Exhibit No.:	
Issue(s):	*Reporting*
Witness:	*Claire M. Eubanks, P.E.*
Sponsoring Party:	*MoPSC Staff*
Type of Exhibit:	*Surrebuttal Testimony*
Case No.:	*ET-2025-0184*
Date Testimony Prepared:	*November 3, 2025*

MISSOURI PUBLIC SERVICE COMMISSION

INDUSTRY ANALYSIS DIVISION

ENGINEERING ANALYSIS DEPARTMENT

SURREBUTTAL TESTIMONY

OF

CLAIRE M. EUBANKS, P.E.

UNION ELECTRIC COMPANY,
d/b/a Ameren Missouri

CASE NO. ET-2025-0184

Jefferson City, Missouri
November 2025

SURREBUTTAL TESTIMONY

OF

CLAIRE M. EUBANKS, P.E.

CASE NO. ET-2025-0184

Q. Please state your name and business address.

A. Claire M. Eubanks, and my business address is Missouri Public Service Commission, P.O. Box 360, Jefferson City, Missouri, 65102.

Q. By whom are you employed and in what capacity?

A. I am employed by the Missouri Public Service Commission ("Commission") as the Manager of the Engineering Analysis Department, Industry Analysis Division, Commission Staff Division.

Q. Are you the same Claire M. Eubanks who previously contributed to Staff's Recommendation in this case?

A. Yes.

Q. What is the purpose of your surrebuttal testimony?

A. The purpose of my surrebuttal testimony is to respond to the rebuttal testimony of the Office of the Public Counsel witness Dr. Geoff Marke on his recommended pre- and post- construction reporting recommendations with an alternate recommendation, and emergency curtailment. Additionally, I respond to Amazon witness Dr. Albert Bremser regarding his criticism of Ameren Missouri's proposed customer approval process.

REPORTING REQUIREMENTS

Q. Dr. Marke recommends in his rebuttal testimony certain metrics and studies be required. What requirements does Dr. Marke recommend?

A. Dr. Marke proposes on Page 45, lines 7-10, of his rebuttal testimony, pre-construction analysis and post- construction reporting metrics of:

- Power Usage Effectiveness ("PUE");
- Water Usage Effectiveness ("WUE"); and
- Total Harmonic Distortion ("THD").

Q. Does Dr. Marke intend for the Commission to receive the metrics or studies?

A. Yes. On page 37, lines 22-24, of his rebuttal testimony, Dr. Marke recommends that these metrics be reported to Ameren Missouri quarterly and Ameren Missouri be required to consolidate the information in an annual public report filed with the Commission.

Q. Is Staff opposed to an annual reporting requirement for Ameren Missouri to report to the Commission and the public on its large load customers?

A. No. However, Dr. Marke's proposal mixes and matches metric reporting with the suggestion of a larger study. Dr. Marke suggests metrics would be reported by individual customers to Ameren Missouri, with Ameren Missouri required to submit an annual report. However, later in testimony Dr. Marke recommends[1] a joint request for proposal ("RFP") be issued for each of the three "studies" in conjunction with all electric utilities, Staff, and OPC. To the extent the Commission orders such metric reporting, Staff recommends appropriate technical standards or guidance documents be referenced.[2]

[1] Rebuttal testimony of Geoff Marke, Page 43, lines 20-23.
[2] For example, International Organization for Standardization (ISO)/ International Electrotechnical Commission (IEC) 30134-2:2016 Information technology — Data centres — Key performance indicators and IEEE 519-2022

In lieu of Dr. Marke's recommendation, Staff recommends the Commission order parties to collaborate on an annual reporting requirement for Ameren Missouri to report to the Commission and the public on its large load customers. Additionally, Staff recognizes that Dr. Marke's concern stems from the same overall public policy observation that Staff made in its Recommendation / Rebuttal Report, "that resources such as land are finite, and that resources such as electric capacity are temporally finite. Staff also must note that generation capacity is expensive, cannot be instantaneously built, is subject to extensive federal and environmental regulation, increases cost of service for decades, and causes its own risks to captive ratepayers."[3] Ameren Missouri recommended a process by which the Commission would approve each customer service agreement under its large load tariff. Staff proposed minimum filing requirements on page 31, lines 6-33 of Staff's Recommendation / Rebuttal Report in this case. Several of the proposed minimum filing requirements address components of Dr. Marke's areas of concern: annual reporting requirements, evidence of interconnection studies that include consideration of harmonics, and documentation of customer consultation with other utility providers (i.e. water, sewer, and gas).

