RASC-2022-1 Environmental Sector Comments

The Environmental Sector appreciates the opportunity to submit stakeholder feedback regarding Identification of Sufficient System Reliability Attributes (RASC-2022-1), and more broadly, on the System Reliability Attributes effort that MISO has been engaged in for nearly a year. We are supportive of the current direction of efforts, including the recently released Attributes Roadmap. Our sector does have questions regarding MISO's approach to ensuring a holistic assessment of system risk and accurate appraisal of necessary system reliability attributes. The success of solutions coming out of this effort is dependent on how well MISO's evaluation of risk and need reflects the potential challenges to reliability, both during and after the expected fleet transition.

The Environmental Sector offers the following comments responding to the questions MISO posed in the MISO presentation on November 8, 2023 at the RASC (RASC Presentation), and references the System Reliability Attributes Analysis and Roadmap Workshop #2 presentation on October 31, 2023 (Workshop), the December 2023 Attributes Roadmap (Roadmap), and the Roadmap's accompanying Technical Appendix (Technical Appendix). Section headings match those used in the MISO's Attributes Roadmap, with the addition of two more sections on specific issues that may overlap the three provided by MISO.

An overarching request for future presentations is that MISO reference the specific appendix slides relevant to each topic being covered on slides in the primary presentations. This can help answer stakeholder questions efficiently before material is presented and ensure that the right questions are asked in stakeholder meetings. Additionally, MISO should include a link to the Technical Appendix within the Attributes Roadmap document itself.

System Adequacy

MISO states under System Adequacy Insight #1 that "Accreditation is aligned with the risk distribution, regardless of the underlying sources of risk modeled, and keeps track of the contribution of individual resources." This should always be true under MISO's proposed Direct-LOL accreditation process, because that accreditation process explicitly accredits resource classes based on their performance during the highest-risk periods MISO identifies in its LOLE Model. While it is helpful to know that MISO's proposed accreditation accurately tracks modeled performance under a variety of forecasted risk scenarios, the value of that correlation is only as good as the accuracy of MISO's LOLE Model. Thus, this "insight" does not necessarily demonstrate that MISO's proposed accreditation is aligned with actual risk periods. For instance, we note that MISO has not modeled a broad range of future scenarios. MISO should explain more clearly why their approach to accreditation *accurately* tracks risk, aside from results provided by the model, and thus why it is a good approach to use.

Indeed, we'd prefer to see MISO demonstrate that its modeling *does* track those risks. There are three primary risks modeled in SERVM – load forecast uncertainty, renewable energy production, and thermal forced outage rates. Some comparison of the types of risk periods identified in the LOLE model and actual historic risk periods would help ensure that the LOLE model is reasonably representative of actual risk periods MISO has faced. MISO can perform a reliability backcast of one or more historical years holding two of these variables at fixed values and letting the third vary to determine how the actual historical outcome of these variables lands in comparison in the distribution of potential outcomes in the LOLE model. This exercise would be immensely helpful to build stakeholder confidence in the LOLE model; it's our understanding that Astrapé has done these types of backcasts in many jurisdictions and can help with the details of how MISO would set these simulations up.

The Environmental Sector appreciates the System Adequacy effort directionally, but we continue to have questions regarding MISO's approach, as noted in previous comments submitted to the RASC in regard to the Direct-LOL accreditation approach and above. The seasonal time series of accreditation values in the System Attributes presentation further demonstrates how sensitive the Direct-LOL approach is to relative penetration of different resources and external factors, like daily hour of sunset, planned maintenance, and battery dispatch assumptions.

MISO's System Adequacy effort is also narrowly focused on capacity and accreditation. We are concerned that this narrow focus is insufficient to address the need for adequate energy supply that is not sourced through thermal resources. More specifically, we are concerned that MISO's analysis regarding accreditation appears to be slanted towards incentivizing new gas capacity, which, for example, does not directly address fuel availability issues that have contributed to recent risk events like Winter Storms Uri and Elliott. A more thorough examination requires, at the very least, consideration of longer-duration storage (e.g. more than 4 hours) and long-duration storage (e.g. multi-day). Many long-duration energy storage (LDES) technologies are no longer experimental [1], having reached early stages of commercialization. A variety of examples exist—both domestically as well as internationally—that demonstrate the maturity of certain LDES technologies, emphasizing their relevance to the modern power grid [2].

