UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

Transmission System Planning Performance	**)**	
Requirements for Extreme Weather	**)**	**Docket No. RM22-10-000**

Comments Regarding the Notice of Proposed Rulemaking on Transmission System Planning Performance Requirements for Extreme Weather

I. Introduction

1. The Electric Power Research Institute (EPRI)[1] respectfully submits these comments (This Response) in response to the Federal Energy Regulatory Commission's (FERC) Notice of Proposed Rulemaking (This NOPR) issued on June 16, 2022, regarding transmission system planning performance requirements for extreme weather. In its role, EPRI conducts research and development relating to the generation, delivery, and use of electric power for the benefit of the public. More specific to This Response, EPRI conducts research in the operations and planning of bulk power systems. While EPRI does not advocate for nor discourage the implementation of specific policies or regulatory rules, we do conduct research and development using unbiased and objective scientific approaches that may lead to improved methods and practices for the planning of bulk power systems and improved reliability and resilience of those systems across a wide variety of operating conditions and electrical consequences, including

[1] EPRI is a nonprofit corporation organized under the laws of the District of Columbia Nonprofit Corporation Act and recognized as a tax exempt organization under Section 501(c)(3) of the U.S. Internal Revenue Code of 1986, as amended, and acts in furtherance of its public benefit mission. EPRI was established in 1972 and has principal offices and laboratories located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass. EPRI conducts research and development relating to the generation, delivery, and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, health, safety, and the environment. EPRI also provides technology, policy and economic analyses to inform long-range research and development planning, as well as supports research in emerging technologies.

extreme weather events. EPRI's comments on the topic of the NOPR are technical in nature based upon EPRI's experience over the last 50 years in technology innovation, planning, and analysis for the electric industry. EPRI's comments address specific questions that are raised by FERC throughout the NOPR, as well as other points that should be considered given the topic of the NOPR. All comments provided reflect only EPRI's opinion and expertise and do not necessarily reflect the opinions of those supporting and working with EPRI to conduct collaborative research and development.

2. The NOPR proposes that the North American Electric Reliability Corporation (NERC) modify the Reliability Standard TPL-001-5.1 (Transmission System Planning Performance Requirements) within one year of the effective date of a final rule in this proceeding to address reliability concerns pertaining to transmission system planning for extreme heat and cold weather events that impact the reliable operations of the Bulk-Power System. The NOPR proposes, more specifically, that the TPL-001-5.1 be updated to require the development of benchmark planning cases based on information such as major prior extreme heat and cold events or future meteorological projections; planning for extreme heat and cold 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 weather conditions and including broad area impacts of extreme weather; and corrective action plans that include mitigation for any instances where performance requirements for extreme heat and cold events are not met. Implementation of these proposed changes will require a decided shift from existing transmission planning practices that are used to meet current planning requirements. Capturing extreme weather conditions, for both heat and cold, requires modeling the temporal response, spatial correlations, behaviors, and uncertainties of both the generation and load that needs to be represented in the power flow snapshots used for transmission planning studies. The current standard allows transmission planners to identify scenarios for planning conditions based on historical performance of the system during key operational periods (e.g., load levels, generator dispatch, etc.), and these scenarios are used as the basis

for determining the limits of reliable system operation under contingencies of specified depth (e.g. N-1, N-1-1, G-1-1, etc.). Capturing the complex dependencies in generation, transmission and load that will be driven by extreme weather will likely require a new transmission planning approach that explicitly considers the temporal evolution of an event, which can be done by first modeling the adequacy and hourly operation of generation in response to temperature-induced variations in load and supply disruptions using steady-state operations tools[2] and then using the results to identify snapshots that are to be studied for transmission planning assessments.

3. Our comments are expressed in detail below in Section II of This Response in order of the applicable questions for which FERC sought comments within the NOPR. We have not addressed all comments requested by FERC, responding only to those for which EPRI's research provides insights on decisions that may have significant impacts on the future of transmission planning methods and processes.

