UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Grid Resilience in Regional Transmission Organizations and Independent System Operators	Docket No. AD18-7-000

COMMENTS OF SOUTHWEST POWER POOL, INC. ON GRID RESILIENCE ISSUES

I. INTRODUCTION

Southwest Power Pool, Inc. ("SPP") appreciates the opportunity the Federal Energy Regulatory Commission ("Commission") has provided in this proceeding[1] to share information regarding SPP's practices and experiences relevant to supporting the resilience of the bulk power system ("BPS").[2] SPP provided initial and reply comments in the Commission's Docket No. RM18-1-000, and SPP agrees with the Commission's approach in initiating the above-captioned proceeding to specifically evaluate the resilience of the BPS in the regions overseen by Regional Transmission Organizations ("RTOs") and Independent System Operators ("ISOs"). SPP also urges the Commission to continue its holistic approach and consider the roles and relationships all participants in the electric industry, not just RTOs and ISOs, have with respect to the resilience of the BPS.

SPP is an Arkansas non-profit corporation with its principal place of business in Little Rock, Arkansas. Founded in 1941 to support an Arkansas aluminum plant necessary for critical defense needs in World War II, SPP's members decided to maintain SPP's existence after the war because of the recognized reliability and coordination benefits it provides. Today, SPP has 95 Members, including 16 investor-owned utilities, 14 municipal systems, 20 generation and transmission cooperatives, 8 state agencies, 14 independent power producers, 12 power marketers, 10 independent transmission companies, and 1 federal agency.

As an RTO, SPP administers open access transmission service over approximately 65,000 miles of transmission lines, covering portions of Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, New Mexico, North

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[1] *Grid Resilience in Regional Transmission Organizations and Independent System Operators*, 162 FERC ¶ 61,012, at P 23 (2018) ("January 8 Order").

[2] For purposes of these comments, SPP will use the term "BPS" to reflect the usage of that term in the Federal Power Act and in the Commission's questions in this proceeding. SPP notes, however, that many of its policies and procedures discussed in these comments refer to the "Bulk Electric System" due to that term's usage in NERC reliability standards.

Dakota, Oklahoma, South Dakota, Texas, and Wyoming, across the facilities of SPP's transmission owners.[3] SPP also administers the Integrated Marketplace, a centralized day ahead and real-time Energy and Operating Reserve market with locational marginal pricing and market-based congestion management.[4]

In 1968, SPP became a founding member of what is now the North American Electric Reliability Corporation ("NERC"). SPP began providing full-time regional security coordination services to its footprint in 1997, and SPP continues in the role of Reliability Coordinator for NERC today. As Reliability Coordinator, SPP monitors power flow throughout the SPP footprint and stands ready to coordinate regional response to emergency events.

II. COMMENTS IN RESPONSE TO THE COMMISSION'S QUESTIONS REGARDING RESILIENCE.

1. <u>A Common Understanding of Resilience</u>

SPP agrees it is important to define the concept of resilience in order to have a discussion grounded in a common understanding of the subject matter and goals. In the January 8 Order, the Commission stated its current understanding of resilience as follows:

> The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event.[5]

SPP believes the foregoing definition is a reasonable way to capture the concept of resilience. SPP also notes that the Commission's definition is consistent with the "framework" that NERC is using to discuss resilience. The NERC Board of Trustees tasked its Reliability Issues Steering Committee ("RISC") to develop such a framework, with a goal of identifying aspects of resilience and how various organizations and industry sectors view it. In a draft issued in February 2018, the RISC proposed an overall resilience framework with three components that can be summarized as follows: (1) develop a common understanding and definition of resilience, (2) understand how resilience fits into the existing NERC framework, and (3) evaluate whether NERC should take additional steps to address resilience.

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3 *See Sw. Power Pool, Inc.*, 89 FERC ¶ 61,084 (1999); *Sw. Power Pool, Inc.*, 86 FERC ¶ 61,090 (1999); *Sw. Power Pool, Inc.*, 82 FERC ¶ 61,267, *order on reh'g*, 85 FERC ¶ 61,031 (1998).

4 *Sw. Power Pool, Inc.*, 146 FERC ¶ 61,130 (2014) (Order approving the start-up and operation of the Integrated Marketplace effective March 1, 2014.).

5 January 8 Order at P 23.

For the first component of that larger framework, defining resilience for a common understanding, the RISC identified as helpful another more specific framework developed in 2010 by the National Infrastructure Advisory Council ("NIAC").[6] As summarized by the RISC, the NIAC framework includes four characteristics of resilience:

1. Robustness – the ability to absorb shocks and continue operating;
2. Resourcefulness – the ability to skillfully manage a crisis as it unfolds;
3. Rapid Recovery – the ability to get services back as quickly as possible; and
4. Adaptability – the ability to incorporate lessons learned from past events to improve resilience.

SPP finds these four concepts to be appropriate characteristics by which to consider resilience, and these concepts will be reflected throughout SPP's descriptions of its practices in response to the Commission's questions below.

In general terms, SPP approaches resilience in terms of (1) resolving potential problems before they have a chance to disrupt daily operation of the BPS and (2) restoring daily operation as quickly and seamlessly as possible in the event a disruption does occur. SPP plans and directs the construction of transmission facilities to meet NERC reliability standards and to facilitate the development of projects that will create economic and resilience benefits for the region. The construction of new transmission facilities pursuant to modern design standards enhance the robustness of the system. SPP supports resourcefulness by continually evaluating risk and upgrading equipment, tools, and procedures accordingly. This ongoing evaluation and adjustment facilitates rapid recovery by minimizing the extent and impact of disruptions. SPP's approach remains adaptive as well, as it is based on historical experience (SPP's experience as well as broader industry experience) in BPS operations combined with forward-looking evaluation of new risks and evolving technologies used in the industry.

