NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Technical Rationale and Justification for TPL-008-1

Project 2023-07 Transmission Planning Performance Requirements for Extreme Weather

December 2024

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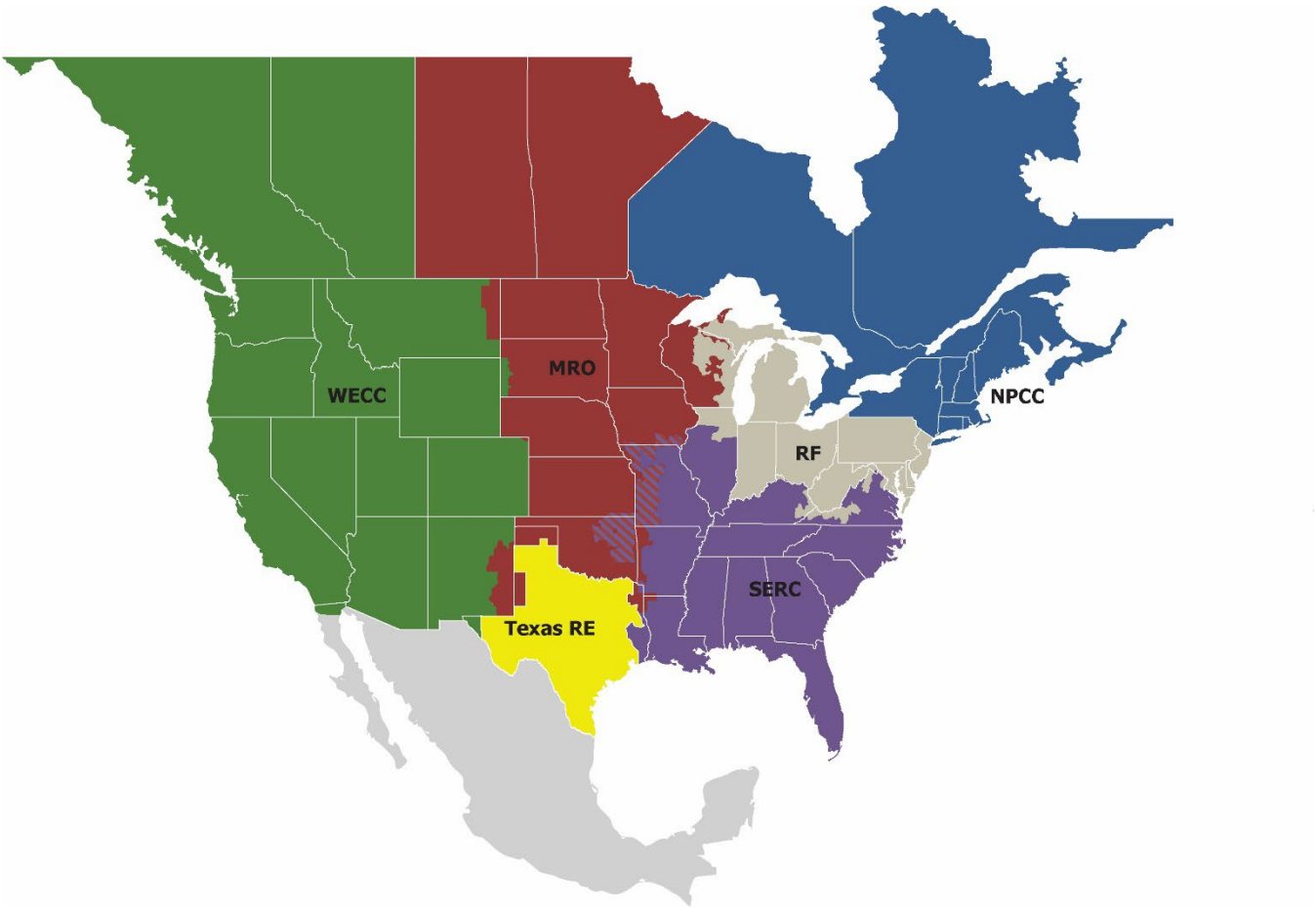
Preface

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 (BPS) 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 Drafting Team (DT) 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 benchmark temperature events.