The Environmental Sector recommends MISO prioritize more holistic representation of "emerging technologies," especially ESRs of varying durations. MISO's assumptions related to the availability and dispatch of ESRs are hampering the technologies' ability to provide attributes to the grid, including energy, during periods of risk. In addition to varying duration, MISO should also consider how its market structure may be an impediment to its use, especially over multiple hours or days of extreme risk events.

MISO also should provide more information on the modeling of the reliability contributions of energy storage. This should include a clearer explanation of how storage is dispatched in models. For example, it is unclear how storage is being dispatched in the scenario provided on Workshop slide 26 specifically, e.g, whether it is economic dispatch, based on risk, or scheduled. Additionally, what if 4-hour storage was dispatched at half its capacity for 8 hours and/or storage units were staggered, as has proven to be effective in other parts of the country? Another way in which to show this would be to require units to meet a 6 or 8-hour runtime for capacity accreditation purposes. In such an analysis, MISO may find that a longer duration (e.g. 6 or 8 hours) results in greater system optimization.

Specifically for the ERA scenario based on Winter Storm Uri, we would like to better understand how the dispatch of energy storage during risk events differs between the North and the South. The results on Workshop slide 27 are counterintuitive and could lead to inaccurate accreditation of resources. Instead of dispatching storage during this period, the higher level of storage ICAP in the North is charging while the South is shedding load because of a transmission constraint and its effect on price separation between the two subregions. It does not make sense to reduce the capacity accreditation of storage because it happens to be charging during a LOL event in MISO South due to lack of transfer capacity via the RDT. This RDT-caused price separation increases the accreditation of wind but decreases that of Energy Storage Resources (ESRs), appearing to falsely reward wind while penalizing ESRs. Additionally there is a concern that thermal units in MISO North may get accreditation for charging storage during the simultaneous risk period in MISO South. Yet, the effect would be that these thermal resources would be getting credit for serving storage charging load, though they also are not able to address the loss of load in MISO South. This in turn would seem to send a planning signal to overbuild ICAP, even though the real issue is deliverability of resources due to a transmission constraint and not their performance during risk periods. If anything, an appropriate approach would be to examine the impact on separating accreditation values of the North and South, not falsely rewarding or punishing resources because of how the RDT impacts the price signal of the two subregions.

MISO should be more circumspect in how the ERA scenario is designed, and we suggest that measures be taken by MISO to ensure that the RDT is independent of determining the accreditation of storage and other resources, in a manner that does not conflate resource performance issues with energy deliverability issues. We also encourage MISO to prioritize the ERA analysis' inclusion of "heat rates, fuel prices, and price-responsive storage dispatch to the BAU scenario" as stated in the presentation on Workshop slide 12.

MISO notes that the addition of "FLEX" units resulted in additional correlated outages in 2027 and 2032. Because FLEX units are modeled similarly to CT units, this outcome makes sense as gas units are highly susceptible to correlated outage risk in the winter. It would be worthwhile to see–as a counterfactual–FLEX units modeled as long duration energy storage (LDES) units so stakeholders can better understand how LDES would impact the results. We would not expect LDES to be as susceptible to correlated outage risks.

We also have a few questions with respect to assumptions used for stand-alone storage and hybrids on page 11 of the Technical Appendix:

- The chart indicates that the initial State of Charge (SOC) is set at 100 percent, and that it does not reset at the beginning of each day. Thus, at what point in time is the initial SOC set at 100 percent?
- Is there a duration element to the "Operation" consideration beyond just maximizing a resource's contribution during LOL events, or is duration otherwise included in the "maximization" of a resource's contribution during LOL events?
- Is it expected that hybrid battery resources will not be able to charge from the grid by 2027 or 2032? Are we forestalling an opportunity for hybrid resources to provide certain

services by assuming such capabilities will not be permitted? As an example, solar-storage hybrids could help with morning peak conditions if they were permitted to charge from a wind-heavy grid during the overnight period. This would be especially helpful in a dual-peaking situation when solar is only able to charge before an evening peak and thus may not be able to contribute again in the morning.

