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**

RESPONSES OF THE MIDCONTINENT INDEPENDENT SYSTEM OPERATOR, INC.

The Midcontinent Independent System Operator, Inc. ("MISO") submits this response to the Federal Energy Regulatory Commission ("Commission") Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures ("Order") issued on January 8, 2018.[1] The Commission Order initiated a new proceeding to specifically evaluate the resilience of the bulk power system in regions operated by Regional Transmission Organizations ("RTOs") and Independent System Operators ("ISOs"). In addition, the Order directed each RTO and ISO to submit information to the Commission on certain resilience issues and concerns.

For nearly two decades, MISO has engaged in thorough planning, thoughtful discussion, and careful consideration with States, members, and the broader stakeholder community to develop tools and processes that promote grid resilience. MISO's core foundation of ensuring regional reliability needs are met at the lowest possible cost has facilitated the creation of robust planning, operations, markets, and security mechanisms that are utilized to not only identify, assess and avoid resilience threats, but also to mitigate any impacts that may occur from high-risk events. Through the collective efforts and investments of MISO, MISO Transmission

[1] *Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures,* 162 FERC ¶ 61,012 (2018).

Owners, Load Serving Entities, States, and other stakeholders, MISO's grid is resilient. Going forward, the Commission should consider enhancements to inter-regional operations and congestion management that will support grid resilience. As the Commission considers its next steps on resilience, MISO notes opportunities to enhance resilience exists in the following areas:

- Information Technology Tools - MISO's extensive review of external risks has led to investments in leading technologies and security tools to mitigate cyber and physical threats to MISO's operation of the grid. The Commission should ensure that inflexible Critical Infrastructure Protection ("CIP") compliance standards do not create limitations on the implementation of superior tools and best practices to support grid security and resilience.
- Transmission Planning - Continued industry dialogue on more effectively identifying, valuing, and incorporating resilience attributes in transmission planning processes will help the Commission identify further opportunities to support and advance grid resilience.
- Inter-regional Operations - Going forward, additional diligence and analysis is necessary to ensure that artificial barriers that may affect inter-regional transactions do not adversely affect resilient grid operations. The Commission should actively support more effective interregional operations to increase the tools and resources available to support grid resilience.

Each of these items is discussed in greater detail in the body of these comments.

I. EXECUTIVE SUMMARY

MISO appreciates the opportunity to provide the Commission with an overview of MISO's efforts to assess and mitigate threats to resilience. RTOs and ISOs are well-positioned to utilize their expertise and experiences to continue this industry dialogue. However, the Commission's evaluation of resilience issues, and any processes that may be developed, should not be limited to just RTOs and ISOs. Rather, grid resilience is a national issue that broadly impacts the bulk power system. While MISO does not have any imminent or immediate resilience concerns, there are opportunities for the Commission to play a greater role by opening an industry dialogue to identify future actions to support on grid resilience efforts in the areas of: (1) information technology tools; (2) transmission planning, and; (3) inter-regional operations.

Definition of Resilience

The Commission's characterization and proposed definition of resilience recognizes that resilience is not just a fuel security matter, but encompasses careful coordination between transmission, operations and markets, information technology, cybersecurity, and system planning functions. MISO views resilience beyond just the ability to respond to events, but also the ability to assess and respond to changes in the nature of "events" that are the result of the transformative industry changes in fuel economics, environmental regulations, technology, customer preferences and State policies.

MISO's Efforts to Assess and Mitigate Resilience Risks

Efforts to assess and mitigate risks span the entire organization. MISO's regional size, scope, and integrated systems support its ability to assess and maintain resilience and provide MISO members with a level of resilience that would not be possible with each member acting individually. Utilizing an expansive footprint with diverse supply and demand profiles, MISO is well positioned to leverage this diversity of resources to effectively respond to events through real-time operations. Examples of MISO's ongoing efforts and initiatives include:

- **Transmission Planning.** MISO's robust transmission planning processes identify regional solutions to address both near-term and long-term grid needs in an efficient, cost-effective manner. On an annual basis, MISO develops the MISO Transmission Expansion Plan ("MTEP") through an inclusive and transparent stakeholder process. Through the MTEP process, MISO evaluates various types of projects that, when taken together, result in an electric infrastructure plan that is sufficiently robust to meet local and regional reliability needs and enable competition among wholesale capacity and energy suppliers in the MISO markets. Further, the majority of

transmission Multi-Value Projects ("MVPs"), approved in 2011 to address the large-scale emergence of wind resources in the MISO footprint, support future grid resilience. MISO regularly evaluates the impact of the evolving industry structure and technology developments as an integral part of its transmission planning processes. Similarly, MISO routinely tests its transmission system for its response to severe events. As a part of the annual planning process, MISO evaluates approximately 6,500 extreme events impacting loss of multiple facilities on the transmission grid

- **Preparation Drills.** Training sessions, including drills and readiness workshops, are routinely offered to stakeholders along with a comprehensive set of protocols to communicate and coordinate with state regulators. MISO readiness drills typically use the Dispatch Training Simulator and other simulator tools to enhance the participant experience and prepare for extreme events. In addition to the above mentioned readiness drills, MISO routinely participates in national resilience drills including the North American Electric Reliability Corporation's ("NERC") GridEx.[2] These drills are not only beneficial to understanding physical threats but also cyber risks.
- **Market Roadmap.** MISO prioritizes market enhancements that align incentives with operational needs of the grid. The Market Roadmap process helps ensure that market investments are done in a cost efficient manner and are able to support the evolving

[2] GridEx is a biennial, two-day exercise hosted by NERC that simulates coordinated cyber and physical security threats so that utilities can exercise response and recovery plans, strengthen their crisis communications relationships, and provide input for lessons learned. The first GridEx event took place in November 2011. NERC's GridEx website is located at http://www.nerc.com/pa/CI/CIPOutreach/Pages/GridEX.aspx.

grid of the future. MISO and its stakeholders continue to develop, evaluate and assess market initiatives, including new products and approaches that will support future resilience needs.

- **Gas-electric coordination enhancements.** MISO has many activities underway to improve gas-electric coordination that support grid resilience. Through the development of advanced communication protocols with the natural gas industry, MISO has enhanced situational awareness that helps to identify pre-event risks and post-event lessons learned. MISO continues to expand this cross-industry engagement. To better understand issues surrounding pipeline contingencies, MISO is conducting a contingency planning study to take an in-depth look at potential gas-electric risks and issues.
- **Reliability Initiatives.** Changing market conditions and policies are contributing to a resource portfolio with altered operational characteristics that may impact resource availability. Given these changes, MISO, States, and other stakeholders have more broadly begun discussions around Resource Availability and Need ("RAN") to determine whether current processes for the conversion of committed capacity to energy enable reliable and efficient operation of the Bulk Electric System today and into the foreseeable future. MISO is committed to improving its ability to understand, forecast and communicate uncertainties regarding resource availability.
- **Market System Enhancement.** MISO's exhaustive review of external risks has led to investments in leading technologies and security tools to mitigate cyber and physical threats to the grid. Collaboration with a diverse set of stakeholder and industry groups facilitates robust dialogue and positions that help mitigate emerging

risks and threats. As part of its Market System Enhancement ("MSE"), MISO conducted a comprehensive assessment to determine the system performance and security requirements that will be necessary to meet MISO's long-term needs. The MSE also will fortify MISO's cyber security measures to protect against cyber and physical-security threats and established a foundation for putting new systems in place to respond to changing conditions.

- **Stakeholder Proceedings.** MISO commenced stakeholder proceedings on resilience in late 2017, prior to the Commission's Order. Members of MISO's Advisory Committee initiated a grid resilience "Hot Topic Session" that is focusing on resilience issues unique to the MISO region. With stakeholder input, MISO prepared an introduction and set of questions for stakeholder sectors to provide written responses. A diverse set of stakeholder sectors submitted written feedback and comments on February 28, 2018. Key themes will be further discussed at MISO's Advisory Committee meeting on March 28, 2018 with the MISO Board and Advisory Committee. Among the comments received to date, the following themes emerged from sector comments:
    - Through the shared efforts of MISO, transmission and generation owners, State and local regulators, and the broader stakeholder community, the MISO region has successfully ensured resilience (and reliability) for decades.
    - Future resilience endeavors must balance risk with costs to consumers.
    - Training, including drills and simulation exercises, as well as continued focus on implications around an evolving resource portfolio, should continue in a collaborative manner with MISO and the stakeholder community.