The definition of Extreme Temperature Assessment was developed by the DT 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 determined that a new Reliability Standard was the cleanest way to address FERC's directives versus modifying Reliability Standard TPL-001-5.1. While the TPL-008-1 standard uses similar requirements, this allows industry to have one standard that focuses on extreme heat and extreme cold benchmark temperature events.

The purpose of TPL-008-1 is to "Establish Transmission system planning performance requirements to develop a Bulk Power System (BPS) that will operate reliably during extreme heat and extreme cold temperature events." The directives in FERC Order No. 896 pertain to the reliable operation of the BPS, and the requirements of TPL-008-1 support that by ensuring Planning Coordinators and Transmission Planners are planning their portions of the Bulk Electric System (BES) to meet performance requirements in extreme heat and extreme cold benchmark temperature events.

Requirement R1

Requirement R1 requires each Planning Coordinator (PC) and the Transmission Planner(s) (TP) within the PC's footprint to identify each entity's individual and joint responsibilities when completing the Extreme Temperature Assessment at least once every five calendar years. Due to significant level of data collection and coordination between the Planning Coordinator(s) and Transmission Planner(s) for the potential wide-area extreme heat and extreme cold benchmark events, as well as the need to document the assumptions and study results, the drafting team opined that completing the Extreme Temperature Assessment once every five calendar years is a reasonable timeframe to allow responsible entities to coordinate, prepare, perform, and document the study results. To the extent that responsible entities want to complete more than one set of the Extreme Temperature 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 complete one set of the Extreme Temperature Assessment.

The purpose of this requirement is to have the PC and its TP(s) identify their individual and joint responsibilities for the following activities:

- Identifying the PC's zone(s) and coordinating with all PCs in each of its identified zone(s) to select one common extreme heat benchmark temperature event and one common extreme cold benchmark temperature event (Requirement R2),
- Implementing a process for developing benchmark planning cases and sensitivity cases (Requirement R3),
- Developing benchmark planning cases and sensitivity cases (Requirement R4),
- Having acceptable criteria (Requirements R5 and R6),
- Identifying Contingencies for evaluation (Requirement R7),
- Performing steady state and transient stability analyses (Requirement R8),
- Developing Corrective Action Plans when required (Requirement R9),
- Evaluating and documenting possible actions for performance deficiencies that do not require Corrective Action Plans (Requirement R10), and
- Providing study results to any functional entity that has a reliability related need (Requirement R11).

The responsibilities described in Requirements R2 and R3 are explicitly assigned to the PC. The responsibilities described in Requirements R4 through R11 may be completed by either the PC or one or more of its TPs. Requirement R1 requires that an agreement is reached on the individual and joint responsibilities for completing the Extreme Temperature Assessment between the PC and its TPs.

Requirement R2

Requirement R2 requires each Planning Coordinator (PC) to identify the zone(s) it will participate in for the components of the Extreme Temperature Assessment that require coordination. PCs in the same zone are required to coordinate to:

- Select one common extreme heat benchmark temperature event and one common extreme cold benchmark temperature event (Requirement R2), and
- Implement a process for developing benchmark planning cases and sensitivity cases (Requirement R3).

FERC Order No. 896 directed NERC to require that transmission planning studies under the new or revised Reliability Standard consider the wide-area impacts of extreme heat and cold weather. Considering this directive, the SDT identified the zones depicted in Attachment 1 as reasonable boundaries that balance the need for studies to cover large regions with similar weather patterns with the need for a manageable level of coordination. An earlier proposal to limit coordination to only adjacent PCs was not adequate for meeting FERC's directives. While the zones depicted in Attachment 1 will require some PCs to coordinate with many other PCs, the industry has demonstrated, through various working groups and organizations, that it is capable of cooperating to build models that represent larger areas. The zones depicted in Attachment 1 are either aligned with existing PC boundaries or boundaries of a group of PCs with similar weather patterns.

Requirement R2 describes the need to select extreme benchmark temperature events 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.