SPP recognizes that many of the practices that support resilience also support reliability. Whereas reliability is often discussed in terms of maintaining power availability in the relatively near term, resilience implicates a longer-term, more holistic view. In the context of operating the BPS, reliability and resilience are distinct, yet complementary, concepts. Indeed, as reflected by certain portions of SPP's responses to the Commission's questions, a well-thought-out discussion of resilience may often require reference to reliability-centered practices and principles.

SPP's responses to the questions the Commission has posed to RTOs/ISOs are below.

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[6] *See*, *generally*, the NIAC's Final Report and Recommendations, entitled "A Framework for Establishing Critical Infrastructure Goals," (October 19, 2010).

2. <u>How RTOs/ISOs Assess Threats to Resilience</u>

(a) What are the primary risks to resilience in your region from both naturally occurring and man-made threats? How do you identify them? Are they short, mid, or long-term challenges?

In SPP's region, weather events are the primary naturally occurring risks to resilience, including severe events such as tornadoes, which can destroy significant portions of the BPS. SPP has also experienced drought conditions, which could result in impacts to hydroelectric generation and to supplies of cooling water for thermal generation. The SPP region can also experience ice storms that can result in significant BPS outages. Other potential naturally-occurring issues include (1) upper-atmosphere instability resulting in sudden ramping of wind generation (2) unseasonably high temperatures resulting in high loading during generators' scheduled maintenance periods, (3) flooding of substations and power plants near waterways, (4) electromagnetic pulse ("EMP") or geomagnetic disturbance ("GMD") events that damage control systems and/or protection systems of multiple substations, (5) grass fires, and (6) severe earthquakes damaging infrastructure.

As for human threats, vandalism, which is usually localized in terms of impact, could conceivably be attempted on a larger scale, and SPP must therefore consider its potential for high impact to the BPS. Vandalism or sabotage events can include cyber-attacks impacting SPP critical systems or infrastructure, sabotage of substations or transmission lines, and damage to communication infrastructure. Other potential human-caused issues include fires in Control Centers and software errors or limitations causing malfunction of critical systems.

In periods of extreme demand for electricity, it is critical that there is enough capacity online at all times, taking into account the potential for planned and unplanned generation outages, the variability of the load, and the variability of any renewable resources on the grid. The risks associated with generation capacity shortages can arise from a number of causes. Equipment failure is a particular concern for facilities requiring long lead times (months and sometimes years) for repair or replacement, as the BPS can be left vulnerable during extended periods of facility outages. Additionally, fuel supply disruption can be a concern for thermal resources. A coal generator can be vulnerable to disruptions to fuel transportation and delivery, and multiple generators could be impacted by a disruption to gas supply or other fuel received via pipeline. While renewable resources provide low-cost energy to the footprint, forecasting their output poses a challenge for grid operators who must operate their system in real-time and plan for the system's long-term needs. Another cause of capacity shortage risk is generation retirement resulting from evolving market forces and regulatory requirements making it less economically feasible for some generating plants to continue operating.

Lack of fleet diversity and any resulting over-dependence upon any particular fuel type also poses a potential capacity shortage risk. This risk has thus far been minimal in SPP because of operations and planning practices SPP has developed in the interest of resourcefulness. SPP's fuel-indifferent approach to planning the Transmission System has led to the approval and development of over $10 billion in transmission infrastructure investment. This additional transmission has enabled resources of all fuel types to help meet customer demand during a range of potential threats to reliability and resilience.

SPP identifies potential risks in its role as a NERC-registered Planning Coordinator ("PC") and plans the Transmission System for robustness (the ability to absorb shocks that enable it to continue operations). As PC, SPP has coordinated with the Transmission Planners within its PC footprint to identify the potential for lower frequency (e.g., N-2) Extreme Events as that term is defined in Table 1 of NERC reliability standard TPL-001-4 (Transmission System Planning Performance Requirements). While certain categories of the TPL-001-4 Extreme Events pertain mainly to local area events (e.g., events within a certain power station or transmission switching station), there are categories that envision wide-area impacts that cause the loss of at least two generating stations.[7] The TPL-001-4 standard also requires PCs to review the state of equipment with long lead times—that is, equipment that would take more than one year to replace. SPP reviews the long-lead equipment in its PC footprint annually.

With regard to the aforementioned risk of generation capacity shortage, SPP performs a Loss of Load Expectation ("LOLE") study bi-annually as part of its resource adequacy process to evaluate the adequacy of its reserve margin requirements. The LOLE study accounts for factors such as load forecast variability, generator outage probability, expected output from renewable resources, and robustness of the Transmission System. SPP also identifies threats through consultations with organizations such as NERC and the North American Transmission Forum ("NATF"), neighboring Reliability Coordinators, Regional Entities, and SPP stakeholder groups. Other means by which SPP monitors for potential threats to resilience include seven-day weather forecasts and the Reliability Coordinator Information System ("RCIS"). Based on SPP's observations, the foregoing challenges can occur and persist on a short-, mid-, and long-term basis.

(b) How do you assess the impact and likelihood of resilience risks?