These discussions are only the beginning of MISO's engagement with stakeholders. In addition to the upcoming Advisory Committee meeting, stakeholders will continue to address and

consider the issues identified above (and throughout this response) through the Resource Adequacy Subcommittee, Market Subcommittee, and Reliability Subcommittee.

Opportunities for Commission Efforts to Enhance Resilience

While MISO does not face any imminent reliability or resilience issues, there are several opportunities for the Commission to continue focused industry dialogue. MISO believes the Commission has several areas worthy of further engagement to enhance the resilience of electric transmission grid, including.

- **Enabling Industry Adoption of Best in Class Technologies**

  Although new information technologies provide significant opportunities to enhance grid security and efficiency, cyber-security risks remain. CIP standards must provide the flexibility to allow for the adoption of superior new technologies and best practices. Industry dialogue will help ensure that CIP standards continue to be a floor for grid security and resilience rather than an artificial ceiling.

- **Valuing Resilience in Transmission Planning Processes**

  Opportunities for industry engagement also exist in transmission planning processes. Additional dialogue on effectively valuing resilience in transmission planning processes would be beneficial for regional planning programs. Industry discussion could help guide stakeholder processes to better evaluate the benefits and costs for projects with significant resilience benefits.

- **Distribution System Resilience**

  Many significant challenges to resilience occur at the distribution level. MISO continues to engage with State and local regulators to better understand our respective roles, particularly as local distribution systems may be vulnerable to high-impact events that

challenge resilience. As demonstrated through recent "Hot Topic" comments from States, Transmission Owners, and other diverse stakeholders submitted to MISO's Advisory Committee, resilience is being addressed in a cross-functional manner across the region. To the extent the Commission is interested in addressing concerns at the distribution level, the Commission should continue working in partnership with State regulators (similar to the upcoming Distributed Energy Resource technical conference) to help ensure a coordinated effort.

- **Enhanced Inter-Regional Operations to Increase Event Response Capabilities**

  MISO urges the Commission to consider enhancements to inter-regional operations processes that will help support grid resilience. Further efforts are necessary to ensure that artificial barriers that may affect inter-regional transactions do not adversely affect resilient grid operations. Improving congestion management processes and visibility tools will not only support seams between neighboring system operators but also will promote the Commission's resilience efforts.

  Broader introduction of advanced operational tools could promote situational awareness and allow for better, more responsive congestion management. Current limitations in both processes and tools restrict the efficient use of transmission and redispatch opportunities to fully leverage available infrastructure. These limitations result in fewer operational options to address unplanned events that may test grid resilience. For example, as increasing levels of intermittent resources connect to the grid, hourly congestion management through the current Transmission Load Relief Process ("TLR") process will no longer be sufficient.

RTO/ISO energy market advancements have facilitated the development of superior market-based congestion management tools, including redispatch, seams coordination, and market-to-market processes that improve reliability and reduce costs (particularly when compared to TLR). MISO's coordination with PJM Interconnection, L.L.C. ("PJM") is a good example of a ruleset that provides mutually beneficial support built upon industry leading operational coordination. Utilization of market-based congestion management tools with PJM, in conjunction with an agreement to share contract path at the MISO-PJM border, equitably maximizes the use of the transmission system and has become the model for seams operation.

The Commission should consider opportunities to apply the MISO-PJM model to advance inter-regional operations more broadly. Continued improvements in seams coordination will help leverage the inter-regional diversity of load and supply generation to support resilient operations. MISO looks forward to working with the Commission and the industry to further discuss these opportunities for enhancements that will promote resilience.

II. QUESTIONS

A. Definition of Resilience

The Commission understands resilience to mean:

> **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.**

We seek comment from the RTOs and ISOs on our understanding of resilience as described above. We also ask for comments on whether any of the terms used above require further elaboration to ensure a common understanding (e.g., identification of the particular types of disruptive events).

MISO Response:

MISO's understanding of resilience generally aligns with the Commission's proposed definition. However, to ensure that key resilience attributes are accounted for and addressed in identifying and mitigating resilience risks, the Commission's definition of resilience should be broadened in scope to acknowledge the changing nature of the electric grid. The definition of resilience should encompass the ability to not only withstand specific disruptive events, but also, include the ability to adapt to ongoing changes and supply portfolio evolution to ensure that grid performance remains reliable.

Specifically, resource adequacy, system reliability, and flexibility are essential qualities that enable the electric supply systems to support system demand. MISO continues to plan for and address the changing resource portfolio and technology evolution by anticipating future challenges that are on the horizon. For example, as wind generation resources increased over the last eight years, MISO has recognized the need to be able to reduce wind output with the appropriate price signal to manage congestion on the transmission system. Understanding these changes, a Dispatchable Intermittent Resource capability product was developed when the installed wind capacity in MISO was 4,000-6,000 MW to provide the necessary operational flexibility. This advanced recognition has proven to be an effective and efficient means of congestion management as installed wind capacity has now grown to over 17,000 MW.

While resource adequacy and reliability are maintained through well-established criteria and processes, resilience involves a more sophisticated evaluation of risks and benefits associated with disruptions arising from natural and man-made events. Resilience should include the ability of the grid to provide sufficient flexibility to accommodate resource portfolio changes over time driven by economics, technology advances, and energy policy.

Turning to the Commission's request for the identification of particular types of disruptive events, MISO's definition includes ongoing stressors (e.g., portfolio evolution, operational flexibility) and captures industry challenges including, but not limited to:

- Extreme weather events
- Unique geological characteristics
- Geographic variations, including load pockets and interconnection boundaries
- Fuel supply, including gas and coal transportation delivery issues
- Cyber security risks
- Seasonal resource variations and operational needs
- Loss of load risks and expectations

MISO continues to actively address ongoing resilience risks and, as explained in more detail below, believes there is continued opportunity for improvement in several areas including interregional operations, transmission planning processes, and through CIP standards.

B. How MISO Assesses Threats to Resilience

(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?

MISO Response

MISO identifies, addresses, and responds to risks related to the supply and delivery of energy in a holistic manner through well-designed systems and clearly defined procedures across all facets of the organization including operations, markets, infrastructure, and planning. These cross-functional efforts position MISO to address current and future risks to grid supply and performance, including cyber-attacks, physical security, fuel supply disruptions, weather driven events, system component failures, and evolving resource portfolios. While all of these events

are credible threats to resilience, MISO does not have any imminent or immediate resilience concerns.

Primary risks to resilience in the MISO region may be both naturally occurring and man-made threats. Naturally occurring threats include hurricanes, ice storms, extreme cold, flooding, tornadoes, and potential geomagnetic disturbances and earthquakes. As the expanse of MISO's geographic region spans three time zones and extends from New Orleans, Louisiana at 30 degrees north latitude, to Winnipeg, Manitoba at 55 degrees north latitude, it is possible to experience multiple naturally occurring events at the same time. Man-made threats include possible electro-magnetic pulse from nuclear attacks, physical attacks, cyber-attacks, and problems in other critical infrastructures.

As described below, MISO has many processes and programs in place that identify risks to resilience across its region. Among naturally occurring and man-made threats to resilience, MISO has identified the following areas as potential challenges in the short, mid, and long-term: communications, natural disasters, evolving resource and technological changes, and physical facility and cyber risks.

Communications Interruptions

Communication is essential to ensuring grid resilience. Man-made interruptions to communications programs and protocols both within MISO, as well as with its members, States, and neighboring systems, are a credible resilience risk. Recognizing the highly integrated nature of the energy sector with the telecommunications sector, MISO has held closed discussions with the Local Balancing Authorities and Transmission Operators on current capabilities and opportunities to improve response capabilities. Risks from communications interruptions could impact multiple Balancing Authorities simultaneously. MISO continues to monitor ongoing

research being conducted by Electric Power Research Institute ("EPRI") and the Electric Infrastructure Security Council ("EISC") around communication alternatives for voice and data.

Natural Disasters

Natural threats include both short-term and long-term resilience risks. In 2017, the MISO region was exposed to a number of natural disasters, including Hurricane Harvey and Tropical Storm Cindy. Natural risks, while unpredictable, are foreseeable events that MISO continues to plan for and address in its resilience risk management processes. Many entities play a role in responding to natural events. In addition to MISO, State authorities, distribution providers, and generation owners have key roles in responding to high-impact events. MISO coordinates activities affecting the Bulk Electric System during natural disasters (e.g., interconnection of islanded areas) while the repair of substations, generation equipment and distribution lines are typically handled by the transmission operator, generation owner, and/or distribution provider.