Q. On page 34, lines 10-12, and page 38, lines 3-5, of his rebuttal testimony, Dr. Marke notes that the PUE and WUE metrics apply to both data centers or other large energy-intensive facilities; do you agree?

A. Not exactly. PUE, the ratio of total energy used by a facility divided by the total energy used by computing equipment, is a metric for data centers and other similar IT driven organizations, but is not helpful as a metric for other large users such as manufacturing.

IEEE Standard for Harmonic Control in Electric Power Systems may be useful. However, Staff notes it does not currently own these standards.

[3] Staff Recommendation, page 6, line 5-9.

Similarly, WUE is the ratio of annual water consumed divided by the energy used by its computing equipment. These metrics are likely helpful to individual data centers, but may be misleading as a metric without additional expectations on the post-construction data collection requirements.

Q. Specific to THD, what is Dr. Marke's recommendation?

A. Dr. Marke suggests using the metric THD to ensure LLCS customers are responsible for the costs associated with harmonic-related and other power quality impacts to the grid.[4]

Q. Does Staff share Dr. Marke's concerns?

A. Yes. Staff shares Dr. Marke's concerns with the potential for harmonic and other power quality impacts to the grid from large load customers. Also, that general principles to ratemaking related to cost causation should be appropriately considered when the Commission sets rates in this case and others.[5]

Q. Are other organizations considering the technical impacts of large loads?

A. Yes. Attached to my testimony is the North American Electric Reliability Corporation's ("NERC") Industry Recommendation regarding Large Load Interconnection, Study, Commissioning, and Operations (Schedule CME-s1). NERC issued the alert "to address the risks observed from the analyzed large load behavior and to assess the status of industry preparedness in relation to large loads." NERC goes on to explain:

[4] Rebuttal testimony of Geoff Marke, Page 43, lines 15-17.
[5] Staff recommends incorporating these costs, if ordered, into the LLCS customer charge.

> Rapid, major swings in load, experienced both in typical operations as well as in response to grid disturbances, can impact the BPS's ability to maintain frequency, regulate transmission voltage, and otherwise maintain stability. The comparatively large size, unique end-use operational characteristics, unique facility design, and unique operational performance of Large Loads necessitate enhancements to interconnection processes, BPS planning studies and models, validation of installed facility equipment, and operational communication with these customers. Accurate, validated models, particularly dynamic models, of Large Loads are critical to capture, assess, and mitigate the impact of Large Loads on the reliable operation of the BPS.

The NERC alert is intended to inform additional actions to mitigate observed reliability risks. NERC's LLTF is expecting to publish a second whitepaper[6] on assessing gaps in existing practices in fourth quarter 2025.

Q. Is Ameren Missouri responding to the NERC alert?

A. Yes.[7] Ameren Missouri further represents it can provide its response to Staff and the Commission after submittal to NERC (due January 28, 2026). Staff recommends the Commission order Ameren Missouri to provide its response to the NERC alert in any order issued in this case.

Q. Does Staff support Dr. Marke's recommendation for a third party to perform PUE, WUE, and THD studies?

A. No, not as Staff currently understands his proposal. I appreciate Dr. Marke's desire for third-party experts to be engaged to ensure the independence of reports presented to the Commission. However, in this case, it is not clear what exactly would be studied. To the extent the Commission orders metric reporting as a result of this case, Staff recommends appropriate technical standards or guidance documents are referenced.

[6] The first whitepaper, *Characteristics and Risks of Emerging Large Loads*, is attached to Staff's Recommendation as Schedule 12.
[7] Ameren Missouri response to Staff data request 54.

ELECTRIC SERVICE AGREEMENT AND CUSTOMER APPROVAL PROCESS

Q. Amazon witness Dr. Albert Bremser argues that the form of the ESA ("Electric Service Agreement") should not be included in the Commission-approved tariff. Does Staff agree?