SPP currently assesses potential resilience risks by working with its member Transmission Planners and Generator Owners to complete the Annual Planning Assessment pursuant to NERC reliability standard TPL-001-4 and the bi-annual LOLE

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[7] Such events include: (1) loss of a large gas pipeline into a region that has significant gas-fired generation, (2) loss of the use of a large body of water as the cooling source for generation, (3) wildfires, (4) severe weather such as hurricanes and tornadoes, (5) successful cyberattack, and (6) shutdown of a nuclear power station.

study. SPP uses operational experience from past events to better prepare for and assess impacts of future events. SPP also uses weather, load, wind, and solar forecasts to assess resilience risks. The advance notice such forecasts can provide facilitates assessment of potential impacts and planning for any preemptive actions needed to maintain resilience. SPP utilizes a combination of past operational experience, forecasting, and planned system topology in identifying possible generation and transmission unplanned outages beyond N-1 situational operational planning. To assess the impact and likelihood of cyber-attacks, SPP participates in and facilitates sharing of cyber-security information via the Electricity Information Sharing and Analysis Center ("E-ISAC"), the SPP Security Working Group,[8] the ISO/RTO Council's Security Working Group, and in consultation with subject matter experts in the cyber-security industry.

(c) Please explain how you identify and plan for risks associated with high-impact, low-frequency events (e.g., physical and cyber-attacks, accidents, extended fuel supply disruptions, or extreme weather events). Please discuss the challenges you face in trying to assess the impact and likelihood of high-impact, low-frequency risks. In addition, please describe what additional information, if any, would be helpful in assessing the impact and likelihood of such risks.

SPP has documented operational plans and procedures for immediate response to events that happen in real time but cannot be predicted with high probability on a near-term basis (e.g., physical attacks, certain natural disasters, software issues, or communication disruptions). SPP also has documented plans and procedures for preemptive response to forecasted events or events that are more likely to occur (e.g., tornadoes, wind ramping, ice storms, extreme temperatures, or flooding). For identified high-impact, low frequency cyber risks, SPP has used controls frameworks including the National Institute of Standards and Technology ("NIST") Cyber Security Framework and the Center for Internet Security ("CIS") Top 20 Controls. After benchmarking comparisons with the practices of its peers, SPP has implemented best practices such as incident response arrangements with a recognized third party and cyber mutual assistance agreements with other utilities to help SPP respond to and recover from cyber incidents.

The type of information that would aid SPP's assessments of potential events may vary based on the nature of the event. For weather-related events, SPP sees benefits in sophisticated software systems based on probabilistic analysis and adequate historical data that can help with a realistic determination of whether to implement a plan on a day-ahead or multi-day-ahead basis. For events that could lead to prolonged fuel shortage

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8 The Security Working Group ("SecWG") was previously called the SPP Critical Infrastructure Working Group. The SecWG is a stakeholder "forum for discussing security issues, establishing security policies and procedures, sharing best practices for SPP member-common resources, and will service as the interface between the NERC Critical Infrastructure Protection Committee (CIPC) and the SPP membership." (*see* SecWG working group charter posted at: https://www.spp.org/documents/56186/secwg%20charter_20171205.pdf).

(coal, gas, oil) of power plants, SPP sees benefits in having access to relevant information including on-site fuel supply storage, access to emergency fuel supply, and outage timeframes for power plants in maintenance. For cyber events, SPP will continue to develop relationships to obtain threat intelligence and information on trends that impact its resilience plans. Information of this nature could be gained through greater involvement in Department of Homeland Security state fusion centers,[9] law enforcement organizations, and other government-sponsored programs.

(d) Should each RTO/ISO be required to identify resilience needs by assessing its portfolio of resources against contingencies that could result in the loss or unavailability of key infrastructure and systems? For example, should RTOs/ISOs identify as a resilience threat the potential for multiple outages that are correlated with each other, such as if a group of generators share a common mode of failure (e.g., a correlated generator outage event, such as a wide-scale disruption to fuel supply that could result in outages of a greater number of generating facilities)? The RTOs/ISOs should also discuss resilience threats other than through a correlated outage approach. Do RTOs/ISOs currently consider these types of possibilities, and if so, how is this information used?

SPP supports further discussion on which types of extreme scenarios should be considered in studies that RTOs perform to assess adequacy of plans, procedures, measures, reserves, fuel diversity etc. The goal should be a balanced approach that evaluates levels of resilience in light of the probability of particular events in each RTO's footprint. Depending on their identified probability in a particular organization's footprint, correlated events could be an important subject of study. SPP has plans, processes, and procedures for a variety of conditions, circumstances, and events, including events that can occur with little warning or no warning at all. SPP is constantly assessing the effectiveness and robustness of its prevention plans that are implemented to lower the risk of being severely impacted by threats that are evolving over time.

(e) Identify any studies that have been conducted, are currently in progress, or are planned to be performed in the future to identify the ability of the bulk power system to withstand a high-impact, low-frequency event (e.g., physical and cyber-attacks, accidents, extended fuel supply disruptions, or extreme weather events). Please describe whether any such studies are conducted as part of a periodic review process or conducted on an as-needed basis.