Since any region can experience temperatures that are higher or lower than normal, PCs within the same zone must coordinate to select one common temperature event that includes hotter temperature assumptions and one common temperature event 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 one common case specific to extreme heat and one common case specific to extreme cold conditions to be studied for the Extreme Temperature Assessment. By selecting the same, common events, PCs ensure that extreme temperatures are studied over the entire zone. The evaluation of a common event taking place over a wide area is foundational to FERC Order No. 896. Furthermore, selecting the same, common events reasonably limits coordination requirements. PCs are required to participate in the selection of events for their zone(s), but have no responsibilities for the selection of events in other zones.

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. The SDT has identified several key features that are used to determine when a temperature event will constitute a valid extreme benchmark temperature event for the purposes of completing the Extreme Temperature Assessment. Specifically, extreme benchmark temperature events must:

- Consider no less than 40 years of temperature data,
- Utilize data ending no more than five years prior to the time benchmark temperature events are selected, and
- Represent one of the worst 20 extreme temperature conditions within the zone.

Temperature events are ranked by computing the 3-day rolling average of daily maximum temperatures (for extreme heat) or daily minimum temperatures (for extreme cold). The 3-day rolling average temperatures are calculated for both extreme heat and extreme cold to identify multi-day periods of extreme heat or extreme cold temperature events. The ERO will maintain a library of benchmark events to provide responsible entities access to vetted benchmark temperature events that meet the criteria of Requirement R2. While selection of events from the ERO's provided library assures entities they are selecting valid events, Requirement R2 does not preclude entities from collecting temperature data and identifying benchmark temperature events through their own process. Entities that elect to develop their own benchmark temperature events are responsible for ensuring the input temperature data and selected benchmark temperature events meet the criteria of Requirement R2. Additionally, because Requirement R2 requires PCs within a zone to coordinate in the selection of the benchmark temperature events, the process used to identify these events must be agreeable to those PCs.

The requirement to consider no less than 40 years of temperature data was established based on the observation that many of the worst events identified in various regions of North America occurred in the 1980s and 1990s. For example, preliminary data indicated that the five worst extreme cold temperature events in the PJM region over the last 43 years occurred between 1983 and 1994. Similar results were seen in other regions for both extreme heat and extreme cold temperature events. Thus, the SDT determined that a minimum of 40 years of temperature data should be used to ensure more extreme events weren't excluded by using a shorter duration of temperature data.

Requirement R3

Requirement R3 aligns with directives in FERC Order No. 896, emphasizing the importance of coordinating the development of benchmark planning cases and sensitivity cases amongst PCs within a zone, where the scope of extreme temperature event studies will likely cover large geographical areas exceeding smaller individual planning areas. The SDT considered comments from the industry expressing concerns regarding the necessity to coordinate among all impacted PCs in developing benchmark planning cases and sensitivity cases for various extreme benchmark temperature events. Recognizing that coordination among all impacted PCs may not be necessary to ensure reliability within an individual planning area, the SDT drafted Requirement R3 to require each PC to coordinate with all PCs within a zone to implement a process for the development of benchmark planning cases and sensitivity cases. The SDT believes this change balances the need to ensure the planning cases capture impacts to/from entities affected by the same benchmark temperature event, while recognizing that reliability will be less impacted by system changes far removed from the zone.

PCs within a zone must coordinate to implement a process that results in the development of benchmark planning cases that represent the benchmark temperature events selected in accordance with Requirement R2, and sensitivity cases that demonstrate the impact of changes to the basic assumptions used in the benchmark planning cases. This process requires several components, outlined in the sub-requirements of Requirement R3.

First, Requirement R3 Part 3.1 requires PCs within a zone to identify System models form the basis for developing the benchmark planning cases. These models must represent one of the years in the Long-Term Transmission Planning Horizon. PCs will also need to ensure models include stability modeling data to provide for the performance of stability analysis later in the process. It is reasonably anticipated that PCs will likely utilize a summer peak model as the starting point for the extreme heat benchmark temperature event and a winter peak model as the starting point for the extreme cold benchmark temperature event.