A. No. Dr. Bremser argues that "Ameren should clearly outline which terms should be included in the Tariff and which terms are to be negotiated in an ESA between Ameren and the Large Load Customer."[8] From Staff's perspective Ameren Missouri did just that by including the form ESA in its proposed tariffs in this case. This provides transparency to large load customers, the Commission, and other ratepayers.

As a specific example of his criticism, Dr. Bremser raises issue with Ameren Missouri including payment terms in its proposed tariff (see Schedule SMW-D1 attached to the direct testimony of Steven Wills), arguing payment terms should be outlined in an ESA and not a tariff.[9] Dr. Bremser's position is inconsistent with Ameren Missouri's existing Commission-approved tariffs for other customer classes. Payment terms are included for residential customers,[10] small general service,[11] large general service,[12] small primary service,[13] street and outdoor area lighting[14] and large primary service.[15]

Q. On page, 15, lines 1-4, of his rebuttal testimony, Dr. Bremser claims Ameren Missouri anticipates conducting a risk analysis for each individual ESA;

[8] Albert Bremser rebuttal testimony, page 14, lines 9-10.
[9] Albert Bremser rebuttal testimony, page 14, lines 10-11.
[10] As an example, see MO P.S.C. Schedule No. 6, 6th Revised Sheet No. 54.1
[11] MO P.S.C. Schedule No. 6, 4th Revised Sheet No. 55.1
[12] MO P.S.C. Schedule No. 6, 3rd revised Sheet No. 56.1
[13] MO P.S.C. Schedule No. 6, 3rd Revised Sheet No. 57.1
[14] MO P.S.C. Schedule No. 6 4th Revised Sheet No. 58.2 and MO PSC Schedule 6, 3rd Revised Sheet No. 59.1
[15] MO P.S.C. Schedule No. 6 3rd Revised Sheet No. 61.1

is Dr. Bremser's portrayal consistent with Staff's discovery regarding Ameren Missouri's proposed customer approval process?

A. No. Ameren Missouri states in response to Staff data request 13 that "[t]he Company anticipates that the Commission's review of the ESA will include an evaluation to ensure that the terms are just, reasonable, and not unduly discriminatory, and that they are consistent with the applicable statutes and currently proposed tariff." While Dr. Bremser cites to discussion in Mr. Wills testimony regarding Ameren Missouri's risk analysis conducted in this case,[16] Mr. Wills did not suggest such an analysis would occur on an individual customer basis.

Q. What does Staff recommend the Commission consider during a customer approval process, if such a process is ordered by the Commission?

A. Staff recommends that the Commission review consist of (1) whether the terms are just, reasonable, and not unduly discriminatory, (2) that they are consistent with the applicable statutes and the tariff approved in this case by the Commission, and (3) review of the projected demand and energy requirements of the potential customer being feasible for service by the utility. Staff further recommends minimum filing requirements to ensure Staff and the Commission receive sufficient information at the time of the filing to, as expeditiously as possible, complete such a review.

Q. Would a customer-approval process address some of OPC's concerns presented by Dr. Marke?

A. Yes, in part. Staff's recommended minimum filing requirements include components of Dr. Marke's areas of concern: annual reporting requirements, evidence of

[16] Steven M. Wills direct testimony page 44 lines 16-22 and page 45 lines 1-2.

interconnection studies that include consideration of harmonics, and documentation of customer consultation with other utility providers (i.e. water, sewer, and gas).

Q. Staff recommends the Commission prioritize the customer approval process; does Staff recommend a specific deadline for Commission decision?

A. No. As the Commission is well aware, Staff and the Commission have finite resources. It is not reasonable to set a strict deadline for such determinations; however, streamlining the process is necessary. The best way for any case to move quickly is for the utility to present credible evidence of its request upon filing and for the Commission to articulate its expectations through minimum filing requirements. This reduces Staff time spent on the discovery process.

Q. If the Commission elects not to approve Ameren Missouri's proposal for a customer-approval process, should the Commission still order Ameren Missouri to address the content in Staff's proposed minimum filing requirements?