Currently, as discussed in response to preceding questions, SPP's primary methods of assessing the impact of resilience risks are the Annual Planning Assessment (pursuant to NERC reliability standard TPL-001-4) and the bi-annual LOLE Study. SPP

[9] For information regarding fusion centers, see https://www.dhs.gov/state-and-major-urban-area-fusion-centers (February 9, 2018).

works with its member Transmission Planners and Generator Owners to complete these analyses. In addition, SPP performs expansion planning through the SPP Integrated Transmission Planning ("ITP") process.[10] In the ITP process, SPP identifies needed transmission infrastructure to address reliability, economic, and public policy needs. The transmission infrastructure requirements that are identified through the ITP process are intended to ensure that low cost generation is available to load, but the requirements also support resilience in that needs are identified beyond shorter-term reliability needs.

For example, the ITP identified the need for a number of 345 kV transmission lines connecting the panhandle of Texas to Oklahoma. These lines were identified as being economically beneficial for bringing low-cost, renewable energy to market, but their construction has also supported resilience by creating and strengthening alternate paths within SPP. SPP is also in the early stages of developing a study process that will focus on generation retirement's impact to reliability and resilience. When generators notify SPP of potential retirement, this study process will evaluate more closely the potential effects such retirements would have on the BPS from a reliability and resilience standpoint.

In addition to planning studies performed by SPP, certain SPP transmission owners perform Physical Security Risk Assessments in accordance with NERC reliability standard CIP-014-2 (Physical Security). These assessments are entirely focused on evaluating catastrophic events for the most critical substations that could be rendered inoperable, and they include a determination of whether the disturbance resulted in instability, uncontrolled separation, or cascading within the Eastern Interconnection. Under the CIP-014-2 standard, the transmission owners are required to have a third party verify the risk assessment, and SPP has assisted certain members in the past.

SPP has also developed plans, processes, and procedures for a variety of potential conditions, circumstances, or events. Examples of these plans include Emergency response plans, Business Continuity plans, Emergency Operations Plans, and a Loss of Critical Applications procedure. SPP performs winter preparedness assessments and winter peak studies calculating capacity adequacy and deliverability for winter scenarios with peak load levels and reduced availability of gas and coal fueled plants. SPP also performs summer preparedness assessments and summer peak studies calculating capacity adequacy and deliverability for summer peak load levels.

To assess adequacy of its Emergency Operating Plans, SPP performs table top exercises for different types of scenarios (e.g., cyber-attack, loss of critical applications, loss of control center, external threats). Such exercises also serve to measure staff

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[10] In addition to the ITP, SPP may also perform high-priority studies, including studies under its High Priority Incremental Load Study ("HPILS") process. Through the HPILS process, SPP can evaluate potential impacts and transmission needs of significant load growth expectations in particular parts of SPP. Depending on the results of a high-priority study, SPP may recommend a high-priority system upgrade for inclusion in the SPP Transmission Expansion Plan ("STEP").

preparedness to implement a plan if needed. SPP also conducts tabletop exercises to assess adequacy of Business Continuity Plans (and staff preparedness) for different types of scenarios (e.g. cyber-attack, loss of control center). To assess resource adequacy for winter and summer, SPP performs winter and summer preparedness studies.

SPP performs studies on an as-needed basis if circumstances or conditions are forecasted that could require a higher level of reliability or resilience. The typical time frame for such studies is seven days, but SPP will run certain studies farther in advance if a need is identified. For example, SPP has studied potential flood events several weeks in advance based on indicators such as snow pack and potential runoff levels. SPP has conducted similar studies of potential icing events, fuel supply disruptions (e.g., barge or rail delivery), and low-water conditions on waterways in SPP that provide cooling water for thermal generation. SPP has also conducted after-the-fact studies of events such as tornadoes and generator plant flooding. In SPP's experience, it is important to conduct a range of studies on both a regularly scheduled and as-needed basis according to the nature of the potential event and the potential impact.

(f) In these studies, what specific events and contingencies are selected, modeled, and assessed? How are these events and contingencies selected?

In the TPL-001-4 Annual Planning Assessment, event characteristics and contingencies are selected in consultation with SPP member Transmission Planners. These characteristics simulate the loss of multiple transmission elements as well as multiple generating stations that may be the cause of the Extreme Events listed in Table 1 of the TPL-001-4 standard. In the bi-annual LOLE study, SPP assess differing potential variables of load and generator outages, including variable output from renewable resources. These varying levels are modeled based on load forecasts, generator outage rates, and historical outputs of renewable resources.

(g) What criteria (e.g., load loss (MW)), duration of load loss, vulnerability of generator outages, duration of generator outages, etc.) are used in these studies to determine if the bulk power system will reasonably be able to withstand a high-impact, low-frequency event? Are the studies based on probabilistic analyses or deterministic analyses?

The LOLE study is based on probabilistic analyses, and it examines the potential loss of any load for any duration in order to make decisions about the sufficiency of the planning reserve margin for the SPP region. Loss of load greater than one day in ten years is seen as a triggering mechanism for considering an increase in the planning reserve margin of the SPP region. SPP's current planning reserve margin is 12%. SPP assesses available capacity by fuel type in relation to the load, reviewing the previous year and looking ahead to the upcoming year. Due to SPP's fuel-diverse resource mix and relatively high reserve margins, SPP has not experienced "real time" reserve margin levels (taking into account scheduled and unscheduled outages) low enough to trigger special studies of lack of capacity in connection with a specific fuel type.

SPP also studies transient stability and plans the Transmission System in order to avoid cascading outages. In the Annual Planning Assessment (TPL-001-4), which is based on deterministic analyses, SPP has criteria for identifying what constitutes a cascading outage, including a limit on the number of generator MWs that can be tripped offline for any Extreme Event.