II. Comments in Response to NOPR Questions

4. Based on EPRI's research and extensive history of engagement with utility and RTO/ISO transmission planners, we see the following gaps in current practices that would need to be addressed in order to integrate extreme temperature impacts into the transmission planning process:

i. The benchmark planning cases (i.e., power flow snapshot scenarios), which serve as the basis for steady state and transient stability assessments, have historically been developed without considering the correlated impacts of a common-mode event such as extreme temperature on the level of load to be served and the availability or derated capacity of generation and transmission facilities. Instead, planning cases have been

[2] "Operational Impact of Extreme Weather Events" ISO-NE, NEPOOL Reliability Committee, July 19, 2022 Available: https://www.iso-ne.com/static-assets/documents/2022/07/a06_operational_impact_of_extreme_weather_events.pptx

generally developed using engineering judgment focused on combinations of expected load levels exceeded at defined probabilities (e.g., 90/10, 80/20, 50/50), renewable output levels, and generator maintenance schedules that would establish the "worst-case" operating conditions. Capturing extreme temperature conditions for both heat and cold would require a new approach that directly accounts for the correlated temperature-related impacts to supply and demand. Based on EPRI's experience and research, a multi-model assessment approach is required, which would allow for the temporal aspects of weather impacts to be captured on both load and generation through new methods applied to both resource adequacy assessments and production cost modeling[3]. More specifically, these operational performance models can be developed to capture the generation and demand changes driven by temperature, which can occur over hours, days, and weeks, by modeling the hour-to-hour operation of the power system. As demand characteristics change, historical data may no longer reflect the more complex interactions between load and temperature. The results of the temperature-based resource adequacy and production cost assessments would serve as the input for a scenario selection process that would identify hours that pose significant challenges to the security and stability of the power system. It is these selected hours that could then be used as the basis for the creation of the benchmark power flow snapshots needed as inputs for transmission planning studies. At present, there is no established guidance or set of tools in place that would sufficiently allow for the development of extreme temperature benchmark cases as specified by the NOPR.

[3] "Operational Impact of Extreme Weather Events" ISO-NE, NEPOOL Reliability Committee, July 19, 2022 Available: https://www.iso-ne.com/static-assets/documents/2022/07/a06_operational_impact_of_extreme_weather_events.pptx

ii. Planners will need to differentiate between the system level impacts of extreme temperature on generation and demand (e.g., increases in demand driven by increased air conditioner usage coincident with the derating of thermal plants and transmission lines due to the extreme heat condition), which need to be captured in the initial power flow conditions and will serve as the primary input for the analysis, and those that need to be studied as an acute contingency event (e.g., asset failures driven by a fault or external threat such as wildfire) that will impact the system beyond a change in baseline operating conditions. There are not yet established processes regarding how these differences are to be captured in planning.

iii. While some of the corrective actions can be studies in planning, many corrective action decisions are often based on changes in the operation of the system over specific points in time which may be easily feasible to capture in the planning case.

iv. Extreme heat or cold conditions can create consequences across multiple infrastructure networks and capturing impacts to the bulk power system may require the co-modeling of the coupled infrastructures, specifically natural gas networks[4] and water networks. There is not yet an establish process for how to assess or consider cross-sector interdependencies when determining benchmark impacts.

A. Develop Benchmark Planning Cases Based on Major Prior Extreme Heat and Cold Weather Events

5. As discussed in Paragraph 4 of This Response, developing benchmark planning cases for future extreme heat or cold weather events requires capturing the future states of the bulk power system under extreme operating conditions. While major prior extreme heat or cold weather events can provide insight

[4] *Exploring the Impacts of Extreme Events, Natural Gas Fuel and Other Contingencies on Resource Adequacy*, EPRI, Palo Alto, CA: 2021. 3002019300

into the expected short-term performance and planning requirements for a given system, rapid changes in future generation and demand profiles will require more comprehensive and integrative planning processes[5]. Preparing for a range of plausible extremes in the coming years potentially requires the integration of future meteorological projections into resource adequacy and production cost models to identify high risk operating conditions to be studied in power flow and transient stability. Understanding how future extreme temperature events may impact generation and transmission performance and demand profiles – both in a given system and across a wider region of neighboring systems – would likely require a temporal representation of the system's operation as is captured in most resource adequacy and production cost assessments, where the hour-to-hour operation of the system's generation in response to variations in load and demand is modeled, often along with the transmission constraints of the system. As mentioned in the NOPR, temperature extremes will impact the availability and efficiency of generation as well as the concurrent demand profiles across an operating area. Based on the geographic extent of the event, these impacts may also extend into neighboring areas, potentially amplifying stressors on the system of interest. EPRI research indicates that these impacts cannot be sufficiently captured through static changes to a series of snapshot conditions as is current practice[6]; instead, based on EPRI's experience, they require assessment methods that capture the temporal and operational impacts of generation and load across representative geographic footprints provided by tools such as resource adequacy assessments and production cost analyses.