Secondly, Requirement R3 Part 3.2 requires that PCs within a zone provide forecasted data for their area within the zone that represents the benchmark temperature events selected in accordance with Requirement R2. Each PC must provide data for their area within the zone that represents seasonal and temperature adjustments for Load, generation, Transmission, and transfers. The provided data should be used to update the starting point models to reflect the selected benchmark temperature events.

Thirdly, Requirement R3 Part 3.3 allows PCs to agree on assumptions for seasonal and temperature adjustments for Load, generation, Transmission, and transfers in areas *outside* of the zone. As a sub-requirement of Requirement R3, these assumptions must be coordinated among PCs in the zone, as needed. As an example, PCs within the zone may identify the need for imported power during a benchmark event. The PCs may evaluate historical import availability and assume an import from an area outside of the zone is reasonable and should be modeled.

Finally, Requirement R3 Part 3.4 requires PCs to coordinate and identify changes to generation, real and reactive forecasted Load, or transfers that should be reflected in sensitivity cases. Sensitivity cases are intended to demonstrate the impact of changes to the basic assumptions used in the benchmark planning cases, and Requirement R3 Part 3.4 ensures PCs are cooperating to identify changes that sufficiently alter the assumptions reflected in the benchmark planning cases. For example, PCs that identified an import external source to the zone for a benchmark planning case may elect to alter the source of that import in the sensitivity case.

Requirement R4

The SDT drafted Requirement R4 to require the responsible entity to use data consistent with Reliability Standard MOD-032, supplemented by other sources as needed, for developing benchmark planning cases that represent System conditions based on selected benchmark temperature events. This aligns with directives in FERC Order No. 896, paragraph 30, emphasizing the requirement of developing both benchmark planning cases and sensitivity study cases. Requirement R4 is consistent with Reliability Standard TPL-001-5.1 in cross-referencing 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. It is also consistent with Reliability Standard TPL-001-5.1 in acknowledging that data from other sources may be required to supplement the data collected through Reliability Standard MOD-032 procedures.

FERC Order No. 896, paragraph 116, directs NERC "to require in the new or modified Reliability Standard that responsible entities model demand load response in their extreme weather event planning area". This requirement can be met via the use of data consistent with Reliability Standard MO-032, as included in the TPL-008-1 standard's Requirement R4. The modeling of the demand load response can be implemented through the use of MOD-032 in which data needed for study base case development can be requested and obtained for development of the benchmark planning cases and sensitivity cases.

Requirement R4 requires entities to use the coordination process developed in accordance with Requirement R3 to develop the following four cases:

- One common extreme heat benchmark planning case (Requirement R4 Part 4.1),
- One common extreme cold benchmark planning case (Requirement R4 Part 4.1),
- One common extreme heat sensitivity case (Requirement R4 Part 4.2), and
- One common extreme cold sensitivity case (Requirement R4 Part 4.2).

At the completion of the case development process, implemented in accordance with Requirement R3, and executed in Requirement R4, responsible entities will have the four cases listed above. This establishes category P0 as the normal System condition in Table 1 for each case. Requirement R3 does not preclude PCs from implementing a process that develops cases for multiple benchmark temperature events or additional sensitivity cases. Moreover, entities may elect to develop additional cases for their internal use.

As per FERC Order No. 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 forecasted Load, or include forecasted generation, to achieve a solution for the benchmark planning cases and/or sensitivity cases and evaluate future Bulk Electric System performance for extreme temperature events. Each responsible entity, as identified in Requirement R1, shall have dated evidence in either electronic or hard copy format that it developed benchmark planning cases and sensitivity cases in accordance with Requirement R4.