A. Yes. As an alternative, Staff recommends the Commission order Ameren Missouri to provide regular reporting as a non-case related submission in EFIS containing:

1. Description of all interconnection facilities, and terms of related agreements, to serve any new LLCS customer, including:
    a. a projection of the cost of removing the facilities at the end of the contract term,
    b. a projection of property tax and insurance expense, each year, associated with the facilities for the projected life of the facilities,
    c. a projection of operation and maintenance expenses, each year, associated with the facilities for the projected life of the facilities,
2. All information required under the Service Agreement included in Staff's recommended tariff. At a high level this includes projected demands and energy requirements for the full term of service, information related to financial assurances, and information related to day-to-day load management.
3. An updated capacity forecast without the new LLCS customer.
4. An updated capacity forecast with the new LLCS customer.

5. The boundary of Ameren Missouri's facilities serving the customer in a format supported by the State's geographic information system (GIS) software.
6. Evidence that Ameren Missouri completed all internal engineering studies supporting the interconnection.

EMERGENCY CURTAILMENT

Q. On page 33, lines 11-18 of his rebuttal testimony, Dr. Marke recommends service under this tariff be subject to mandatory emergency curtailments. Did Staff propose tariff language that addresses Dr. Marke's concern?

A. Yes. Staff recommends the following language be included in Ameren Missouri's Emergency Energy Conservation Plan tariff:[17]

> Customers taking service under Schedule LLCS may be interrupted during grid emergencies under the same circumstances as any other customer.

Staff recommends the above language as it allows for operational flexibility while making clear that LLCS customers not receive special advantages in reliability as compared to other customers.

Q. On page 34, lines 3-7 of his rebuttal testimony, Dr. Marke discusses an ongoing Value of Lost Load ("VOLL") Study, suggesting the study should influence the emergency curtailment tariffs. Do you agree?

A. Not at this time. Staff will continue to engage in discussions regarding the VOLL study.

Q. Does this conclude your surrebuttal testimony?

A. Yes it does.

[17] MO. P.S.C. Schedule 6 1st Revised Sheet No. 146 through 148.

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Approval of New Modified Tariffs for Service to Large Load Customers	))))	Case No. ET-2025-0184

AFFIDAVIT OF CLAIRE M. EUBANKS, PE

STATE OF MISSOURI)
) ss.
COUNTY OF COLE)

COMES NOW CLAIRE M. EUBANKS, PE, and on her oath declares that she is of sound mind and lawful age; that she contributed to the foregoing *Surrebuttal Testimony of Claire M. Eubanks, PE;* and that the same is true and correct according to her best knowledge and belief.

Further the Affiant sayeth not.

Claire M Eubanks
CLAIRE M. EUBANKS, PE

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 29th day of October 2025.

DIANNA L. VAUGHT
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: July 18, 2027
Commission Number: 15207377

Dianna L. Vaught
Notary Public

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Industry Recommendation

Large Load Interconnection, Study, Commissioning, and Operations

Initial Distribution: September 9, 2025

The purpose of this alert is to address the risks observed from the analyzed large load behavior and to assess the status of industry preparedness in relation to large loads.

NERC, Regional Entities, and NERC registered entities have analyzed a series of disturbances that occurred on the bulk power system (BPS) resulting in widespread and unexpected customer-initiated load reduction of large loads. These disturbances involved multiple events during which 1,000+ MW of unexpected Large Loads output reduction occurred, with most events occurring in 2024 or 2025. The increase of Large Loads-related events coincides with an increase in Large Load penetration across the BPS.

To better understand the reliability impact(s) of emerging large loads on the BPS, NERC established the Large Loads Task Force (LLTF) in August 2024. In July 2025, NERC published a white paper titled *Characteristics and Risks of Emerging Large Loads*[1] that highlights characteristics of Large Loads such as rapid fluctuations in demand and cyclical ramping. That paper includes the following high-priority categories of risks: Long-Term Planning, Operations/Balancing, and Stability.