6. The current transmission planning (TPL) standard TPL-001-5 from the North American Reliability Corporation (NERC) focuses on capturing peak and off-peak conditions over a five-year time horizon. These cases are generally constructed based on modifications to the historical peak and off-peak

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[5] *Resource Adequacy for a Decarbonized Future*, EPRI, Palo Alto, CA: 2021. 3002022192

[6] "Operational Impact of Extreme Weather Events" ISO-NE, NEPOOL Reliability Committee, July 19, 2022 Available: https://www.iso-ne.com/static-assets/documents/2022/07/a06_operational_impact_of_extreme_weather_events.pptx

conditions identified by the planning entities. As mentioned in Paragraph 4, probabilities of exceeding targeted demand levels are used as modifiers to the historical cases. These year-to-year changes for peak and off-peak cases are typically incremental, allowing planners to make straightforward adjustments to the power flow scenarios that then capture impacts of load growth and allow for the inclusion of new generation and the decommitment of retired generation. Based on the current requirements of the standard, resource adequacy assessments that study a range of weather years and outage draws or production cost models that simulate detailed operations in one or more years are not required pre-requisites for the development of these power flow scenarios.

7. Given that the practice of including extreme heat and cold events has not been an analysis approach used in traditional transmission planning assessments, there is a need to establish common practices that entities can apply to identify extreme temperature conditions to use as the basis for analysis. Our research has shown that in order to best identify and represent critical future extreme temperature conditions and subsequent impacts to the power sector, a multi-model approach is required. This approach allows planners to link results from resource adequacy or production cost analyses to the identification and development of power flow case snapshots for transmission planning studies. While resource adequacy and production cost modeling assessments may not be explicitly required in the TPL-001-5 update, the development of future planning cases will need to be informed through some level of operational simulation or study in order to capture the necessary interactions between weather impacts and the power system. Establishing common approaches and identifying best practices can provide planning entities with critical guidance toward the development of benchmark cases for extreme temperature events.

B. Transmission System Planning for Extreme Heat and Cold Weather Events

8. In this section of the NOPR, FERC highlights six different topics to be addressed by NERC during the update of the Reliability Standard pursuant to the proposed directive: (1) steady state and transient

stability analysis; (2) transmission planning studies of wide area issues; (3) concurrent generator and transmission outages; (4) sensitivity analysis; (5) consideration of modifications to the traditional planning approach; and (6) coordination among planning coordinators and transmission planners and sharing of results. FERC asks for comments on these six topical areas to inform the NERC directive as part of the final rule. In this section of This Response, we provide comments to be considered for the technical implementation of the NOPR requests.

B.1 Steady State and Transient Stability Analyses

9. In this section of the NOPR, FERC seeks comments on the set of contingencies planning coordinators must consider as part of assessing extreme temperature events. In transmission planning assessments, as prescribed by the TPL-001-5, planners evaluate the steady state and transient stability impacts of contingency events driven by the network topology and protection systems across seven different categories (P1-P7)[7] for the selected power flow snapshots. Evaluating all categories of these contingencies may provide insight into which events could result in stability impacts that cause consequential load shed during the extreme temperature condition.

10. Additionally, the TPL-001-5 identifies wide area events to be studied in steady state[8]. These wide area events include wildfires and severe weather events that are evaluated for the peak and off-peak conditions currently studied as part of the existing standard. These wide area events are generally studied as acute contingencies that result in the loss of multiple power system elements. Related, in Section B.2 of the NOPR, FERC directs planners to consider the impacts of wide area events. Although possibly intended, we suggest that FERC clarify the explicit need to study extreme event contingencies concurrently with the extreme temperature condition over a wide area. More specifically, is the wide area

[7] *See* Reliability Standard TPL-001-5, Table 1 – Steady State & Stability Performance Planning Events

[8] *See* Reliability Standard TPL-001-5, Table 1, Section 3.a, Steady State & Stability Performance Extreme Events

event intended to be captured in the initial conditions of a power flow snapshot, or is it intended to be studied as a discrete contingency event in steady-state and dynamic stability assessments?