Natural gas supply may also be impacted by natural disasters. MISO's reliance on gas-fired generation has grown significantly in recent years. In 2014, following the integration of the MISO South region, gas-fired generation increased to 18 percent of energy produced. By 2016 this percentage increased to 27 percent. The percentage of these resources is likely to further increase, with over 8,000 MW of gas-fired generation in the advanced stages of MISO's generator interconnection queue. While MISO's geographic scope and position makes natural gas supply interruptions from natural disasters a lower-probability risk, MISO continues to advance gas-electric coordination in operations, markets, and planning. These important efforts will continue as gas-fired generation resources enter the region and serve as a critical source of supply flexibility, particularly in severe weather situations.

Changing resource portfolio and technological advances

Medium to long-term challenges include having the right products in place to support the evolving portfolio and technology changes. Various policies at the State and Federal level, coupled with the expedient rate of technological improvements, are driving the rate of change to the portfolio. Different regions will likely have distinct resource portfolios based on both geographic/population characteristics and technological investments. The regions may need to introduce different products to be prepared to operate the grid of the future to address regional differences. MISO's continued markets structure, which co-optimizes energy and ancillary services, will be critical to addressing the changing resource portfolio brought on by new technologies and state policies.

Physical facility and cyber threats

Physical facility and cyber threats reflect a short-term threat and will likely need to be protected against on both a mid-term and long-term basis. The risk of internal threats include: loss of redundancy at both our primary and backup sites; cybersecurity threats, both internal and external, and; human error and/or sabotage.

MISO actively mitigates these threats through its internal processes and protections. Built-in redundancies protect MISO's physical facilities from resilience risks. To protect against cyber risks, MISO maintains a cyber operations team to monitor critical systems daily for Indicators of Compromise ("IOC"). All cyber alerts and events are coordinated through a central management console.

To mitigate threats from human error, MISO mandates that all system changes are managed through a change and configuration management program. Training for operators on procedures, standards, and drills all contribute to reducing the risk of human error incidents.

Event reviews are conducted regardless of whether there is human error, in order to develop lessons learned and identify mitigation activities that minimize reoccurrences.

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

MISO Response

The MISO region is undergoing a significant transformation in its resource portfolio due to a combination of factors including federal and state policies, economics, evolving technologies and consumer preferences. The trends indicate a shift to increased amounts of variable energy resources, both on the Bulk Electric System and at lower sub-transmission and distribution voltages, as well as a reduction in traditional base load resources designed to meet energy and capacity needs. As this new model emerges, MISO is planning for a transmission system that is fundamentally more flexible to support an increasingly diverse set of resource types.

Through the annual MTEP process, consistent with the MISO Tariff[3] and the requirements of FERC Order 1000, MISO seeks to identify the set of local and regional transmission solutions that, when taken together ensure the reliable and resilient operation of the transmission system; support achievement of state and federal energy policy requirements; and enable a competitive electricity market to benefit all customers.

MISO's open, transparent, and collaborative planning process continuously evaluates potential disruptions and their impact on the grid's ability to meet demand. Although the exact future resource mix remains uncertain, MISO uses its value-based planning approach to proactively identify infrastructure that is valuable under a number of long-term future scenarios

[3] MISO's Open Access Transmission, Energy and Operating Reserve Markets Tariff ("Tariff" or "MISO Tariff").

reflecting a wide range of potential resource portfolios. It is critical to identify necessary and efficient investment despite the uncertainty, particularly given the long lead time typically needed to plan, approve and construct regional transmission solutions. Regional analyses, taken together with analysis of near-term reliability needs that include assessment of extreme events, analysis of transmission needed to support resources joining and leaving the system, and identification of local system needs, provide a strong foundation to ensure that MISO has a transmission system that continues to meet customer needs in the future.

MISO also regularly conducts analyses to understand the impacts on both the grid and the MISO markets of resource changes over time. A current effort, the Renewable Integration Impact Analysis ("RIIA"), seeks to quantify the impacts of increased levels of renewable resource s and understand the ability of the grid to accommodate these changes. The RIIA will facilitate broader conversations around renewable energy impacts on the reliability of the electric system. Research and development efforts will identify technically rigorous, concrete examples of integration issues and examine potential solutions to mitigate them. Further, MISO's Market Roadmap will allow potential resilience solutions that provide the most value (and can be implemented in a cost-effective manner) to be prioritized over more costly alternatives.

Other risks are addressed through MISO's mature Enterprise Risk Management ("ERM") program. The ERM program helps to identify, assess, respond, and report on its high-level risks. Specific risk criteria have been developed to assess potential risk impacts and the likelihood of events. Risks are evaluated according to their impact to: operations, stakeholders, financials, regulatory constructs, and employees. Other factors that are analyzed when determining risk impacts include the complexity, velocity, and persistence of the risk as well as MISO's adaptability and ability to recover from a major risk event. The likelihood of risks is assessed

based on the probability that they occur over a five-year future time horizon. MISO closely monitors its risk register on a routine basis. Examples of matters on the risk register include cyber security, portfolio evolution, and event-driven grid reliability. During the risk assessment process MISO identifies the key internal and external factors driving the risks, determines the appropriate risk response and treatment activities, and assigns ownership for these treatment activities. The ERM program has touchpoints throughout the organization and regular reporting to executive leadership.

Risks are also identified through lessons-learned processes and prior experiences. Previous experiences with the Polar Vortex and other extreme weather events, and post-event analysis allow MISO to better understand the risk likelihood and impact of reliability and resilience risk. In addition, MISO leverages neighboring entities' experience to gain risk treatment planning insight. Gas and electric entities utilize NERC's Transmission System Planning Performance ("TPL") standards to assess and consider a wide range of probable contingencies. MISO continues to actively coordinate with our stakeholders and leverage ERMs to evaluate the probability and risk associated with potential events.

(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.

MISO Response

MISO has ongoing processes in place to identify and plan for high-impact, low-frequency events. As a result of these deliberate planning processes, MISO is well-positioned to assess the impact and likelihood of these risks. However, MISO notes that access to additional information, including information across related industry sectors, would further improve these processes. For

example, access to additional information used to study gas pipeline contingency risks would help improve MISO's current modeling processes.

Identifying and Planning for Risks

To identify and plan for high-impact, low-frequency events, MISO routinely tests its transmission system for its response to severe events. As a part of the annual planning process, MISO evaluates approximately 6,500 extreme events impacting loss of multiple facilities on the transmission grid. MISO collaborates with Transmission Owning members to select events each year. MISO's extreme event analysis includes events involving:

- Loss of all circuits on a multi-circuit right-of-way
- Loss of three or more circuits on a common transmission tower
- Loss of all facilities at a switching station or a load service substation
- Loss of all generating units at a multiple unit generating station
- Loss of all generating units at two independent generating stations
- Loss of gas pipeline segments and all generation served by the pipeline

Specifically, in terms of gas pipeline reviews, MISO typically evaluates between 20 and 30 gas pipeline outages each planning cycle. Events are evaluated to determine the amount of load loss expected resulting from the event, and to determine if the event results in system instability or cascading loss of facilities and load. In addition to the events mentioned above, MISO is performing a review of its gas pipeline contingency set to determine whether analysis of additional events should be increased. MISO is also working to increase its understanding of the time-domain impacts of pipeline outages (i.e., after a pipeline contingency occurs, what are the impacts 5-minutes later, 1-hour later, 1-day later, 1-month later).

While NERC's Transmission Planning Standards do not require mitigation of load loss resulting from events classified as extreme events, MISO presents summaries of these events to stakeholders, including state regulatory staffs, at the Sub-regional Planning Meetings ("SPM") that are a part of MISO's open and transparent annual reliability planning process. These meetings provide MISO stakeholders, including State regulatory bodies, with the opportunity to better understand resilience risks and consider industry best practices in a collaborative manner.

To prepare for risks associated with low-frequency, high-impact events, MISO also maintains disaster recovery plans, business continuity plans, and an overarching crisis management plan to ensure MISO can recover from a significant event.[4] These plans are reviewed and exercised at least annually and are able to leverage real world scenarios based on current high-risk events. In addition, critical system transfers are performed several times a year between our primary and backup site to ensure operations continue at either location with no degradation. Each of these activities help to mitigate our overall risk associated with high-impact, low-frequency events.

