into the Extreme Temperature Assessment when performing steady state and transient stability analyses and should be documented clearly. The identification of instability, uncontrolled separation, and Cascading analyses should include thorough technical criteria and supporting information.

## Requirement R7

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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 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.

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

- Past studies,
- Subject matter expert knowledge and judgment 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
<b>Benchmark Planning Case Analysis</b>	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
<b>Sensitivity Analysis</b>	A minimum of one sensitivity study case for one of the following:  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:  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	
<b>Total</b>			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

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FERC Order 896 identifies a deficiency in the existing NERC TPL-001-5.1 Transmission Planning Reliability Standard 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 P1 Contingencies, 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 transmission system is required to be P1-secure (using contingency analysis, voltage stability and transient stability).

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 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 either curtail load, or model most likely future resources in the interconnection queue, to achieve a solution for the benchmark planning case. Under these conditions, the amount of load curtailment or potential new resources assumed in the benchmark planning cases need to be documented Extreme Temperature Assessment to be reported to the applicable regulatory authorities or governing bodies responsible for retail electric service issues.

Given that a P0 Contingency 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 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 R10, and notify the applicable regulatory authorities or governing bodies responsible for retail electric service issues.



## Requirement R10

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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, P5, and P7 Contingencies is in response to directives outlined in FERC Order 896.

The P2, P4, P5, 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 is required for P2, P3, 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 SDT finds it reasonable to exclude P3 and P6 Contingencies from the Extreme Temperature Assessment. 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, P5, 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 derates within relevant benchmark planning cases. This ensures that the benchmark planning case accurately reflects system conditions under extreme temperatures, with generation and transmission outages already factored in. Therefore, the SDT believes excluding P3 and P6 is justified, as generation and transmission outages are already accounted for within the benchmark planning cases.

## Requirement R11

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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.