11. Additionally, any dynamic simulation of extreme events would require significant representation of protection systems to provide for convergence of the numerical simulation[9]. Currently, there is limited modeling of protection systems in dynamic assessments. Dynamic models of variable energy resources (VER) would also have to be sufficiently robust to accurately capture system performance under extreme temperature and potential low short-circuit current conditions on the bulk transmission system[10].

12. Steady state simulation cannot sufficiently capture demand response, and there is limited capability to capture the aggregated dynamic response of demand in the load models used in positive sequence platforms. EPRI research has shown, on aggregate, the impacts of demand response are better represented through appropriate temporal and diurnal patterns that would inform the load and demand profile under a given extreme temperature condition. This information is best represented in operational assessments such as resource adequacy or production cost modeling. Using profiles that capture the impacts of demand response and developing initial power flow conditions for analysis in steady state and dynamics would ensure that planning decisions are fully informed on this basis. This is the focus of discussion in Paragraph 16 of This Response.

B.2 Transmission Planning Studies of Wide-Area Events

13. In this section of the NOPR, FERC aims to identify the scope and impact of wide-area events that should be studied and included in the TPL-001-5 update. Key to this decision is the definition of what constitutes a wide area event. More specifically, further clarification is needed to differentiate between events that impact the initial conditions of the benchmark scenario for which the contingency events will

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[9] *Model User Guide for Generic Renewable Energy System Models,* EPRI, Palo Alto, CA. 2018. 3002014083
[10] Ramasubramanian, D., Wang, W.,Pourbeik, P.,Farantatos, E., Gaikwad, A., Soni, S.,Chadliev, V., "Positive sequence voltage source converter mathematical model for use in low short circuit systems," IET Generation, Transmission, & Distribution, Vol. 14, Issue 1, Jan. 2020.

be analyzed, and the actual contingencies meant to be captured as acute impacts to the system that occur over a wide area and can be studied through the steady state and transient stability processes.

14. The NOPR asks "that study criteria for extreme heat and cold events include a consideration of wide area conditions affecting neighboring regions and their impact on one planning area's ability to rely on resources of another during the weather event." To accomplish this in a transmission planning assessment, entirely new initial conditions will likely need to be defined in order to capture generator unavailability and subsequent changes in inter-regional power flows across the geographic footprint impacted by the extreme temperature condition. This constitutes a major change in transmission planning methods, and, while analytically possible, it is far more complex than traditional approaches. In transmission planning analyses, we can capture the near-instantaneous impacts of generator outages and other switching events using specialized algebraic and differential models that represent the fast-moving equipment in power systems for steady state and dynamic assessments, respectively. These impacts are generally localized to the region under study and occur in the millisecond to second timeframes. Generation unavailability spread over a large geographical footprint is not a phenomenon that can be captured and quantified solely through a snapshot power flow assessment. The relationship between weather and the power system requires a simulation process that is able to capture the spatial and temporal impacts across hours and days as the temperature event evolves. This capability can be developed using resource adequacy and production cost modeling tools, which already capture the diurnal interactions between generation and flow and how those impacts manifest as exchanges in flow across regions over a defined time period (e.g., days, weeks, months, or a year).

15. To accurately represent these interactions, an operational assessment, resource adequacy, or production cost model analysis may be required prior to identifying the snapshot conditions that should serve as the primary inputs to the transmission planning assessments. If an extreme weather event occurs over a period of days, there may be multiple hours during that event that present different reliability

challenges. Scaling or adjusting a single historical snapshot to represent these conditions may not be feasible and could result in a significant loss in accuracy.

16. As more temperature-dependent load interconnects to the system, extreme weather is likely to drive significant changes in load profiles. Increased use of electric heating or cooling, demand side response, and electric vehicle and home battery energy system charging and discharging are examples of behind-the-meter behavior that may drive significant changes in the load as weather extremes increase. Capturing these interactions through modifications to a static historical power flow snapshot may fail to capture the complexities involved. Instead, using the results of operational simulations or analyses is expected to result in more realistic adjustments or development of the power flow initial conditions. The development of standardized methods or practices on how operational behavior and weather interactions should be modeled in adequacy or production cost assessment to accurately capture hourly commitments and dispatches of generation and load can provide critical guidance and can support the development of new planning methods that will integrate weather data into power system modeling tools.