(h) Do any studies that you have conducted indicate whether the bulk power system is able to reasonably withstand a high-impact, low frequency event? If so, please describe any actions you have taken or are planning as mitigation, and whether additional actions are needed.

The studies that SPP has undertaken to promote resilience have been aimed primarily at limiting the impact of high-impact events. For example, the primary goal of the Annual Planning Assessment is to prevent or limit the scope of cascading outages. With regard to the LOLE study, if a loss of load with a duration greater than one day is identified in a ten year period, the capacity margin of the region may be adjusted. Operationally, mitigating actions are specific to the type of threat and only applicable for the duration of the threat.

(i) How do you determine whether the threats from severe disturbances, such as those from low probability, high impact events require mitigation? Please describe any approaches or criteria you currently use or otherwise believe are useful in determining whether certain threats require mitigation.

If SPP forecasts or becomes aware of conditions or circumstances that increase the probability of an event, SPP facilitates communication with involved Transmission Operators, Neighboring Reliability Coordinators, NERC, and the Commission to discuss the potential need for mitigation and gather information needed for a study. Throughout the duration of the threat, SPP maintains communications with impacted and interested parties to update study results and discuss required mitigation and precautions. As part of the foregoing process, SPP will develop specific criteria based on the nature of the threat and its severity levels, its probability of occurrence, and its possible impacts. SPP also refers the Commission to its responses to questions 2(g)-(h).

(j) How do you evaluate whether further steps are needed to ensure that the system is capable of withstanding or reducing the magnitude of these high-impact, low frequency events?

SPP involves relevant stakeholder groups in reviews of the event and discussions of whether changes are needed to SPP governing documents or internal procedures. SPP also refers the Commission to its responses to questions 2(g)-(h).

(k) What attributes of the bulk power system contribute to resilience? How do you evaluate whether specific components of the bulk power system contribute to system resilience? What component-level characteristic, such as useful life or emergency ratings, support resilience at the system level?

SPP believes cold standby generation and spare equipment for transmission are two specific keys to resilience. SPP refers specifically to cold standby generation capacity (i.e., not in maintenance) that can be called on within a reasonable amount of time to mitigate unforeseen events. With regard to spare equipment for transmission, SPP refers to equipment such as poles, transmission towers, conductors, transformers, switches, and breakers that can be used to expeditiously restore transmission lines and high voltage substations after an extreme event such as a tornado, hurricane, grass fire, ice storm, flooding, sabotage event, EMP/GMD disturbance, or earthquake.

SPP believes component-level characteristics such as higher useful life and high emergency ratings would support resilience at the system level. SPP's Planning Criteria currently allow for emergency ratings that will allow certain amounts of loss of equipment life. SPP transmission owners currently follow these criteria and their own criteria in determining their normal and emergency facility ratings in adherence to NERC reliability standard FAC-008-3 (Facility Ratings).

(l) If applicable, how do you determine the quantity and type of bulk power system physical asset attributes needed to support resilience? Please include, if applicable, what engineering and design requirements, and equipment standards you currently have in place to support resilience? Are those engineering and design requirements designed to address high-impact, low-frequency events? Do these requirements change by location or other factors?

Most equipment and system design criteria are determined by the manufacturing and asset owner industry segments in order to set the applicable American National Standards Institute ("ANSI") and related standards. Additionally, the National Electric Safety Code ("NESC") contains requirements designed to address high-impact, low frequency events for different locations. For example, some requirements apply to portions of the country that experience wind and ice loadings. These requirements support the resilience of the system by protecting against severe weather events. In terms of operations practices, SPP does not have specific criteria or guidelines with respect to requirements such as a spare equipment strategy, but Transmission Operators sometimes have spare equipment sharing arrangements in place with other Transmission Operators in the region.

(m) To what extent do you consider whether specific challenges to resilience, such as extreme weather, drought, and physical or cyber threats, affect various generation technologies differently? If applicable, please explain how the

different generation technologies used in your system perform in the face of these challenges.

From a planning perspective, extreme weather events can impact all generation technologies. Periods of extremely low temperatures can cause outages for numerous types of generation. Tornadoes can potentially impact both wind farms and thermal power stations. Wind farms are perhaps more likely to be impacted than thermal power stations because of the fact that wind farms are spread out across more territory, but a direct hit on a larger thermal station could potentially be more impactful due to the number of MWs at issue in a smaller footprint. As discussed previously, drought could impact hydroelectric and thermal plants but would have little impact on wind and solar resources.

From the standpoint of operations, SPP maintains awareness of the locations of power plants and how they depend on infrastructure and natural resources, including cooling water supply from river sources. As discussed above, SPP facilitates communication with involved Transmission Operators, Neighboring Reliability Coordinators, NERC, and the Commission to discuss identified potential events and gather all available information needed to perform a study. This effort will include identifying specific resources that could be affected by the event or scenario for which a study was requested or determined necessary to support resilience.

(n) To what extent are the challenges to the resilience of the bulk power system associated with the transmission system or distribution systems, rather than electric generation, and what could be done to further protect the transmission system from these challenges?