Further, MISO routinely holds system restoration drills and hurricane preparedness drills which allow MISO, Local Balancing Areas, and Transmission Operators to identify risks and areas for improvement while running the drills. These drills are also utilized to better understand cyber threats. MISO maintains a formalized cyber security incident response plan that is tested annually through paper drills and participation in NERC activities.

More specifically, NERC's nationwide GridEx drill and the Federal Emergency Management Agency's ("FEMA") regional drills which cross critical infrastructures are very valuable in recognizing potential cross-sector issues. Simulation based drills are important for

[4] Disaster recovery and business continue plans are required under NERC Reliability Standards.

the industry to practice and identify response improvement. We strongly encourage FEMA and NERC to continue the valuable opportunities that helps grid operators and utilities prepare for, and respond to, high-impact, low-frequency events.

Addressing Challenges

MISO has not experienced significant challenges in assessing extreme event impacts in the planning timeframe. Member Transmission Owners collaborate with MISO in developing events to be reviewed. Beyond the assessment of event impacts, a more significant challenge is quantifying the risk and benefits associated with mitigating events with very low probabilities, but potentially high costs, to customers of such disruptions. MISO believes that each region has its own unique set of events that pose the most likely threats to resilience. As a result, regional stakeholders should continue to be engaged in determining which threats and consequences are appropriate to be mitigated and what costs should be incurred to do so. In this regard MISO continues to ensure that regional stakeholders are aware of the consequences to the grid and loss of load service that could result from such events.

(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?

MISO Response

As part of MISO's core operations and planning programs, MISO is already identifying resilience needs against contingencies that could result in the loss or unavailability of key infrastructure and systems. MISO has many ongoing initiatives that identify threats to resilience

as well as support measures that plan for system contingencies that could impact system reliability. Commission directives have provided MISO with the tools to address resilience, including the planning assessments of the ability of the grid to withstand severe events (including impacts to gas-electric coordination). Generally, assessments are included in the overall planning responsibilities of RTO/ISOs (as promulgated in Orders 2000, 890, and 1000) as well as in the current NERC Planning Standards requirements. Additional Commission dialogue on these issues may allow for more robust data collection opportunities for RTOs/ISOs.

NERC Standards requiring system assessments in planning and operating horizons effectively support resilience and consider risks of multiple outage impacts. Specifically, system operating limit methodologies focus on a broad set of contingencies, including correlated outages and wide-scale disruption that are factored into system operating limits.[5] Likewise, flowgate methodologies are able to be defined with multiple monitored elements, particularly when stability issues may arise.[6] Identified constraints are used in MISO's next-day studies to identify potential risks, as well as generation that needs to be on-line to mitigate potential thermal, voltage and/or stability issues.

Similarly, MISO has internal processes, including gas and electric pipeline monitoring protocols, which have proven effective and been successfully utilized during the cold weather snap in January 2018. MISO monitors and reports on gas pipeline critical notices and events that allow MISO to anticipate potential resource availability issues due to published flow limitations. Generation owners (or representatives) are responsible for ensuring submitted generation parameters meet performance capabilities. Individual Market Participant strategies are then used

[5] *See* NERC Reliability Standard FAC-001-3.

[6] *See* NERC Reliability Standard MOD-030-3.

to determine what pipeline services (i.e., Firm or Interruptible), flexible/enhanced services (non-ratable, no-notice, etc.) are subscribed.

MISO's operations processes incorporate Market Participants gas procurement strategies (Timeline, Intraday) to assess potential fuel availability risks. Resources without firm transportation or enhanced services may have difficulty procuring supply on peak operating days. Generation units that are unable to line up supply are expected to enter an outage into MISO's outage coordination tool with the appropriate code around fuel supply. The MISO commitment process includes assessments to identify and commit additional generation on-line due to any increase in reported generator outages.

Further, near-term study tools apply transmission outages and analyze the system based on the projected topology. Contingencies are studied on top of the applied topology, providing insight into areas that may need an operating guide. In the near-term, the current processes help identify risks from transmission or generation forced outages which may result from natural or man-made causes.

(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.[7]

MISO Response

From a systems operations perspective, MISO performs qualitative reviews of potential interruptions to key processes and surveys the local balancing authority areas to understand their

[7] The Commission is not directing that these studies be included in the RTO/ISO submissions filed in response to this order. Instead, the RTOs/ISOs are required to identify and describe such studies in their submissions.

capabilities. MISO is currently benchmarking key processes with other RTOs/ISOs to identify potential cost-effective enhancements to further MISO's business continuity. MISO is also working to validate diversity of service providers in key utility services. To properly balance personnel resources with risk concerns, MISO typically performs these analyses on an as-needed basis.

MISO has made significant investments in resilience over the last five years. Multiple, active (staffed), control centers and data centers provide flexibility to operate in the event of a disruption. MISO has invested in dedicated cyber and physical security teams to mitigate and respond to potential threats. MISO has formally added physical and cyber security to our strategic plan. Because of the constantly changing environment, MISO assesses these risks on an ongoing process.

As noted above, MISO conducts ongoing transmission planning studies on extreme events and on future scenarios that may occur as generation resource portfolios continue to evolve. These regularly performed planning studies are supplemented with periodic targeted studies such as the RIIA addressing specific supply configurations and solutions to any limitations that might result.

Through extreme event studies that MISO conducts on an annual basis, MISO's current assessment is that natural gas pipeline contingencies do not represent an imminent or immediate resilience risk in the MISO region. Nonetheless, to better understand how an increase in natural gas resources may affect MISO's dispatch capabilities, MISO recently initiated an in-depth study to identify potential consequences that may occur in the event of natural gas pipeline contingencies. Further, MISO conducts an annual Coordinated Seasonal Assessment that includes extreme natural gas pipeline contingencies (as identified in the TPL study).

Similarly, MISO participated in a study performed by the Eastern Interconnection Planning Collaborative to, among other things, determine the impacts of gas pipeline system failures on the electric system. Additionally, MISO worked closely with NERC and the Argonne National Laboratory on a Single Point of Disruption ("SPOD") analysis, investigating reliance on gas storage and other gas infrastructure to serve the needs of gas-fired generation. MISO offers High-Impact / Low-Frequency ("HILF") specific security protection and safeguards as a benefit to its members. Through participation in NERC sponsored GridEx exercises, MISO leverages industry expertise to identify and implement the appropriate security controls to protect the bulk power system.

MISO also utilizes industry best practices, including key studies and reports, that highlight opportunities to support resilience. The North American Transmission Forum ("NATF") developed the Bulk Electric Systems Operations absent Energy Management System and Supervisory Control and Data Acquisition Capabilities report. This "spare tire" report lists 11 key capabilities needed for system operations.[8] As a result of this study, MISO agrees that external voice communications represent an important resilience risk that merits additional consideration by the Commission.

In addition, the "FERC-NERC-Regional Entity Joint Renew of Restoration and Recovery Plans"[9] provided useful findings and conclusions. Specifically, the study noted that:

- All participants would remain capable of executing their restoration plan without SCADA/EMS availability.

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[8] *See* spare tire report (http://www.natf.net/docs/natf/documents/resources/natf-bes-operations-absent-ems-and-scada-capabilities---a-spare-tire-approach.pdf).

[9] *See* https://www.ferc.gov/legal/staff-reports/2017/06-09-17-FERC-NERC-Report.pdf.

- Completion of all restoration steps would be more time consuming and more involved under such conditions, especially those steps requiring a larger degree of coordination.

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

MISO Response

In monitoring and assessing system operations, MISO and MISO members review failures of key applications at a single and multiple location(s), loss of key systems, loss of data center(s), and loss of telecommunications. The events are selected based on daily control room functions MISO provides to its members. Whether an event was externally instigated or internally instigated, the focus is on reviewing the likelihood and/or impact from an event. Personnel impacts, including pandemics, are also considered.

For gas-electric coordination assessments, MISO utilizes industry best practices and focuses on higher probability contingencies, such as loss of a single segment of pipeline or loss of a single compressor station. MISO utilizes standard P1 contingencies defined in NERC Reliability Standard TPL 001-4 in its Coordinated Seasonal Assessment and Planning Reliability studies. More comprehensive studies are being developed to help MISO address and better understand emerging issues.