17. Additionally, new methods and processes will need to be developed to identify the specific hours that should serve as the initial conditions for the development of extreme temperature benchmark cases. For extreme temperature conditions, ensuring that the extreme temperature event is modeled and captured operationally is critical. The extreme event window is likely to have multiple potential hours with varying dispatches, commitments, and demand levels that will pose challenges to system reliability and resilience. System operators may also adjust the size and location of reserves to reduce the impact of individual contingencies on system risk, which would need to be captured in any power flow cases[11]. Planners will need to develop tools and processes so that power flow cases can be identified and built around these hours and studied adequately in widely used planning tools.

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[11] Mieth, R., Dvorkin, Y., & Ortega-Vazquez, M. A. (Accepted/In press). Risk-Aware Dimensioning and Procurement of Contingency Reserve. *IEEE Transactions on Power Systems*, 1. https://doi.org/10.1109/TPWRS.2022.3174343

18. The answers to the questions posed in this section of This Response will play a critical role in providing the foundation for the comments to which FERC seeks a response in Paragraph 67 of the NOPR. More specifically, geographic definitions of wide area events will need to be developed for inclusion in resource adequacy or production cost models for the reasons discussed in Paragraphs 15 and 16. In contrast, wide area events defined electrically can be used to represent acute switching events that occur over much shorter timescales and can be used to capture discrete impacts defined as contingency events, which occur concurrent with the extreme temperature condition. From a reliability and resilience perspective, evaluating both the geographic and electrical aspects of wide area events is critical to developing comprehensive long-term planning strategies.

19. Given EPRI's position as an objective, non-biased, scientific organization, we will not provide direct comments as to the need or methods with which entities should coordinate or share data; rather, we will again refer to the discussion from Paragraphs 15 and 16 that highlights the modeling requirements to capture weather-driven impacts across generation and load. For accurate assessments of wide area events that impact geographic footprints across multiple planning entities, it is clear some level of coordination will be needed. Lastly, we will address the needs and requirements for the development of corrective action later in This Response, specifically in Section C.

B.3 Study Concurrent Generation and Transmission Outages

20. In this section of the NOPR, FERC discuss the need to capture concurrent generation and transmission outage events as part of planning assessments in order to determine the impacts on availability and deliverability of power across a system impacted by extreme heat or cold. Extreme temperatures, and in particular extreme heat, will reduce generation efficiency and availability as discussed in Section B.2 of This Response, and these operational constraints can be represented through resource adequacy or production cost model analysis. Extreme heat impacts to transmission lines and transformers, which may result in reduced capacities for flow of power across the system, will need to

first be represented as adjustments to the maximum ratings used to define thermal constraints in dc power flow equations within the operational models. These same limits need to then be reflected in the initial conditions of the study system in the ac power flow models used in planning studies for the hours selected to represent challenging extreme heat conditions. Again, EPRI research suggests that a multi-model approach is required to accurately capture and reflect system conditions inclusive of generation, demand, and the associated weather impacts.

21. If FERC intends for the concurrent outages of generation and transmission assets to be modeled as an acute event, clarification needs to be provided as to how this event would differ from the P3 category of contingency events from the TPL-001-5[12]. The P3 category asks planners to study the impacts of a loss of generation followed by the loss of another element including: (1) generator, (2) transmission circuit, (3) transformer, (4) shunt device, or (5) single pole of a dc line. Given that these events are currently studied in planning assessments, including concurrent loss of generation and transmission as a discrete contingency event is unnecessary.

B.4 Sensitivity Analysis

22. In this section of the NOPR, FERC seeks comments regarding the required sensitivity analysis across the planning horizon of the extreme weather events. As discussed throughout This Response, snapshot-based assessments developed using traditional transmission planning methods will not sufficiently capture the scope and scale of impacts from extreme temperature events. Referring to Paragraph 15 of This Response, EPRI research suggests that multiple hours may need to be studied over the course of the extreme temperature window in order to capture sensitivities related to generation and demand that can lead to differing steady state and dynamic stability impacts. This analysis approach lends itself to an informed sensitivity analysis that reflects the varying operational impacts that may result in significant reliability and resilience challenges to the transmission system.