While we support MISO's initial analysis focusing on the Future 2A resource assumptions, using the results of only one future resource mix is inadequate going forward to fully understand the interactions of the many variables involved here or to base future policy on. MISO has stressed the importance of analyzing multiple scenarios, and we do not believe that only one future should be the sole scenario analyzed in the System Reliability Attributes effort. This is different from the consideration of more storage in the transmission planning process context because the current aim of the System Reliability Attributes effort is to understand how the grid may behave under a variety of evolving system conditions in the future, and it is from this analysis that MISO expects to develop new tools with which to manage the future grid.

One such possible, if not likely, system condition includes high penetrations of wind, solar, and storage beyond what is contemplated by Future 2A. We recommend that MISO analyze a range of resource mixes with the most important additional scenario being one with both high levels of renewables (such as Future 2A has) coupled with high levels of storage such as what would reasonably be expected to be interconnected based on the current MISO queue. Analyzing the results of two scenarios would give MISO and stakeholders greater insight in how penetration (and potentially location) of different variable resources affects capacity accreditation and other system attributes, and to understand how the grid may behave under a variety of system conditions in the future. And it is from this analysis that MISO expects to develop new tools with which to manage the future grid. In addition, MISO should consider non-optimized outage timing, among other variations. We are concerned that without these analyses, MISO may miss opportunities that will help it successfully meet the energy transition.

Similarly, while we understand why MISO would want to study extreme situations without factoring in the possibility of operator actions, it also would be worthwhile to study the risk including operator actions, such as utilizing interregional flows and operator actions in neighboring regions. Such an examination would help MISO understand which risks will be the most difficult to mitigate even with operator actions, which may not be otherwise identified as the highest-risk periods.

We also support MISO continuing to explore and report additional resource adequacy metrics, including EUE and LOLH to better understand the depth and breadth of system impacts during risky periods.

Flexibility

On Workshop slide 48, it would be beneficial for stakeholders to see a deeper dive into why the Day Ahead (DA) commitment of resources falls short. Tight margins often occur because of incorrect load forecasting assumptions, but is this the result of inadequate data being provided to inform the adequate commitment of resources? If so, what data would help MISO improve DA commitment from a Real Time (RT) operational standpoint?

The meaning of the term ‘extreme days’ on Workshop slide 37 and others, and in the Technical Appendix, is unclear. MISO should clarify. The underlying conditions leading to extreme days need to be more explicitly defined, and MISO should explain what proportion of this risk is generator outages, fuel unavailability, transmission limitations, or other forms of risk that are leading to ‘extreme days’. We note that MISO also refers to “stressed periods” or “stressed days”. MISO should explain the difference between “stressed” periods or days and “extreme days.”

More information on the concept of “net load uncertainty” as defined by MISO is needed, and how it is informed by load uncertainty as well as generation availability. Currently it seems only to be tied to the latter, but load uncertainty is an important consideration in net load as well. The contribution of different resources and the resulting net load shape represented is incomplete without the inclusion of energy storage, both charging and discharging, for example on Workshop slide 42. This is important to understanding the impacts that more energy storage would have on the grid, and it may show potential solutions that without such illustration are hidden from sight.

Additionally, on Workshop slide 49, it’s referenced at the bottom that “Quick start units are mostly Gas or Oil-fired Combustion Turbines (CTs), Hydro units and also FLEX units in future years”, but there is no inclusion of energy storage in that analysis. Again, this analysis is incomplete without the inclusion of energy storage. MISO has stated that it will consider different resource mixes for the Flexibility effort, and we again reiterate our recommendation that storage – short and long duration – specifically be represented in the net load uncertainty analysis going forward.