For cyber-related risks, MISO leverages studies such as ICS-CERT's annual year in Review reports, as well as the Mandiant M-Trend report. The M-Trend report gives MISO an intelligence-led look into new phishing trends, new cyber security attack methodologies, as well as insights into developing modern cyber security defensive strategies. MISO studies annual reports, including Verizon's Data Breach Investigations, to identify electric industry specific impacting events. MISO also utilizes these reports to identify current and evolving threats.

Utilizing lessons learned and issues raised in these studies and reports, coupled with on-going Electricity Information Sharing and Analysis Center (E-ISAC), Industrial Control Systems Cyber Security Emergency Response Team (ICS-CERT), and FBI InfraGard alerts/bulletins, MISO has implemented a continuous improvement process to evolve its existing security capabilities based on real scenarios.

In addition, MISO notes that response (c) provides additional context and information on specific events and contingencies that have been studied, modeled, and utilized to test the resilience of the regional transmission system.

(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?

MISO Response

In evaluating impacts of high-impact, low-frequency events, from a planning perspective MISO studies the system for its ability to maintain stability and avoid cascading loss of facilities and load. Cascading events are determined based upon a number of factors including: the number of facilities that exceed safe design ratings; events that results in loss of 1,000 MW or more of load, or; that otherwise demonstrate system instability in which loss of load is more difficult to predict but can be substantial.

For system operations, MISO's study criterion considers reliability, regulations, financial exposure, and people (internal and external). On a daily basis, MISO's operations engineers perform power flow-based Interconnection Reliability Operating Limit ("IROL") studies focusing on identification and mitigation of potential cascading events in response to a forced

outage of a bulk electric system element. The intent is to make certain that MISO is prepared for the next event that may impact the bulk power system.

Events are deterministically selected based on guidance from NERC Standards and by operator experiences and judgment that balance the magnitude and impact of such a risk with MISO's operations. MISO has considered further development of probabilistic contingency evaluation techniques; however, these methods often prove difficult to apply to extreme events unrelated to component failure probabilities, including severe weather or man-made events.

(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.

MISO Response

As described above, MISO's studies of extreme events are evaluated for impact on grid performance and load serving capability. The vast majority of events do not indicate system instability or cascading failures would occur. Notably, none of the gas pipeline failure simulations indicated reliability limitations due to transmission grid inadequacies or loss of load risk above the 1-day-in-10 years planning criteria due to resource inadequacy. Only in one scenario, under the extreme and long-term event of the loss of the largest natural gas pipeline for the entire summer peak season, was a slightly elevated regional loss of load risk observed.

Benchmarking potential methods to further mitigate risk to key processes is occurring with stakeholders in a closed working group. MISO is working to validate communication diversity through the utilization of multiple communication providers consistent with utility best practices. Further, MISO is following research being conducting by the EIS Council and EPRI around the Black Sky Emergency Communication and Coordination System ("BSX"). The BSX may mitigate the unavailability of the communication backbone.

In addition to those studies, MISO utilizes simulation based training for itself and members as part of its power system restoration drills and hurricane preparedness drills. This simulation based training was also use for the control room as part of the GridEx IV exercise. To enhance the training to include other resilience risks, MISO has expanded participation to include positions beyond reliability coordinator and cybersecurity. Further, MISO plans to include the market operation positions in its next hurricane drill, which is conducted on an annual basis.

MISO's ongoing training is necessary to enable better response and communication as conditions continue to change and evolve. MISO stakeholders are actively engaged in mitigation planning, and have identified numerous touchpoints between the broader industry and government agencies. As identified by the Electricity Subsector Coordinating Council, twenty-one different entities may be involved in a multi-state event. Clear rules exist on expectations for reporting to DOE, FERC, NERC and the RTO/ISO. Large-scale gas contingencies impacting an entire pipeline have not been explicitly analyzed, though many smaller scale gas contingences have been reviewed.

Additional clarity from the Commission on how coordination is addressed at the national level amongst federal agencies would be beneficial for Balancing Authorities. Currently, it is unclear which federal entities should be contacted in the event of an incident or potential risks related to incidents. MISO urges the Commission to consider opportunities to partner with other federal agencies to provide proactive guidance on federal agencies that should be included to help streamline event coordination.

(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.

MISO Response

To determine whether potential threats may require mitigation, MISO applies a risk framework that utilizes qualitative criteria to predict risk impact and likelihood. These items are incorporated into a heat map that depicts events with the highest potential risk. MISO also reviews benefits associated with the interconnected nature of the transmission system.

As explained above, MISO continuously reviews high-impact, low-frequency events and looks for opportunities to improve. Communication with the impacted transmission operator increases as an event occurs. MISO actively takes steps to prepare for an event, such as hurricanes, where advanced notice exists. Distribution system operators perform the bulk of the restoration activities with MISO providing oversight when the restored area is ready to interconnect. MISO applies the requirements of the NERC standards along with discussion with regional stakeholders to determine mitigation steps. This includes NERC TPL-001-4 Extreme Event analysis and CIP-00-14 Physical Security evaluations for which MISO provides independent review of the critical transmission facility analyses performed by member transmission owners.

(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?

MISO Response

High-impact, low-frequency events are continually evaluated within the MTEP planning process to ensure that actual and projected changes to the system do not result in unanticipated impacts to the system. Nonetheless, evaluating whether further steps are necessary to ensure the system is capable of withstanding or reducing the magnitude of these high-impact, low-frequency events is challenging. In certain situations, the system may not be capable of

withstanding the event without some loss of load. Hurricanes, tornadoes and ice storms likely will harm the transmission and distribution system. Reducing the impact of the high-impact, low-frequency event is accomplished by learning from the event and implementing techniques that lessen the impact of future risks.

(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?

MISO Response

MISO agrees that there are many components and system level characteristics designed into the electric power system that support resilience. These components work in aggregate to allow the system to withstand the vast majority of high-impact, low-frequency events. At the component level, protection systems are specifically designed to clear system failures at high speed, with high availability, before system faults escalate into additional component failures, including machine or system instabilities. Reclosing schemes enable immediate restoration of faulted transmission facilities associated with temporary fault events. Redundant and back-up protection schemes anticipate component failures in their design. In some cases Special Protection Systems are employed that provide additional protection for lower frequency events and involve automated corrective actions remote from the direct facility under fault conditions. Other protection schemes such as “under voltage” and “under frequency” provide for controlled fast automatic reductions of selected loads to mitigate the extent of more severe low frequency events.

Transmission facilities, including transmission lines, are generally designed with ratings that provide considerable margin to protect against loading levels that trigger catastrophic stability and/or cascading issues. System design factors in multiple critical element failures

affecting the same load area at the most critical load levels as a means of building "withstand" capability into overall system design.

In addition to the transmission component and design features that support resilience, generation supply plays a key role. The location of Fast Start generating facilities in high load areas can reduce stress on the transmission system during times of critical generator outages. Fuel diversity within market resources, together with geographical diversity of resources, mitigates events impacting specific fuel resources or geographic areas. Resource planning reserve margins based loss of load expectation criteria, together with planning for deliverability of all network resources, ensures robustness of supplies against greater than typical forced outage conditions. In the event that a large area of the system loses load, Black Start plans and procedures are in place and reviewed for effectiveness in re-energizing those areas.

At the system level, the integrated nature of the bulk power system helps support resilience. Since the bulk power system is a synchronous interconnected system, generation units with governor response throughout the Eastern Interconnection provide primary frequency response to assist in managing the frequency of the system. Coordination in the planning and operation of the bulk power system, including visibility into the status, flows and response of the equipment in the field all strengthens system resilience to a risk event. Operating reserves provide the capability to respond to unanticipated events in a timely manner. Emergency ratings and ramp capability, including the ability to order off-line generation (or shed load) provide operational flexibility that supports shared resilience objectives.

Synchrophasor information has been beneficial in understanding the dynamic and transient behavior of the bulk power system. MISO is improving its dynamic modeling information by comparing actual performance information to modeled performance. Specifically,

MISO is refining details within its dynamic modeling to reflect current performance in the field. Improved modeling performance will help MISO better predict possible voltage or transient issues. Further, these improvements will support operating plans to reduce the possible impact of the voltage or transient issue.

(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?

MISO Response

MISO's member asset owners are responsible for the design standards applicable to their transmission and generation equipment. MISO supports system design through analysis and planning of the aggregate transmission system in accordance with applicable local, regional, and national standards. Accordingly, MISO focuses on essential reliability services rather than physical resource attributes.