Requirement R5

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

Requirement R6

Requirement R6 was drafted to require the responsible entity to define and document the criteria or methodology used in evaluating the Extreme Temperature Assessment analysis to identify instability, uncontrolled separation, or Cascading within an Interconnection. In developing planning benchmark as well as sensitivity cases for steady-state and transient stability analyses, the Planning Coordinators and Transmission Planners typically use Interconnection-wide starting cases prior to further modifications to reflect the conditions of the benchmark events as well as modifications for sensitivity cases. Analyses that may result in instability, uncontrolled separation, or Cascading typically are confined within an Interconnection where generation and transmission Facilities are interconnected. It is not expected that instability, uncontrolled separation, or Cascading that affect Facilities within an Interconnection would impact other Interconnection(s) as these systems are asynchronous systems (i.e., not connecting synchronously). 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 Extreme Temperature 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 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 within each category of Table 1, 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 included categories P0, P1, and P7 in Table 1 of TPL-008-1. The SDT finds it reasonable to exclude P2, P3, P4, P5 and P6 Contingencies from the Extreme Temperature Assessment. Studying categories P0, P1 and P7 is the minimum requirement of TPL-008-1. The standard does not preclude entities from studying additional Contingencies if desired. The following discusses the rationale for excluding P2 through P6 Contingencies for TPL-008-1:

1. Excluding P2 and P4 Contingencies:

   After consideration of comments received from the industry, the SDT removed P2 and P4 Contingencies due to lower probability of occurrence than P1 and P7 Contingencies. TPL-008 now focuses on the single Contingencies (P1) or multiple Contingencies on common structure (P7) that are more likely to be monitored in operational scenarios. P2 Contingencies (e.g. Contingencies caused by internal breaker fault, bus section fault, opening line section without a fault), and P4 Contingencies (e.g., Contingencies caused by stuck breaker), while plausible under extreme temperature conditions, occur in much less frequency when compared to P1 and P7 Contingencies. The standard establishes minimum requirement for Contingencies with higher probability of occurrence. To the extent that the responsible entity determines the need for studying beyond the minimum requirements, the standard does not preclude the entity from doing so.

2. Excluding P3 and P6 Contingencies:

   Part of the decision stems from the complexity of P3 and P6 Contingencies, which involve multiple element outages triggered by multiple Contingencies, with System adjustments allowed between them. Consequently, the occurrence likelihood of P3 and P6 Contingencies could be even lower compared to P1 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.

3. Excluding P5 Contingencies:

   After consideration of comments received from the industry, 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 Contingency 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 Contingency events is expected to be a significant burden. Since these events only require evaluations of possible mitigations (and not Corrective Action Plans), 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.

The SDT discussed and decided to keep the P7 Contingency category because common structure Contingencies are often evaluated after categories P0 and P1 as the most common minimum level of transmission reliability assessment. These events have a high likelihood of occurrence due to the following reasons:

- Historical events that include simultaneous forced outage due to tripping of the double-circuit power lines due to electrical storm events;
- Environment-caused factors include pollution buildup, such as dust, that could cause faulted condition that trips both transmission lines on a common tower;
- Avian-caused outages that impact both transmission lines on a common tower;
- Smoke from nearby wildfires can cause simultaneous tripping of both circuits on a common tower;
- Nearby wildfires can impact System Operation as System Operators proactively de-energize both lines on a common tower to avoid further impact to the transmission grid in the event of a simultaneous tripping of both lines that may be carrying high power transfer between areas;
- Weather-related causes such as lightning, flooding, wind, or icing can cause tripping of both transmission lines on a common tower;
- Natural disaster such as winter storm can cause transmission tower to collapse, taking out both lines strung on the same tower;
- Other incidents such as vehicle accident, aircraft accident, vandalism, or animal contact that can adversely impact both transmission lines on the common tower.

Loss of two circuits running in parallel, simultaneously, is likely to have a greater system impact versus loss of two unrelated or geographically separated circuits. Therefore, there is greater potential for reliability concerns, especially during heavy transfers that are likely during periods of extreme weather, due to loss of both circuits of a double-circuit line. Due to the reasons above, Contingencies that involve double-line circuits on a common tower are included in the critical multiple Contingency list in either transmission planning or System Operations reliability assessment.

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.

Lastly, regarding the Bulk Electric System (BES) voltage levels for the Contingencies, the SDT reviewed previous major wide-area benchmark events and found that the Facilities that were out of service by these events have voltages that are 200 kV and above. Thus, it is the reason for establishing voltages of 200 kV and above for Contingencies in Table 1 of TPL-008-1. The monitoring of potential impact is still applicable to Facilities with all BES voltage levels. However, with that said, the SDT recognized that many PCs and TPs have Contingencies that include all BES levels. Responsible entities may elect to use the existing Contingencies that they already have and report the criteria violations for the categories in TPL-008-1 Table 1.