Because of distinctions in footprint size, severe weather is more likely to impact the transmission and distribution systems than generation. SPP believes the current practice of evaluating extreme events through the Annual Planning Assessment (pursuant to NERC reliability standard TPL-001-4) and assuring that cascading outages do not occur is a reasonable approach to preventing widespread damage to transmission and distribution infrastructure. Transmission Operators and owners and Distribution Operators and owners may store spare transmission system and distribution system equipment that can be used to restore transmission, distribution lines, and high voltage substations on a relatively expeditious basis. To the extent such stockpiles are not currently monitored or otherwise assessed, further development of measures by which to increase transparency or awareness of such spare equipment reserves may be one area for exploration.[11] Another area in which more can done is the development and refinement of resilience-supporting cost recovery and cost allocation mechanisms. Without clear objectives in support of resilience, the planning that SPP and other organizations perform

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[11] SPP notes the work of NERC's Spare Equipment Working Group in this area, including the Spare Equipment Database, which currently focuses on long lead-time equipment. *See, e.g.*, http://www.nerc.com/comm/PC/Spare%20Equipment%20Database%20Task%20Force%20SEDTF%202013/Spare%20Equipment%20Database%20notice.pdf

in order to support the robustness of the BPS may be undermined if an entity or jurisdiction resists funding for transmission it deems unnecessary. Resilience has an associated cost, and it is important that state regulators be included in the discussion of how that cost is to be allocated and ultimately paid.

(o) Over what time horizon should the resilience assessments discussed above be conducted, and how frequently should RTOs/ISOs conduct such an analysis? How could these studies inform planning or operations?

In general terms, SPP believes the assessments discussed in these responses could be conducted on both a regular (e.g., annual) schedule and an as-needed basis. Some studies could be conducted if conditions or circumstances requiring a higher resilience level are forecasted. For example, SPP conducted wind integration studies in 2009 and 2015 and a variable generation integration study in 2017. These studies assessed the potential impacts to the SPP system associated with anticipated increases of installed variable generation capacity in the SPP region and looked at issues including voltage stability, transient stability, frequency response, and ramping. An example of more regularly scheduled resilience assessments would be those that are incorporated into the winter and summer assessments that are performed yearly by the Reliability Coordinator. SPP planning and operations study results are exchanged between relevant SPP departments, shared with Transmission Operators, and, if applicable, shared with Neighboring Reliability Coordinators. The SPP Reliability Coordinator also hosts winter and summer preparedness workshops that include the SPP Transmission Operators.

(p) How do you coordinate with other RTOs/ISOs, Planning Coordinators, and other relevant stakeholders to identify potential resilience threats and mitigation needs?

SPP coordinates with other RTOs/ISOs pursuant to procedures outlined in the different Joint Operating Agreements ("JOAs") SPP has executed with its neighbors. Additionally, SPP coordinates with interregional stakeholder groups through the individual Interregional Planning Stakeholder Advisory Committees ("IPSACs") that are provided for in the JOAs that SPP has executed. SPP also coordinates with regional stakeholders through groups including SPP's Seams Steering Committee, Transmission Working Group, and Supply Adequacy Working Group. See also SPP's responses to questions 2(i) and (o).

(q) Are there obstacles to obtaining the information necessary to assess threats to resilience? Is there a role for the Commission in addressing those obstacles?

SPP has not identified any obstacles to obtaining necessary and relevant information. Reliability Coordinators, Transmission Operators, and transmission owners generally have a good track record of sharing information.

(r) Have you performed after-the-fact analyses of any high-impact, low-frequency events experienced in the past on your system? If so, please describe any recommendations in your analyses and whether they have or have not been implemented.

SPP has performed analyses for large-scale events including the August 2003 Northeast Blackout and the 2014 Polar Vortex event. SPP has also conducted post-event studies of more localized events including tornado impacts, flooding, and icing events. Recommendations resulting from such reviews mainly concerned the importance of timely notification of all relevant parties including Reliability Coordinators, Transmission Operators, transmission owners, Planning Coordinators, NERC, and the Commission. Other findings involved frequency of information exchange by all parties, including the open discussion and exchange of plans for handling the impacts of the possible event with as low as an impact as possible to the BPS.

(s) Please provide any other information that you believe the Commission would find helpful in its evaluation of the resilience of the RTO/ISO systems.

SPP refers the Commission to its earlier statements regarding the need to involve, to the extent possible, all members of the electric industry in this discussion. SPP also refers the Commission to its statements in response to question 2(n) about the need for cost allocation mechanisms that ensure sufficient funding for construction of identified transmission needs.

3. <u>How RTOs/ISOs Mitigate Threats to Resilience</u>

(a) Describe any existing operational policies or procedures you have in place to address specific identified threats to bulk power system resilience within your region. Identify each resilience threat (e.g., the potential for correlated generator outage events) and any operational policies and procedures to address the threat. Describe how these policies or procedures were developed in order to ensure their effectiveness in mitigating the identified risks and also describe any historical circumstances where you implemented these policies or procedures.

SPP has Remedial Action Schemes that have been identified to protect the Transmission System from low frequency, high impact events. When triggered, these schemes will isolate impacted equipment in order to minimize regional impacts. SPP's Underfrequency Load Shedding Plan supports resilience by confining disturbances to local areas and preventing cascading. SPP also has operating directives that will reduce generation output in areas of concern in order to allow the Transmission System to operate reliably and to minimize potential disruptions of regional power supply. SPP's overall approach is having documented emergency plans and procedures in place for response to the individual threats. These plans are reviewed and exercised regularly by staff on a 24x7 basis. SPP's efforts to reduce risk of event occurrence primarily involve communicating and consulting with organizations outside of SPP for increased awareness and preparedness for events ranging from severe weather to cyber-attack. Policies and procedures have been written based on SPP's past operational experiences. As discussed previously, SPP conducts operational exercises to test plan effectiveness, and plans are refined based on daily operational rigor and current and forecasted events.