[12] Reliability Standard TPL-001-5, Table 1 – Steady State & Stability Performance Planning Events

23. In addition to the sensitivities driven by the operational performance of the system, it may be beneficial to consider the inclusion of other external drivers that may compound system conditions during the extreme temperature events. As a specific example, it may prove valuable for a sensitivity case under extreme heat conditions to consider the impacts of a concurrent lull in wind speeds that would limit wind generation outputs. Correlating additional weather impacts during extreme temperature conditions will be required, and examples of such conditions can be seen with the ERCOT Conservation Appeal issued July 13, 2022[13]. Here, record-high demand was coincident with low wind output, forced thermal outages, and cloud cover over solar generation in West Texas, all during a period of sustained high temperatures. Understanding the planning implications of such scenarios is critical.

B.5 Modifications to the Traditional Planning Approach

24. Throughout this response we have emphasized the need to capture extreme temperature events using analysis approaches that are traditionally not applied during transmission planning assessments and evaluations. In futures where uncertainty and variability will increase on both the generation and demand side across a variety of temperature extremes, traditional deterministic approaches may not be sufficient to capture scenarios or systems conditions that result in consequential stability implications. Therefore, probabilistic or risk-informed processes may need to be established for identifying and selecting scenarios to serve as the inputs for transmission planning assessments, and guidance may need to be issued for using said scenarios in probabilistic approaches.

25. Transitioning to a risk-informed approach will require new processes to link and pass data across models in order to capture power system operation and behavior across different timeframes, e.g., linking generation and transmission expansion assessments, resource adequacy, production cost models, and transmission planning assessments[14]. Additionally, new statistical methods and processes

[13] ERCOT New Release, *"ERCOT Issues Conservation Appeal to Texans and Businesses,"* Wednesday, Jul 13, 2022, https://www.ercot.com/news/release?id=8926f1a4-4e8f-9dfb-e393-7d6609eda6a3
[14] EPRI Integrated Strategic System Planning Initiative. https://www.epri.com/issp

will need to be applied to inform and support the selection of multiple power flow snapshots for planning assessments. Common guidelines can help facilitate the development of approaches that can be used to determine transmission planning scenarios for which the events defined in the NERC TPL-001-5 can be evaluated. This can enable reliability and promote resilience by considering system performance across more cases that capture greater levels of variability and uncertainty for future system years.

B.6 Coordination Among Planning Coordinators and Transmission Planners and Sharing of Results

26. EPRI will not comment on mechanisms for increasing coordination among planning entities, coordinators or transmission planners.

C. Implement a Corrective Action Plan If Performance Standards are Not Met

27. This section of the NOPR highlights potential options for implementing corrective actions to mitigate instances where performance requirements are not met for extreme heat and cold events. The NOPR cites a variety of different options including *"planning for additional contingency reserves or implementing new energy efficiency programs to decrease load, increasing intra- and inter-regional transfer capabilities, transmission switching, or adjusting transmission and generation maintenance outages based on longer-lead forecast."* Particular focus is given to the increase in inter-regional transmission as a mitigation measure. While we agree that increasing transmission transfer capability across broader areas can provide increased reliability and resilience, relying on and developing long-term plans based on the availability of such transmission may not always be feasible. Coordination to provide the necessary inter-regional transfer capability will require accurate forecasts over large operating areas. This, combined with information sharing, may facilitate the delivery of the transfers when the impacted areas are facing shortfalls of generation driven by the extreme temperature conditions. This type of assessment is generally completed outside of the transmission planning process. Planning entities can identify impacts that are driven by increased transfer capability for the studied extreme temperature

scenarios, but developing specific corrective actions plans based on that capability through the transmission planning process might not be reflective of the actions or processes that need to occur in order to provide for system security during the actual weather event. We suggest that local measures of mitigation be considered in parallel while working toward increasing inter-regional transfer capability[15].