For this Alert, the term "Large Load" is consistent with the definition in the LLTF white paper referenced above:

> **Large Load - "Any commercial or industrial individual load facility or aggregation of load facilities at a single site behind one or more point(s) of interconnection that can pose reliability risks to the BPS due to its demand, operational characteristics, or other factors. Examples include, but are not limited to, data centers, cryptocurrency mining facilities, hydrogen electrolyzers, manufacturing facilities, and arc furnaces."**

Rapid, major swings in load, experienced both in typical operations as well as in response to grid disturbances, can impact the BPS's ability to maintain frequency, regulate transmission voltage, and otherwise maintain stability. The comparatively large size, unique end-use operational characteristics, unique facility design, and unique operational performance of Large Loads necessitate enhancements to interconnection processes, BPS planning studies and models, validation of installed facility equipment, and operational communication with these customers. Accurate,

[1] "White Paper: Characteristics and Risks of Emerging Large Loads," NERC, Jul. 2025. Available: https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Whitepaper%20Characteristics%20and%20Risks%20of%20Emerging%20Large%20Loads.pdf

validated models, particularly dynamic models, of Large Loads are critical to capture, assess, and mitigate the impact of Large Loads on the reliable operation of the BPS.

As the process improvement recommendations are applicable across all footprints, this alert is being distributed to all Distribution Providers (DP), Resource Planners (RP), Transmission Owners (TO), Transmission Operators (TOP), and Transmission Planners (TP), Balancing Authorities (BA), Planning Coordinators (PC), and Reliability Coordinators (RC) to address the risks observed from the analyzed Large Load behavior. NERC encourages registered entities to work with Large Load owners and operators to assist with responses to this alert.

This alert will assess the status of industry's Large Load dynamic modeling and simulation practices of interconnection requirements, study process, and commissioning procedures. This will subsequently inform the additional actions necessary to mitigate observed reliability risks. The results of this assessment will be issued in a forthcoming report on the Alert data.

The *NERC Incident Review* contains detailed information about the impact of Large Load performance on the BPS.[2] All recipients of this alert are strongly encouraged to read the findings arising from the incident review, as well as NERC's *Dynamic Modeling Recommendations*.[3]

Why am I receiving this? >>
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Status:	**Acknowledgement Required[4] by Midnight Eastern on September 16, 2025** **Reporting Required by Midnight Eastern on January 28, 2026**
	**PUBLIC:** No Restrictions More on handling >>
Instructions:	This Level 2 Industry Recommendation provides specific actions that NERC registered entities should consider when encountering a particular issue. Pursuant to Rule 810 of NERC's Rules of Procedure (ROP), NERC registered entities shall 1) acknowledge receipt of this Industry Recommendation within the NERC Alert System, and 2) submit a response to the questions in relation to this Industry Recommendation as provided below. For U.S. entities, NERC will compile the responses and report the results to the Federal Energy Regulatory Commission (FERC). The data submitted to NERC within the NERC Alert System is protected under Section 1500 of NERC's ROP that governs data

[2] https://www.nerc.com/pa/rrm/ea/Documents/Incident_Review_Large_Load_Loss.pdf
[3] https://www.nerc.com/pa/RAPA/ModelAssessment/Documents/Dynamic%20Modeling%20Recommendations.pdf
[4] To the extent that Canadian jurisdictions have implemented laws or requirements that vary from Section 810 of the ROP, NERC requests entities in such jurisdictions voluntarily participate in response to this Alert.