SPP's approach to planning and operational studies balances potential impact and likelihood of events. SPP's policies and procedures in this regard therefore accord with the aforementioned framework NERC has adopted for discussing resilience. SPP is conservative in planning for a robust system. For example, as discussed in response to other questions, SPP maintains a planning reserve margin requirement of 12%. In the interest of resourcefulness, SPP conducts training exercises and drills to familiarize operations staff with potential events. This familiarity from reoccurring review and drills supports the ability to recover rapidly from an event as increased exposure better reveals potential shortcomings on factors such as data availability, communication practices, or equipment limitations. SPP remains adaptive as it develops or revises procedures, learning from its experiences and those of others. In that regard, SPP is also collaborative, communicating with relevant parties and conducting drills with its Transmission Operators in order to share experiences and mutually develop greater breadth of preparation.

(b) How do existing market-based mechanisms (e.g., capacity markets, scarcity pricing, or ancillary services) currently address these risks and support resilience?

SPP does not have a capacity market, but SPP does have planning reserve margin requirements of 12% that each load responsible entity ("LRE") is required to maintain. This ensures there is enough capacity per LRE and helps support resilience by ensuring there is a margin of installed capacity above and beyond forecasted load plus obligations. SPP performs numerous capacity adequacy studies in the market, and these studies cover future periods of time ranging from 15 minutes to seven days out. These studies are performed using an algorithm capable of committing resources to supply Energy and/or Operating Reserve (regulating reserve, online contingency reserve, offline contingency reserve) co-optimally to minimize capacity costs while enforcing multiple security constraints such as thermal loading and resource operating characteristics. As part of these analyses, SPP ensures sufficient capacity, ramp, regulating reserve, online contingency reserve and offline contingency reserve are procured in order to flexibly respond to a multitude of N-1 contingencies and net obligation deviations from what is expected.[12]

Prior to real-time, SPP dispatches and prices Energy and Operating Reserve (regulating reserve, online contingency reserve, offline contingency reserve) co-optimally

[12] SPP performs Interconnection Reliability Operating Limit ("IROL") assessments on an ad hoc basis and in accordance with NERC reliability standards to address N-2 situations within the operating horizon. SPP also performs seasonal assessments and ad hoc N-2 analyses based on forecasted Operating Day risks.

to minimize production costs while enforcing multiple security constraints such as thermal loading and resource operating characteristics. Through this analysis, SPP ensures that for every five-minute period the physical dispatch of resources both meets the forecasted net obligation and is flexible enough to respond to a multitude of N-1 contingencies and net obligation deviations. In the event that a given security constraint cannot be met for the expected online resource mix, price formation (including scarcity pricing) for any related market products indicates the need for additional supply and can help drive investment in the BPS in the areas where it is most beneficial.

(c) Are there other generation or transmission services that support resilience? If yes, please describe the service, how it supports resilience, and how it is procured.

SPP has followed the lead of NERC's Essential Reliability Services Task Force and has developed a set of six Essential Reliability Services. These services include Capacity, Thermal Transmission congestion management, Ramp/Flexibility, Voltage support, Frequency Response, and System Inertia. Each of these services supports resilience by virtue of unique characteristics and abilities to respond to a significant disturbance.

With regard to capacity, SPP utilizes centralized unit commitment software in order to ensure there is adequate capacity committed to serve load plus obligations every Operating Day (calendar day). Having capacity reserves to respond to a disturbance on the BPS (such as SPP adding instantaneous available capacity to the top of the minimum capacity required for forecasted events) supports resilience. Capacity required to serve load plus obligations is procured via SPP's Reliability Unit Commitment ("RUC") studies, the Day-Ahead Market, and manual operational procedures. SPP's Open Access Transmission Tariff requires full participation of all resources in real time (RUC and Real-Time Balancing Market).

Thermal transmission congestion management encompasses the majority of the transmission constraints within SPP's Reliability Coordinator footprint. This reliability service maintains thermal loading on transmission facilities to protect equipment, reduce wear and tear on equipment, and reduce impacts from load loss. This service supports resilience by allowing for considerations of low probability, high-impact disturbances to occur through management of N-1 protection philosophy. SPP manages this reliability service through outage coordination, current day/next day processes, and through a variety of time-point targeted market studies including Security Constrained Unit Commitment ("SCUC") and Security Constrained Economic Dispatch ("SCED"). To increase resilience against thermal loading, SPP may work with the Transmission Operators to move scheduled outages. At this time, however, SPP adheres to an N-1 protection philosophy and does not typically consider N-2+ in operational resilience planning. SPP does review N-2+ events through the evaluation of P3-P7 planning events. While these planning events do not necessarily require transmission construction projects to mitigate the findings, SPP and its transmission owners do develop mitigating plans to address these potential issues. These mitigations include allowable redispatch of the available generation fleet as well as limited shedding of load in order to avoid a higher impact event from occurring. These potential mitigation plans, particularly ones that are identified with planned outages of longer durations (greater than six months) are shared with operations personnel for further consultation and information.

With regard to ramp/flexibility, SPP's role as a Balancing Authority requires adherence to NERC BAL reliability standards and, accordingly, sufficient Energy, Regulation, Spinning Reserve, and Supplemental Reserve products to meet minimum requirements of power balance. These are forms of providing ramp capability for normal operation in the event of a particular disturbance or for correction of load/wind/solar forecasting errors. Ramp is a need for reliability, but it also supports resilience by supporting recovery from unforeseen disturbances. SPP does not directly price ramp, but it does have minimum hourly requirements that are embedded in its SCUC software. To mitigate forecasted impacts, SPP has the ability to procure more ramp if warranted via SCUC offsets and manual procedures.