28. Additionally, we would like to highlight other corrective actions that can be implemented outside of the transmission planning process[16]. Asset hardening in particular may provide additional avenues for risk mitigation. For example, undergrounding transmission lines in high-risk wildfire areas could increase transmission availability under extreme temperature and high fire risk conditions. Weatherizing generation facilities can increase availability across a broad set of operating conditions, such as extreme cold and potential icing associated with it. Identifying and evaluating asset vulnerabilities to climate and weather threats, which are often unique to the asset class or hazard type, is a critical risk mitigation and corrective action measure that should be considered and reflected in the power flow condition used to complete the planning evaluation.

D. Other Extreme Weather-related Events and Issues

29. In the final section of the NOPR, FERC asks whether other weather-related events should be considered for transmission planning assessments. While some severe weather events can occur concurrently with extreme temperature conditions and can pose additional challenges to reliable system operation, it is critical to note that not all systems will face the same type of weather-related events or issues. For example, the threat of drought concurrent with an extreme heat condition may be felt more acutely in the Western U.S. than in the Northeastern U.S. Thus, the inclusion of other, specific weather-related event types will not be relevant across all planning entities. Additionally, some of the weather-

[15] LADWP Climate Assessment and Transmission Resilience Analysis: Highlights, EPRI, Palo Alto, CA: 2021. 3002023326

[16] A Starting Point for Physical Climate Risk Assessment and Mitigation: Future Resilience and Adaptation Planning, EPRI, Palo Alto, CA, 2022: 3002024895

related events will occur independent of the temperature conditions, e.g., hurricanes or flooding. As such, it is more appropriate to identify climate and weather-related threats that occur concurrently or independently based on the geographic region of the transmission system and to develop planning scenarios accordingly[17]. Therefore, it would be useful to develop guidance on how to characterize and capture the impacts of additional weather-related issues based on the local conditions of the operating footprint. It is prudent for planning coordinators to examine the hazards most prevalent in their regions and to assess whether impacts may worsen in the future. Depending on their findings, entities may decide to address additional vulnerability assessments to best plan for reliable and resilient operations against the relevant weather threats.

III. Conclusions

30. Throughout This Response, we have emphasized the importance of robust analysis and assessment methods that will be critical to the development of representative scenarios for extreme heat and extreme cold conditions that may impact transmission systems in the future. EPRI research indicates that this process must include accurate resource adequacy and production cost modeling so that the variability and uncertainty of generation, demand, and weather conditions across a large geographical region and suitable temporal horizon are sufficiently captured and used to develop power flow scenarios that represent potential system operation and performance in the future. This approach may require the development of probabilistic methods or alternative approaches that are currently beyond the scope of what is required in the NERC TPL-001-5. New planning processes and tools will need to be developed for entities to identify and create the appropriate extreme weather scenarios that planners need to study as part of transmission planning assessments. These processes and tools should allow for flexibility to account for the varying needs and nature of planning entities across the United States.

[17] LADWP Climate Assessment and Transmission Resilience Analysis: Highlights, EPRI, Palo Alto, CA: 2021. 3002023326

31. Lastly, given in EPRI's role as a nonprofit, collaborative research institute focusing on energy, we are collaborating with many of the transmission entities that will need to implement these standard changes on processes to consider extreme weather impacts[18]. As we have iterated throughout This Response, many of the proposed changes to the TPL-001-5 would require the application and development of new tools, methods, and processes to allow for the critical extreme temperature cases to be captured for transmission planning assessments. Most of these methods are not currently applied by planners, and there may be a steep learning curve across the transmission planning entities given the different types of planning entities that will need to implement this standard change; regional transmission organizations/independent system operators (RTO/ISO) and vertically integrated utilities have access to data and tools that may allow for more straightforward implementation compared to rural cooperatives or transmission-only entities. Standardizing the development of scenario requirements may pose different challenges and burdens across the various transmission owning and planning entities across the United States. Implementing a standard change in a period of 12 months from rule creation may prove challenging given where transmission planners, tools, and practices are today.

32. EPRI appreciates the opportunity to provide comments on these important topics to FERC. EPRI looks forward to working with its members, FERC, and other stakeholders to facilitate the development of an improved assessment process that can be applied in a robust and accurate manner to provide for better system reliability and improve resilience to extreme temperature events in the future.

[18] A Starting Point for Physical Climate Risk Assessment and Mitigation: Future Resilience and Adaptation Planning, EPRI, Palo Alto, CA, 2022: 3002024895

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