(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.

MISO Response

Extreme weather affects various generation technologies differently. Very hot summer days can impact coal and gas generation differently than renewable generation. Large generation units located on rivers may need to limit output to avoid releasing water that is too warm into the river. Droughts may impact run of the river hydro as well as generation units located on rivers, as opposed to wind or solar facilities.

Cold weather may result in non-firm gas being unavailable to purchase resulting in gas generator(s) outage or switching to alternate fuel. Wind turbines may be exposed to icing and unable to generate. As a result, many wind generation resources have installed cold weather packages to be able to operate in extreme cold. High wind may result in over-speed conditions where the wind generation is taken off-line MISO considers each of these differing impacts in preparing the system for resilient operation during critical system conditions.

MISO conducts a winter generator fuel survey and holds an annual winter readiness workshop in addition to summer readiness efforts. This survey focuses on fuel supply and supports a better understanding of existing fuel supply contracts that are in place as well as a common understanding of the status of generation prior to the winter season. MISO also receives icing predictions from wind forecast providers.

(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?

MISO Response

Generation, transmission and distribution systems must work together to provide electricity to end-use customers. Overhead transmission and distribution lines are exposed to high winds, extreme cold (including ice), physical threats and cyber threats. Underground facilities are susceptible to flooding, physical threats, cyber threats, longer restoration times, and higher failure rates due to the need for continuous cable insulation systems. Reviewing the performance of all of the components of the bulk power system following a threat and implementing improvements will strengthen the capability of the bulk power system. The review should consider critical infrastructure performance such as energy management systems, telecommunications, firewalls, and emergency services.

The vast majority of loss of load events and cumulative interruption time per customer or megawatt are associated with the distribution system. While far fewer events are caused by disruptions to the transmission system, transmission disruptions may cause more widespread outage impacts when transmission outages do occur. As noted in comments submitted by the Organization of MISO States ("OMS") to MISO's Advisory Committee, resilience issues are likely to originate within state and local distribution systems.[10] State and local regulators continue to address resilience risks that are more prone to occur on the distribution system. The Commission should continue to engage with State and local regulators, including the OMS and the National Association of Regulatory Utility Commissioners, on these resilience risks.

(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?

MISO Response

MISO performs extreme event analysis annually as described in response (c). In addition to the risks identified in MISO's risk register that are being closely monitored on a routine basis, MISO evaluates system performance impacts of extreme events for near, intermediate and longer term horizons – typically 2, 5, and 10 years forward. Results of these evaluations inform impacted stakeholders of the extent of the impact of such events. Additional dialogue is needed with regional stakeholders and State regulatory bodies, on the cost and value of mitigating low-frequency events.

Following large natural or man-made events, MISO conducts post event assessments to facilitate lessons learned. These reviews help identify potential areas for improvement. The

[10] Organization of MISO States "Hot Topic" Response (February 28, 2018) https://cdn.misoenergy.org/20180328%20AC%20Item%2002%20OMS%20Hot%20Topic%20Comments139611.pdf.

broader energy industry has been especially collaborative in sharing information and lessons learned, to help build a more resilient bulk power system. For example, NATF and NERC's "Lessons Learned" provide avenues to identify improvements and best practices that anticipate, absorb, adapt to, and/or rapidly recover from future events.

As previously discussed, MISO's winter readiness generator survey supports MISO's planning and operations prior to the winter season. Similarly, ad-hoc generator surveys ahead of forecasted extreme weather provide operations with transparency around resource fuel availability and generator preparedness. With high-impact seasonal events including hurricanes and winter icing, communication between MISO and the transmission operator increases to help inform planning and operations. However, MISO notes that much of the responsibilities around hurricane and seasonal weather planning rest with local utilities and State agencies.

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

MISO Response

MISO has many touch points with neighboring regions, including national forums, to share views on risks and assessments of threats. MISO coordinates planning issues, reviews, and assessments under Joint Operating Agreements with neighboring entities on a continuous basis. Best practices are shared amongst RTOs and ISOs through the ISO/RTO Council, industry-wide through the NATF. The NATF's vision is to promote excellence in the reliable and resilient operation of the electric transmission system. Current NATF initiatives include resilience (GMD, EMP, security), operations, 345 kV breakers, Minimum Vegetation Clearance Distance ("MVCD"), and human performance near-miss reporting. In addition, MISO participates in the Eastern Interconnection Planning Collaborative that coordinates planning models and issues

reviews for the interconnection. MISO also participated in the Single Point of Disruption ("SPOD") analysis performed by NERC and the Argonne National Laboratory.

Other industry best practices are achieved through participation in reliability peer groups. Coordination with our Regional Entities, Midwest Reliability Organization ("MRO"), Reliability First ("RF"), and SERC Reliability Corporation ("SERC"), helps promote and facilitate effective communication of potential threats and concerns. MISO actively participates in electric sector events hosted by Regional Entities. Likewise, MISO actively partners with neighboring RTOs/ISOs to share in best practices and collaborate on lessons learned following an event. Former, MISO participates in security working groups and executive forums to stay abreast of current threats and mitigation options.

Identification of resilience threats and mitigation needs are often discovered through simulation and drills. Simulation-based training is paramount to planning for risks associated with high-impact, low-frequency events. MISO hosts hurricane preparedness drills using simulator-based tools with the Transmission Owners and Local Balancing Areas to help the MISO community to be better prepared for an event. NERC-sponsored GridEx drills are a very important source of identifying potential risks and areas for improvement. Summer and winter readiness drills include MISO, MISO members, State regulators, and neighboring RTO/ISOs.

(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?

MISO Response

MISO utilizes industry best practices and has generally been successful in obtaining sufficient data to protect against resilience risks. Information is obtained through coordination with grid planners, operators, and other stakeholders. These system analyses are able to identify system failure modes that are representative of historic and projected low frequency failure

modes. Even with this information, it is sometimes challenging to weigh the costs of mitigating certain risks with preventative benefits.

While these processes have been effective at gathering information, there are still obstacles present that make it more difficult to obtain additional information that would be beneficial to assessing resilience threats. Obstacles include the ability to share relevant information between critical infrastructures and with the federal government. As commonly discussed in gas-electric coordination forums, the approach taken to model electrical system problems does not translate directly to gas infrastructure. Developing a common understanding of issues and being able to communicate more effectively will facilitate access to valuable data that can help assess resilience risks.

Gathering data for modeling risk scenarios will also be beneficial to assessing resilience risks. There is no common topology information for pipeline modeling across the industry, nor is there a uniform post event reporting requirement. A process similar to the NERC Multi-Area Modeling Working Group ("MMWG") modeling process that unifies modeling to create baselines would be extremely helpful. The MMWG process would involve a gas industry-wide effort to develop a standardized gas pipeline system model to be used in reliability analyses. Gas industry participants would submit standardized modeling data for their system, so that the gas and electric industries would have an off-the-shelf base case model to perform reliability analyses.

The Commission's Office of Energy Infrastructure Security has been helpful in addressing some of these obstacles by facilitating collaboration between federal, state and industry in identification and communication of risks and vulnerabilities. Nonetheless, challenges still exist in developing holistic processes that protect sensitive information while

enabling the necessary personnel with tools to develop robust plans with the relevant prioritization.

(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.

MISO Response

Yes. Following the 2014 Polar Vortex, MISO collaborated with stakeholders through its Electric and Natural Gas Coordination Task Force to produce an issue summary paper.[11] This paper documented MISO and stakeholder observations, challenges, and lessons learned.

Lessons learned from the 2014 Polar Vortex have been implemented and resulted in MISO being better prepared for the extreme cold snap that occurred in January 2018. These lessons facilitated the establishment of an internal gas/electric team that has been collaborating with stakeholders and the industry to increase MISO (and the pipelines) situational awareness and ability to respond. MISO has started reviewing the January 2018 cold weather information to identify opportunities for improvement.

In addition, NERC and industry members have processes in place and participate in analysis of high-impact, low-frequency events that have resulted in NERC Standard Authorization Requests ("SAR") to resolve any gaps in reliability standards that may have contributed to these events. MISO participates in the NERC Standards development process to help improve grid reliability and resilience.

[11] *See* 20141009 ENGCTF Issue Summary Paper - Polar Vortex, MISO and Stakeholder Polar Vortex Experiences with Natural Gas Availability and Enhanced RTO/Pipeline Communication. https://www.misoenergy.org/stakeholder-engagement/committees/retired-committees/#/entityname|ENGTF/year|2014.