Risk days represented on Workshop slide 44 and Technical Appendix page 36 should show not just the day in which the risk occurred but also the hours and duration of that risk. That information is critical to understanding the characteristics of the risk and what type of quick start resources are necessary to address shortfalls. Regarding the latter, MISO should provide information on what proportion of quick start resources are deployed to meet the needs analyzed under modeled Extreme Events, and as stated above, quick start should also include energy storage resources.

The Environmental Sector is concerned about the sole focus in the multi-configuration resource model on Combined-Cycle Gas Turbines (CCGT’s) in providing fast response operational needs. We are encouraged by the recognition that ‘MISO should work to identify and mitigate any participation barriers for energy storage resources and co-located resources in MISO’s markets that could help enable the additional optimization of such resources.’ This work should also recognize the nuances related to the (lack of) availability of fuel for gas generation during risk events requiring quick start resources. MISO must also recognize that major events have been successfully managed in other markets with energy storage by ensuring adequate state of charge management and stacking of resources to prevent load shed. MISO must explore this potential on its own system.

Ensuring state of charge for energy storage resources is crucial for quick start capabilities but so is maintaining fuel availability for CCGTs. It should not be simply assumed that gas resources will maintain adequate supply during extreme events given that during recent events like winter storms Uri and Elliott, lack of gas supply was a major contributing risk factor.

System Stability

Generally, the Environmental Sector applauds the effort made by MISO to incorporate the cutting edge techniques of the dynamic impedance method to increase visibility of system stability. There is a growing body of research that supports MISO's main conclusion that "indicate[s] grid-forming controls will be an important part of the solution to counteract risks associated with declining system strength driven by traditional resource retirements" (Roadmap pg. 42). Given this fact, it is a reasonable position for MISO to start implementing performance requirements that "target control (i.e., software) capabilities without major cost implications" (Roadmap pg. 43) in the interconnection requirements. It is important however that these requirements be established with technology neutral definitions focused on the desired outputs from the technology and not on a specific technology itself. To that end, NERC is currently re-evaluating its standards under FERC Order 901 [3], which will provide direction on defining some of these characteristics (particularly ride-through) in MISOs interconnection process.

Page 45 of the Roadmap outlines new requirements for Inverter-Based Resources (IBRs) that will help strengthen the grid. These requirements, in particular black-start capability, should be implemented equally for all new generation interconnecting in MISO, not just IBRs. If IBRs are to be required to incorporate black start capabilities and/or power electronic upsizing to increase the reactive fault current injection, then new non-IBRs also need to meet these same requirements. These requirements should be defined by their characteristics as viewed from the point of interconnection (e.g. "the generator must be capable of injecting x reactive fault current"), not as a specific technology description (e.g. "the IBR generator will be equipped with grid-forming inverter as defined by MISO"). Alternatively, a better solution would be to evaluate, not require, black-start capability of new resources and provide a technology neutral incentive for providing the service. It appears that this is the intent as described on page 49 of the Roadmap where it states, "Solution: Require remaining support services to enable an inverter-based-resource-dominant system", but as written on page 45 it appears to be a requirement.

The Environmental Sector strongly agrees with the findings of the NERC Whitepaper cited as footnote 42 on Roadmap page 47 (NERC, "White Paper: Grid Forming Functional Specifications for BPS-Connected Battery Energy Storage Systems", September 2023) and is encouraged that MISO is considering phasing in these requirements through the stakeholder process. The recommendation to "assess industry readiness to expand grid-forming requirements to other IBR such as wind and solar resources without a storage component" (Roadmap pg. 48) is also well founded. While there are examples of non-storage IBRs providing grid-forming capability, the vast majority of IBR installations remain grid-following. However, the Environmental Sector recommends that MISO commits to taking the output of the System Stability analysis to identify locations where grid-forming controlled, non-storage IBRs could be piloted. This would help unlock the grid-forming inverter control stalemate identified by the Energy Systems Integration Group (ESIG) in their 2022 Grid Forming Technology report [4], and provide MISO operators the opportunity to better understand the capabilities of the technology in anticipation of broad deployment.