Requirement R8

Requirement R8 was drafted to provide clarity on the following:

1. What planning study cases are required?

   The Requirement R8 includes the following number of assessments to complete the Extreme Temperature Assessment and address FERC Order No. 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 Order No. 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 Order No. 896 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 changes to at least one of the following conditions: generation, real and reactive forecasted Load, 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 number of assessments required for the benchmark planning and sensitivity cases to complete the Extreme Temperature Assessment.

Type of Extreme Temperature Assessment	Extreme Cold Temperature Event	Extreme Heat Temperature Event	Total
Benchmark Planning Case Analysis	One extreme cold benchmark planning case assessment	One extreme heat benchmark planning case assessment	Two benchmark planning case assessments
Sensitivity Case Analysis	One sensitivity case with changes to at least one of the following conditions: generation, real and reactive forecasted Load, or transfers	One sensitivity case with changes to at least one of the following conditions: generation, real and reactive forecasted Load, or transfers	Two sensitivity case assessments
Total			A total of four assessments to complete the Extreme Temperature Assessment

2. What are the types of analyses required?

   There are two types of analyses required: steady-state and transient stability. Each type of analysis must be completed for each of the four cases described in the table above. This requirement is to satisfy FERC Order No. 896 directive paragraph 111.

Requirement R9

FERC Order No. 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 No. 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 categories P0 and P1, these categories are held to a higher performance requirement in benchmark planning cases. Corrective Action Plans are required to address performance deficiencies for categories P0 and P1 in benchmark planning cases analyzed in the Extreme Temperature Assessment.

Furthermore, having a Corrective Action Plan requirement for categories P0 and P1 in benchmark planning cases ensures resilience during future extreme cold and extreme heat temperature events, when the transmission System is required to be P1 Contingency-secure (for steady-state and transient stability).

Given that a category P0 represents a continuous System condition without any system disturbances, the SDT determined that load shedding should not be considered as a Corrective Action Plan. However, the SDT has determined that load curtailment may be considered for a P1 Contingency as a Corrective Action Plan 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 alternative solutions, other than firm load curtailment, are evaluated in higher priorities. Non-Consequential Load Loss is permitted as an interim solution in situations that are beyond the control of the Planning Coordinator or Transmission Planner that prevent the implementation of a Corrective Action Plan in the required timeframe; however, the responsible entity must document the situation causing the problem, alternatives evaluated, and take actions to resolve the situation. Future revisions to the Corrective Action Plan are allowed, provided that the planned Bulk Electric System continues to meet the performance requirements of Table 1.

FERC Order No. 896 also directs NERC "to develop certain processes to facilitate interaction and coordination with applicable regulatory authorities or governing bodies responsible for retail electric service as appropriate in implementing a corrective action plan" (¶152). In the event that Non-Consequential Load Loss is included in the Corrective Action Plan for a P1 Contingency, the responsible entity shall document alternative(s) considered, make the Corrective Action Plan available to, and solicit feedback from, applicable regulatory authorities or governing bodies responsible for retail electric service issues.

Lastly, the standard also permits the responsible entities to revise or update the Corrective Action Plan that was considered and approved in the previous Extreme Temperature Assessment. This allows responsible entities to incorporate approved mitigation measures from other planning assessments, such as annual transmission reliability assessment under TPL-001-5 or subsequent related planning standard, or from other planning assessments for policy-driven or economic needs. The revised or updated Corrective Action Plan associated with TPL-008-1 can be documented as an addendum to the previous Extreme Temperature Assessment's Corrective Action Plan.

Requirement R10

The requirement for responsible entities to evaluate and document possible actions designed to reduce the likelihood or mitigate the consequences and adverse impacts when the study results in the benchmark planning cases analyses conclude there could be instability, uncontrolled separation, or Cascading for P7 Contingencies is in response to directives outlined in FERC Order No. 896.