(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.

MISO Response

RTOs/ISOs, including MISO, have realized FERC's vision of efficient and open access of the transmission system as memorialized in Order No. 2000. End-use consumers of entities participating in RTOs/ISOs are enjoying numerous benefits, including: improved efficiencies in transmission grid management through improved pricing and congestion management; improved parallel flow management; more efficient planning; improved reliability; improved market performance; and lighter handed regulation.[12] The scope and configuration achieved by the current RTOs/ISOs, including MISO, have exceeded that vision, unlocking billions in annual benefits to our membership through enhanced reliability, more efficient use of existing transmission and generation assets, reduced need for new assets, and region-wide grid planning and management. MISO's regional scope provides resilience as described in a 2015 Lloyd's of London report on the risks of a cyber-attack on the U.S. power grid:[13]

> Regional resilience of grid - The disruption of power delivery in the US cannot be achieved by disabling a single generator. The grid system compensates for losses in generating capacity and manages considerable variation in capacity at any one time, through load balancing and importing power from neighbouring regions via market mechanisms. The regional structure of the US electricity market makes it resilient.

The Commission has been very supportive of the RTO/ISO and NERC efforts on resilience. Assisting the RTOs/ISOs as they consider resilience processes from an interconnection perspective will only make the community stronger. Requesting relevant natural gas subsector information and other critical infrastructure considerations will be important next

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[12] *Regional Transmission Organizations*, Order No. 2000, FERC Stats. & Regs. ¶ 31,089 (1999).

[13] *See* Lloyd's Emerging Risk Report 2015. https://www.lloyds.com/~/media/files/news-and-insight/risk-insight/2015/business-blackout/business-blackout20150708.pdf.

steps. Communications, energy, and water are all considered lifeline critical infrastructures and need to work together to improve resilience.

C. How MISO Mitigates Threats to Resilience

(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.

MISO Response

MISO has developed and enhanced many policies and procedures as part of its ongoing resilience assessment. Various threats to bulk power system resilience, whether physical security, cyber security, natural gas-electric coordination, or hurricane preparedness, each have a policy and/or procedure for use by control center operators and other MISO personnel. System threat protocols are reviewed and updated on a periodic basis. Training sessions, including drills and readiness workshops, are provided to stakeholders along with a comprehensive set of protocols to communicate and coordinate with state regulators. Readiness drills typically use the Dispatch Training Simulator and other simulator tools to enhance the participant experience. In addition to the above mentioned readiness drills, MISO participates in national resilience drills including GridEx.

These drills are not only beneficial to understanding physical threats but also cyber risks. Cyber threats are mitigated using a formalized cyber security incident response plan. MISO's cyber security incident response plan is tested annually through paper drills and participation in activities. When a resilience event occurs (e.g., capacity emergency, hurricane, loss of real-time monitoring tool, etc.) MISO performs an event review, which includes root cause analysis (if

applicable), procedure review and updating, and sharing lessons learned. MISO also participates in NERC's voluntary Event Analysis Program, which facilities industry-wide information exchange in order to promote reliability excellence.

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

MISO Response

MISO's market based mechanisms are utilized in its Resource Adequacy Construct, Day-Ahead and Real-Time Energy and Ancillary Services Markets, congestion management processes, and interconnection seams processes to support resilience as highlighted below.

Resource Adequacy

MISO's Resource Adequacy Requirements provides mandatory requirements to be met by MISO and Market Participants serving Load in the MISO Region. These requirements are designed to ensure access to deliverable, reliable and adequate supply to meet Coincident Peak Demand and zonal Peak Demand requirements on the Transmission System. These requirements recognize and are complementary to the reliability mechanisms of the States and the Regional Entities ("RE") within the MISO Region. MISO's Tariff recognizes and supports the independent authority of State regulators over generation resources. This longstanding recognition is acknowledged in MISO's resource adequacy programs, which are designed to complement the reliability mechanisms and authority of the MISO states. To enhance balancing opportunities among utilities, MISO offers a resource adequacy construct, including a voluntary Planning Resource Auction ("PRA"), specifically designed to facilitate voluntary trades between and among its members. These requirements establish standards, qualifications, and minimum levels of capacity, assuring MISO is able to meet system needs ahead of each planning year starting on June 1st.

These Resource Adequacy processes mitigate risks associated with high-impact events. As a result of the proactive measures taken by the MISO States, coupled with the PRA as an additional tool to procure capacity resources to meet reliability requirements, MISO currently has a sufficient amount of excess resources (on a regional basis) to support grid resilience.

Day-Ahead and Real-Time Energy and Ancillary Services Markets

Day-Ahead and Real-Time Energy and Ancillary Service Markets provide centralized unit commitment, dispatch, procurement and deployment of Operating Reserves. MISO provided comments in response to the Department of Energy's proposed resilience rule[14] describing how market enhancements have improved energy price formation, and value resource reliability attributes on a fuel-neutral basis. These comments addressed price formation, including advances in demand participation, valuing reliability attributes, and scarcity pricing during normal operations and emergencies.[15]

Recent initiatives, including Extended Locational Marginal Pricing ("ELMP"), as well as the creation of Ramp Capability and Emergency Pricing products, have made additional progress towards improving energy price formation in MISO's Day-Ahead and Real-Time Energy markets. ELMP enhances price signals by providing more transparency into the costs that resources incur in order to meet demand obligations. The Ramp Capability Product enforces ramp requirements based on anticipated system ramping needs and helps to reduce price volatility and scarcity pricing. Recent Emergency Pricing reforms have also helped to ensure proper value for all resources that support reliability during short-term periods of tight supply,

[14] *See* MISO's October 23, 2017 comments in RM18-1-000 at P. 7-8.

[15] *Id.*

such as summer peak conditions. Collectively, these reforms improve price transparency and allow resources to recover costs associated with the reliability value they provide.

MISO values discrete reliability attributes for generation resources through proven market-based mechanisms and continues to work with stakeholders on further market-based reliability improvements. Through its Market Roadmap, MISO is exploring several initiatives including: enhanced modeling of combined cycle generators; multi-day market commitments; revisions to its Energy Offer Cap and Value of Lost Load, and; additional enhancements to ELMP. Future initiatives also include an Automatic Generation Control ("AGC") Enhancement that will improve regulation service through better utilization of fast-ramping resources.

MISO is also exploring short-term operating reserve and reliability requirements that incent resource participation and mitigate Voltage and Local Reliability constraints. MISO's Market Roadmap process is intended to prioritize mechanisms that provide the most value and can be implemented in a cost effective manner.

Congestion Management

In Order No. 2000, FERC established the requirement for RTOs/ISOs to provide market mechanisms for congestion management, producing "efficient price signals regarding the consequences of [market participant] transmission usage decisions.[16] While FERC's declaration that "traditional approaches to congestion management such as those that rely exclusively on the use of administrative curtailment procedures may no longer be acceptable" has resulted in the near extinction of use of those procedures in RTOs/ISOs including MISO, other, non-RTO system operators continue to rely on them entirely.

[16] *Regional Transmission Organizations,* Order No. 2000, FERC Stats. & Regs. ¶ 31,089 (1999).

The advancement of RTO/ISO energy markets over the past decade facilitated solutions that may be more effective than TLR processes that rely on regional curtailments for localized congestion management. Superior market-based congestion management tools, including redispatch, seams coordination, and market-to-market processes improve reliability and reduce costs compared to TLR. These methods are proven to be more reliable and cost effective even in non-RTO systems.

Local redispatch permits rapid congestion management to meet fast changing conditions without over-curtailing. This method manages congestion in real-time and allows operators to target the congested area and make localized decisions based on real-time data. This flexibility to address congestion at the local level reduces the impact TLR decisions have on the broader Bulk Electric System. Redispatch also utilizes the least amount of power necessary to relieve congestion, which in turn allows generation not redispatched to be available for the next potential problem on the grid. This ability to quickly adjust the system following unplanned events improves resilience.

Seams

Improved coordination across the seams within each interconnection allows the grid to more effectively leverage the supply and demand diversity across each interconnection. During times of operational stress, excess supplies in neighboring regions can provide much needed relief. For example, during the Polar Vortex, intra-regional transfers helped support reliable operations in both RTO/ISO and non-RTO/ISO regions affected by the extreme event.