The solution outlined on page 49, “Evaluate targeted cost-of-service procurements to incentivize other technologies and the ‘energy buffer’ required for more advanced grid-forming inverter-based resource performance”, should incorporate a more holistic approach to evaluating technologies that can provide system stability benefits. STATCOMs, Synchronous Condensers, High-Voltage Direct Current (HVDC) Terminals, and grid-forming ESR systems can all provide system stability benefits but vary widely in the other benefits that they can provide. Grid-forming ESR systems can provide resource adequacy, energy price arbitrage, blackstart capability, and other services in addition to dynamic voltage response, whereas Flexible AC Transmission Systems (FACTS) like STATCOMS cannot. Voltage Source Conversion (VSC) HVDC terminals can provide significant transmission capacity benefits in addition to system stability benefits [5]. As a result, MISO should incorporate a net-benefit analysis that captures the various value streams of each technology as part of selecting the best cost-of-service procurement to provide the stability needs. If it is not feasible to perform this analysis at each location where stability needs exist, MISO should at least develop a screening methodology to identify locations where tools such as grid-forming ESRs or HVDC could be deployed to address multiple grid needs.

The Environmental Sector agrees with the findings on Roadmap page 50 that “Recent NERC event reports have indicated that there are reliability risks associated with inaccurate models and insufficient tool granularity,” and agrees with MISO’s recommendation to engage stakeholders in the effort to improve model accuracy. While the Environmental Sector understands the need to investigate the need for EMT simulation capabilities and operational sensing and monitoring technologies, MISO must be thoughtful in how requirements are developed to ensure they do not unreasonably burden IBR development and are equally required (to the extent it is applicable) to new non-IBR interconnections.

Finally, page 42 of the Technical Appendix states that grid-forming controls for IBRs were not considered as a solution under the RIIA study, and considering the importance of grid-forming controls discussed in the Roadmap and its Technical Appendix, we are wondering how MISO plans to adjust any conclusions that were formed as part of the RIIA study.

The Value of Transmission for System Attributes

MISO’s system attributes work and the Attributes Roadmap does not yet acknowledge the role of transmission in supporting or providing needed system attributes. We understand that MISO may see transmission as out of scope for this first round of analysis, but transmission must not be excluded going forward. Transmission plays a critical role in resource adequacy by ensuring that capacity can meet load in all locations within the MISO grid. It also has a clear role in supporting voltage stability and may also help to address other system attributes. MISO may be focusing in this paper on the system needs, but given the recommendations included in the Attributes Roadmap and ongoing work to understand the costs and benefits of potential solutions, it will be critical to make sure that the potential for transmission to provide and support the adequacy of these system attributes is evaluated in order to ensure the most cost effective overall set of solutions.

For example, along with MISO's other recommendations for improving the capacity accreditation methodology, consideration of transmission outages may also be important. And along with MISO's recommendations for new IBR requirements to support system stability, how can transmission also support this need, especially HVDC as discussed in the System Stability section above? As another example, what role may synchronous condensers play?

Low renewable, high net-load risk periods [6]

MISO should examine how the system may respond to conditions where load net renewable generation is high. Typically, strong cold waves are accompanied by strong winds. Thus, as penetrations increase, the winter risk periods may shift away from those with the coldest temperatures to those where temperature-driven load is high, but not at peak, and renewable generation is low. These may occur as a strong cold wave moderates or as part of less severe cold waves. MISO should examine the risk posed by these periods, and compare them to the risks already explored for major cold events. Further, MISO should explore which drivers are most important as wind penetration increases. Extreme load, or moderate load together with low wind and/or low solar, should be evaluated. When such events occur, it is important to understand how geographically broad the events are and whether support from neighboring regions is likely to be available. It would also be helpful to understand the impact of different geographic distributions of resources and resource combinations in order to send appropriate signals related to geographic diversity and future resource mix. It may also be useful to expand such analysis beyond the 14 weather years used in MISO's Attributes Roadmap.