As a Reliability Coordinator, SPP works with individual Transmission Operators to ensure proper Voltage Support is planned and operated within specific criteria for facilities within the BPS. Voltage sources such as generators, capacitors, synchronous condensers, and static Volt Ampere Reactive ("VAR") compensators support resilience when those devices help maintain voltage levels within criteria following a low occurrence, high-impact disturbance. SPP does not procure voltage support, but it utilizes multiple software packages and reviews multiple time points on a recurring basis (working closely with Transmission Operators) to ensure proper voltage support is available, specifically to support N-1 scenarios. SPP also believes that all generating sources on the Transmission System should support resilience through voltage support.

As a Balancing Authority, SPP measures frequency response following a variety of system disturbances within and outside of SPP's Balancing Authority Area. Frequency response is required for responding to system disturbances within the eastern interconnection. SPP indirectly procures frequency response through the SPP Integrated Marketplace's Regulation-Up and Regulation-Down products. These products are procured on an hourly basis in the Day-Ahead Market and at a five-minute granularity in the Real-Time Balancing Market. They are deployed in the four-second time horizon. Primary Frequency Response is not currently targeted or procured, though it is being considered for future applications. Frequency response supports resilience by directly arresting the system frequency through the use of control systems at power plants. The larger a disturbance, the more frequency response may be required.

System inertia is required to initially arrest a frequency decline within a particular AC-interconnected system. With the advent of organized markets and larger penetration of non-synchronous generation, system inertia within the eastern interconnection is in decline. This reliability product supports resilience by preventing underfrequency load shedding events from occurring without human intervention. SPP does not currently require or procure this reliability product, but SPP is working with other large Balancing Authorities to monitor the amount of system inertia. SPP will work to recommend policy changes as necessary to maintain the level of inertia required to withstand events, including those of a low occurrence, high-impact nature.

(d) How do existing operating procedures, reliability standards (e.g., N-1 NERC TPL contingencies), and RTO/ISO planning processes (e.g., resource adequacy programs or regional transmission planning) currently consider and address resilience?

From a planning perspective, SPP has previously discussed the Annual Planning Assessment it conducts pursuant to NERC reliability standard TPL-001-4 as well as the LOLE Study for resource adequacy. From an operations perspective, SPP has procedures and processes in place for responding to different types of extreme weather forecast situations. The procedures include maintaining additional reserve margins; communicating with transmission owners, Transmission Operators, generator owners, and generator operators; and agreeing to a certain level of precaution believed to be appropriate for supporting reliability and resilience. SPP's procedures also cover instances of physical sabotage as these can result in the same degree of outage/damage as that caused by extreme weather. SPP has cyber-security procedures and measures in place to isolate SPP's core operations technology networks and redundant communication pathways, thereby decreasing their vulnerability.

(e) Are there any market-based constructs, operating procedures, NERC reliability standards, or planning processes that should be modified to better address resilience? If so, please describe the potential modifications.

SPP continues to examine current and potential new market-based constructs to enhance reliability, including Operating Reserves and ramping. Current Operating Reserves address more transient needs such as balancing and the ability to quickly recover from any single contingency. In the interest of supporting resilience, a longer term reserve, in addition to the balancing function of the market, may be useful. SPP's current design does not value ramping capability except indirectly through the quantity of energy. Valuing ramping may increase flexibility to meet both foreseen and unforeseen ramping needs. SPP is also considering modifications to its variable energy resource registration requirements that would provide SPP greater operational control and more efficient utilization of certain variable energy resources. Having systematic control over more resources enables a faster and more effective response to unforeseen system conditions.

SPP believes the current NERC construct for continually monitoring and enhancing the NERC reliability standards is sufficient to address current and future needs with regards to enhancing resilience for the BPS. As discussed in response to the Commission's description of resilience above, the NERC Board of Trustees has adopted a "framework" for discussing resilience (based, in part, on the NIAC's recommendations) that will begin a NERC effort to assess what activities, including any proposed reliability standards, may be appropriate to address areas where the industry can improve resilience of the BPS. SPP supports NERC's Resilience Framework and will be actively engaged in NERC activities that may propose additional standards.

III. CONCLUSION

SPP thanks the Commission for seeking its perspective on current and future practices and policy questions surrounding the issue of grid resilience. SPP supports efforts to examine and enhance practices that support a resilient power grid. SPP agrees with the Commission's premise that a one-size-fits-all approach to resilience is not appropriate given the differences that can exist between the various regions the BPS serves. In evaluating present requirements and determining whether changes may be necessary for resilience, SPP believes it is important to weigh the potential benefits against the costs. Changes to requirements to address resilience could increase the costs of transmission owners' systems, and those increased costs would ultimately impact transmission customers and their end-use customers. Accordingly, SPP respectfully submits that the perspectives and practices of non-RTO entities, including, without limitation, transmission owners, generation owners, and state regulators, should be sought out and considered, as different participants in the electric industry can provide valuable insight regarding their experiences.

Respectfully submitted,

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March 9, 2018

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document on each person designated on the service list compiled by the Secretary in this proceeding.

Dated at Little Rock, Arkansas, this 9th day of March, 2018.

/s/ Michelle Harris
Michelle Harris

Document Content(s)