MISO continues important work with its seams partners to enhance operational coordination. For example, MISO's sophisticated operations at the seams enhances reliability and resilience with RTO neighbors providing an elegant, least cost congestion re-dispatch, which

reduces the dependence on less sophisticated curtailments of transmission service between regions such as the backstop NERC TLR process based on the technologies of the 1960s. MISO continues to advance the Joint and Common Market initiative with PJM through enhancements such as interface pricing and coordinated transaction scheduling that both improve pricing efficiency and ultimately reliability at the seams.

The maximization of the use of the transmission system (e.g., contract path sharing at the MISO – PJM border) has become the model for seams operation. In addition, MISO continues to collaborate with SPP and other non-RTO neighbors to advance inter-regional operational improvements to further enhance grid reliability and resilience. MISO encourages the Commission to continue to promote advancements in seams coordination to ensure that resources across the interconnection can be effectively leveraged to respond to unexpected events and disturbances on the system.

(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.

MISO Response

MISO provides other generation and transmissions services that support resilience. Black Start service is paid to generators that have the ability to reenergize an area without outside support. Black Start units are the building blocks for Transmission Operator restoration plans. MISO has the authority to make emergency energy purchases or sales to maintain the integrity of the Bulk Electric System. Reliability Coordination service provides monitoring of the transmission system and oversight to balancing authorities. Other transmission services MISO offers that support resilience include: HVDC Service; Interconnection Agreements; System Support Service Agreements; Transmission Service Agreements; Wholesale Distribution Service Agreements, and; Power Factor Correction Service.

(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?

MISO Response

NERC Reliability Standards provide for common operating parameters across the grid. Generally, they are designed to ensure appropriate response to threats on a contingency basis for long-term, near-term and real-time periods. Certain NERC Reliability Standards also directly support resilience by requiring the development and implementation of restoration and recovery plans, which seek to ensure that the Bulk Electric System can be recovered following a widespread outage. The NERC Standards focus on system restoration, recovery of critical cyber assets, and response to cyber security incidents. Other NERC Standards support resilience indirectly, e.g. by ensuring off-site electrical power to nuclear facilities.

NERC's compliance monitoring program provides oversight of the development of such resilience efforts. Not only are the requirements of the NERC Standards subject to audit and resulting enforcement proceedings, the audits and other compliance monitoring efforts also provide a touchpoint for continuous improvement even when entities meet baseline compliance requirements.

(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.

MISO Response

Yes. There are opportunities to modify NERC TLR processes and associated NAESB TLR Business Practices to enable a much more resilient operation of the Eastern Interconnection ("EI"). Currently, TLR can be a threat to resilient operations because a Reliability Coordinator may block and curtail power transfers across the EI, even when viable redispatch options are

available to facilitate the original transaction reliably. These transfers may be vital to withstanding and reducing the magnitude and/or duration of a disruptive event. TLR may be slow and is typically an hourly process. Rather than curtailing power transfers through TLR, Reliability Coordinators should work together on managing congestion through redispatch of generation, with appropriate compensation, to enable transfers to reliability continue. More coordinated operation of the EI would enhance reliability and resilience and support more economic management of the EI.

Resilient operations may also be harmed through proxy or substitute flowgates to control constraints. A typical proxy flowgate is a combination of higher voltage facilities in the area of the actual transmission constraint. Proxy flowgates can be used to circumvent the TLR five percent transmission distribution factor ("TDF") threshold established by NERC to identify power flows that are significantly impacting a local transmission constraint.

By utilizing TLR on a proxy flowgate, a Reliability Coordinator essentially curtails a large amount of power flows over much wider area instead of locally managing the constraint through redispatch. In the event that the five percent TDF does not identifying enough flow to solve a constraint, and the Reliability Coordinator is unable solve the constraint, Reliability Coordinators are able to utilize protocols that lower the threshold, while still being more precise through joint redispatch in managing the constraints.

The increasing complexity of the grid, with additional wind, solar and gas generation, has catapulted the industry to a place where reliability and cost-effectiveness is dependent on more flexible methods to balance supply and demand. Curtailing schedules between regions may be an inherently ineffective operational tool, as efficiencies developed through inter-regional planning

processes are minimized. Opportunities exist to better coordinate across the EI by using modern congestion management methods for improved reliability, efficiency and resilience.

Congestion may be better managed at the local level in a coordinated manner. TLR should not be considered as the default method to keep power flows within safe and reliable operating limits. Redispatch, seams coordination, and market-to-market processes are more reliable, cost effective methods to relieve congestion, even in non-RTO systems. While such efforts will take effort and time within the industry, with the Commission's leadership, there is the potential for significant reliability, efficiency and resilience gains.

FERC should also continue to promote industry progress on congestion management mechanisms. Order No. 693[17] facilitated MISO and PJM work with NAESB to develop a future path for TLR through coordination with NERC. Enhancements to the TLR procedure would be split into a reliability component managed by NERC (known as Future Path of TLR Phase 1) and an equity component managed by NAESB (Future Path of TLR Phase 2).

Phase 1 will be utilized to support Parallel Flow Visualization ("PFV"). PFV seeks to improve the wide-area view of Reliability Coordinators in the Eastern Interconnection providing a better understanding of the current operating state of the Bulk Electric System. PFV addresses an Interchange Distribution Calculator ("IDC") shortcoming by having operators submit real-time generator output every 15 minutes along with the type of transmission service for each generator.

At this time, MISO has not identified any other major market-based construct modifications necessary to bolster resilience, although continued evolution of markets to meet

[17] *Mandatory Reliability Standards for the Bulk-Power System*, Order No. 693, 120 FERC ¶ 61,053 (2007).

reliability needs must continue, including expansion of market-constructs, particularly in inter-regional congestion management as discussed above. Through the Market Roadmap process, MISO and our stakeholders continue ongoing evaluation of energy market design and performance and the practices of other best-in-class electric market performers. Based on this process, MISO identifies ways to improve performance and increase value to its member markets. Together with stakeholders, MISO incorporates the highest value enhancements and products throughout the development life cycle. The Market Roadmap guides the ongoing development and implementation of projects that enhance MISO's suite of market services.

III. COMMUNICATIONS

All correspondence and communications in this matter should be addressed to:[18]

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[18] MISO requests waiver of section 385.203(b)(3) of the Commission's regulations to permit the designation of more than two persons upon whom service is to be made in this proceeding. 18 C.F.R. § 385.203(b)(3) (2016).

IV. NOTICE AND SERVICE

MISO notes that it has served a copy of this filing electronically, including attachments, upon all Tariff Customers, MISO Members, Member representatives of Transmission Owners and Non-Transmission Owners, as well as all state commissions within the Region, and the Organization of MISO States. In addition, the filing has been posted electronically on MISO's website at https://www.misoenergy.org/legal/ferc-filings/ for other parties interested in this matter.

V. CONCLUSION

MISO's extensive review of external risks has led to investments in leading technologies and security tools to mitigate cyber and physical threats to MISO's operation of the grid. MISO's MSE will fortify MISO's ability to protect against cyber and physical-security threats and establishes a foundation for putting new market products in place to respond to changing conditions. In addition, MISO is focused on robust transmission planning processes, executing market rule changes guided by the Market Roadmap, utilizing operations drills and simulations, improving visibility into gas-electric coordination and continuous improvement into system visibility.

Opportunities to further improve and enhance resilience should continue across the industry in a collaborative manner. Continued industry dialogue on effectively valuing resilience in transmission planning processes and ensuring CIP standards provide the flexibility to allow for the adoption of industry best practices will help the Commission identify and consider key resilience issues. To the extent FERC is considering resilience issues on the distribution system it should engage in coordination with State and local regulators.

There is an opportunity to ensure that artificial barriers that may affect inter-regional transactions do not adversely affect resilient grid operations. Processes that support more frequent and flexible congestion management and widespread usage of tools that support improved system visibility across seams, will promote more resilient grid operations. MISO looks forward to continuing this dialogue with the Commission and appreciates the opportunity to participate in this important industry endeavor.

Respectfully,

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CERTIFICATE OF SERVICE

I hereby certify that I have this day e-served a copy of this document upon all parties listed on the official service list compiled by the Secretary in the above-captioned proceeding, in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2012).

Dated this 9th day of March, 2018 in Carmel, Indiana.

/s/ Julie Bunn

Julie Bunn

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Document Content(s)