P7 Contingencies involve multiple element outages resulting from a single event, making them relatively less likely to occur, compared to categories P0 and P1, 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 Corrective Action Plans should not be required for P7 Contingencies. However, due to the 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 of the event(s) when analyses conclude there could be instability, uncontrolled separation, or Cascading. The biggest benefit from the evaluation and documentation of the possible mitigating actions is it allows a responsible entity to see where major reliability concerns exist that may need to be addressed; and, if a sufficiently large number of reliability concerns are identified, it may encourage transmission upgrade mitigation option(s) to be considered and implemented without it being strictly called for in the standard. Not requiring Corrective Action Plans for these Contingencies, but requiring the evaluation, is a compromise from having Corrective Action Plans for all studied Contingencies.

Furthermore, FERC Order No. 896 requires “the use of sensitivity cases to demonstrate the impact of changes to the assumptions used in the benchmark planning case” (¶124). FERC Order No. 896 also states: “NERC should determine whether corrective action plans should be required for single or multiple sensitivity cases, and whether corrective action plans should be developed if a contingency event that is not already included in benchmark planning case would result in cascading outages, uncontrolled separation, or instability” (¶158). The SDT acknowledges that sensitivity analysis is an important component of a robust transmission planning study. A requirement to develop and implement Corrective Action Plans for sensitivity cases may incentivize responsible entities to select fewer or less severe sensitivities. An incentive to select fewer sensitivities is undesirable because sensitivity study results are used to identify constraints and initiate deeper analysis into the variables that impact those constraints. The study results of sensitivity cases are also important to inform the development of Corrective Action Plans in the benchmark planning cases. Therefore, the SDT determined the responsible entity must evaluate and document possible actions designed to reduce the likelihood or mitigate the consequences and adverse impacts of the event(s) when analyses of sensitivity cases conclude there could be instability, uncontrolled separation, or Cascading for categories P0, P1, and P7. Finally, TPL-008-1 does not preclude the responsible entity from developing Corrective Action Plans for sensitivity cases beyond what is required in the standard.

Requirement R11

The requirement for responsible entities to share Extreme Temperature Assessment results aligns with directives in FERC Order No. 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.

Attachment 1: Extreme Temperature Assessment Zones

The map depicts an approximation of the zones to be used in the Extreme Temperature Assessment and is provided as a visual aid for each Planning Coordinator to identify the zone(s) to which the Planning Coordinator belongs to under Attachment 1. The zone topology is a function of balancing authority jurisdiction and general knowledge of zonal weather patterns, or in some cases, are limited by transmission constraints, or lack of transmission thereof, between zones. The goal of the topology was to split the North American System into several distinct zones that have similar electric power system properties (i.e., balancing authority and interconnections) and similar weather or climatological patterns. Balancing authorities with large areas of jurisdiction, exclusively ISOs and RTOs, are assigned their own weather zone. In geographical areas comprised of multiple balancing authorities, generalized weather zones are created to best represent zonal weather patterns.

The NPCC region of the Eastern Interconnection was divided into New England, New York, Quebec Interconnection, Ontario, and Maritimes. The Planning Coordinators for the NPCC region of the Eastern Interconnection are listed below:

- New England: Planning Coordinators in NPCC that primarily serve the six New England States.
- New York: Planning Coordinators in NPCC that primarily serve New York.
- Quebec: Planning Coordinators that primarily serve Quebec in the NPCC Region.
- Ontario: Planning Coordinators in NPCC that primarily serve Ontario.
- Maritimes: Planning Coordinators in NPCC that primarily serve New Brunswick, Nova Scotia, Prince Edward Island, and the Northern Maine Independent System Administrator (NMISA). The NMISA is responsible for the administration of the northern Maine transmission system and electric power markets in Aroostook and Washington counties, with the load served radially from New Brunswick. It was not included in the New England division since there are no physical transmission ties between NMISA and ISO-NE which is the Planning Coordinator serving the remainder of the six New England States.

Additionally, SERC combined NERC Assessment areas of SERC-East, SERC-Central, and SERC-Southeast into a single zone based on climate similarities. Northwest Regions, WECC-SW, SERC, and SERC-FP were based on balancing authority PNNL data. SPP-N, SPP-S, MISO-N, and MISO-S were aggregated based on county-level PNNL data.