The Environmental Sector acknowledges that a complete set of data of appropriate fidelity and accuracy covering long enough periods is not available. In the near term, and to minimize additional work, MISO could cherry pick particularly difficult events, such as the extreme cold experienced on and around December 25, 1983 and on and around December 23, 1989, though we recognize that currently available data makes wind and solar challenging to model during those periods. Long term, we hope that MISO will join with us in promoting efforts and supporting proposals to develop historical weather datasets that meet the needs of the electric power sector as weather dependence becomes increasingly central to risk analysis.

Endnotes

[1] Long Duration Energy Storage Council, "Long duration energy storage for the power system: a diverse field of technologies eager for deployment", September 2023, *available at*

https://www.ldescouncil.com/news/long-duration-energy-storage-for-the-power-system-a-diverse-field-of-technologies-eager-for-deployment/.

[2] Some recent relevant examples of LDES include:

- Form Energy's recent 30M USD grant to deploy a 100 hour battery for PG&E, which is expected to be operational as early as 2025, *see* https://www.utilitydive.com/news/form-energy-30m-grant-california-largest-long-duration-energy-storage/702765/#:~:text=The%20California%20Energy%20Commission%2C%20or,the%20grid%20for%20100%20hours;
- Xcel Energy's partnership with Form Energy to deploy two 100 hour batteries in both Minnesota and Colorado, which are expected to come online as early as 2025, *see* https://formenergy.com/form-energy-partners-with-xcel-energy-on-two-multi-day-energy-storage-projects/;
- Hydrostor's 500 MW, 8 hour compressed air energy storage (CAES) project in California, which is expected to come online as early as 2028, *see* https://pv-magazine-usa.com/2023/01/13/500-mw-compressed-air-energy-storage-project-in-california-secures-offtaker/; and
- Duke Energy's partnership with Malta Inc., a company that makes thermo-electric energy storage systems, to install a 100MW, 10 hour pumped heat system at the site of a coal plant, *see* https://news.duke-energy.com/releases/malta-teams-up-with-duke-energy-to-study-possibility-of-converting-coal-units-into-clean-energy-storage-facilities. Malta Inc.'s proprietary technology can be configured to provide up to 200h of storage, *see* https://ldescouncil.com/resources/the-malta-pumped-heat-energy-storage-phes-system/#:~:text=The%20base%20Malta%20plant%20can,media%20%E2%80%93%20the%20lowest%20cost%20components.

[3] FERC Order No. 901, 2023, *available at* https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20231019-3157.

[4] Energy Systems Integration Group, "Defining and Deploying Advanced, Grid-Forming Controls for Solar, Wind, and Battery Resources - Fact Sheet", 2022, *available at* https://www.esig.energy/wp-content/uploads/2022/03/ESIG-GFM-deployment-fact-sheet-2022.pdf.

[5] Brattle, "Brattle Consultants Highlight the Operational and Market Benefits of HVDC Transmission to System Operators in New Report", September 19, 2023, *available at* https://www.brattle.com/insights-events/publications/brattle-consultants-highlight-the-operational-and-market-benefits-of-hvdc-transmission-to-system-operators-in-new-report/.

[6] We appreciate that MISO has thus far restrained itself from using the term, "Dunkelflaute," as that term more appropriately applies to the specific conditions experienced in Northern Europe. The Environmental Sector also believes that the term "Dunkelflaute"—while trendy—is generally not applied accurately in the North American context and should, therefore, instead be described using a descriptive term, such as "low resource, high net-load period," at least until

such North American specific phenomenon is realized. The “Dunkelflaute” experienced in Northern Europe is based on a different set of geographic and meteorological variables than that which exists in MISO and the Eastern Interconnect. In Northern Europe, a Dunkelflaute occurs from the combination of a strong surface high pressure and surface inversion resulting in: a) little wind; b) fog and/or low cloud formation; and c) a temperature inversion with cold temperatures at the surface. By contrast, the Eastern Interconnect has not experienced “Dunkelflaute” type conditions, lending largely to being lower in latitude (meaning longer days) and a lack of a track record showing long duration blocking high pressure systems of the type experienced in Northern Europe, thus less likely to experience an extended period of low solar radiation in combination of low wind speeds.