	protection of Confidential Information. This data will be used to compile and share aggregate responses to FERC and in carrying out NERC's regulatory duties. This Industry Recommendation is not the same as a Reliability Standard, and your organization will not be subject to penalties for a failure to implement. Issuance of this recommendation does not replace or modify the requirements of any approved Reliability Standard or excuse the prior failure to follow the practices discussed in the recommendation if such failure constitutes a violation of a Reliability Standard.
Distribution:	Transmission Owners (TO), Resource Planners (RP), Transmission Operators (TOP), Transmission Planners (TP), Balancing Authorities (BA), Planning Coordinators (PC), Distribution Providers (DP), and Reliability Coordinators (RC). **Who else will get this alert? >>**
Primary Interest Groups:	System Operators, System Operations - Transmission Engineering, Transmission Planning
Recommendation:	**The recommendations in this alert should be implemented by the applicable segments of the industry to help mitigate risks to BPS reliability resulting from integrating Large Loads to the BPS.** **Recommendation 1:** TOs should establish clear facility design and performance criteria in their interconnection requirements for Large Loads to mitigate the reliability risk posed by their expected behavior during normal operations and in response to System Disturbances. As part of these requirements, TOs should also require installation of high-speed disturbance data capture devices to monitor and assess the operational performance of Large Loads (e.g., Phasor Measurement Units (PMU)). Where relevant, DPs are also recommended to include these same criteria and disturbance monitoring devices. These interconnection requirements should be informed by the actions taken by the TP and PC in response to Recommendation 2. These criteria and monitoring capabilities should also incorporate additional considerations from NERC registered entities as follows: 1. TOs and DPs should consult with TPs and PCs to establish a list of detailed modeling data, settings, and parameters needed from Large Loads to support Large Load interconnection studies. This process should include: a. Procedures to make the Large Load steady-state, dynamic, and short-circuit models available for TPs and PCs for their studies.

   b. Requirements for Large Loads to verify on-site settings and provide the TO, in advance, with any updates to the modeling data based upon design changes or upgrades.

   c. Procedures for validation of the Large Load model performance with real event data.

2. TOs should coordinate with TPs, PCs, RCs, TOPs, and BAs to integrate any operational requirements that need to be met by the Large Load to maintain reliability within the TOs interconnection requirements. These requirements should include:

   a. Establishment of operational load ramp limits in consultation with BAs and RCs for normal and Emergency System states.

   b. Establishment of post-Disturbance voltage and frequency recovery requirements in consultation with BAs, RCs, TPs, and PCs. This should include, at a minimum, the characteristics needed to limit the maximum amount of load that could be disconnected (e.g., through tripping or customer isolation) for a single, credible System Contingency.

3. TOs should establish performance-based disturbance recovery requirements for Large Loads in coordination with TPs and PCs. This coordination may include:

   a. Criteria for on-fault and post-fault performance.

   b. Voltage control modes, settings, or parameters (e.g., power factor or dynamic voltage control).

4. TOs should consult with TPs and PCs to establish design requirements that minimize and mitigate unintentional power oscillation interaction[5] during normal operations and in the recovery post-System Disturbance for the following frequencies:

   a. Interconnection inter-area modes,

   b. Sub-regional area modes,

   c. Local modes, and

   d. Sub-synchronous unit modes

5. TOs should require high-resolution data monitoring and fault capture (e.g., advanced Digital Fault Recorders) for Large Loads interconnecting into areas of the system that have known high participation factors for the modes listed in 4. These devices should have sufficient sample rate, data storage, and bandwidth to capture the Large Load behavior.

[5] That is, designed in a way to increase damping of the listed mode shapes for known power system oscillations.

6. TOs should periodically review their load interconnection requirements in the context of known performance behavior of Large Loads and grid system changes to determine if requirements, procedures, processes, and/or mitigation should be amended.

Recommendation 2: TPs and PCs should establish a comprehensive interconnection and system-wide study process using steady state, dynamic, and short-circuit models to assess reliability impacts of Large Loads. This process should be implemented through the TO actions in Recommendation 1. This comprehensive study process should include practices for the following:

1. TPs and PCs should acquire or develop detailed and accurate (e.g., steady state, dynamic, short circuit) models of the Large Loads in their footprint. This may be accomplished through coordination with the TO or DP in Recommendation 1. Models should accurately reflect load response to disturbance conditions as well as the post-Disturbance load behavior, including recovery, in order to assess interactions with other loads and system protection devices.
2. TPs and PCs should conduct periodic planning studies to identify reliability risks associated with any new Large Load interconnection, and coordinate with TOs and DPs to identify mitigation. This periodic process should include:
    a. Initial studies based on the as-planned data provided by Large Loads to the TOs and updated, as necessary, based on design, upgrades, or other qualifying changes.
    b. Transient dynamic analyses that consider the Large Load on-fault and post-Disturbance frequency and voltage recovery behavior; the collective impact of electrically close facilities, including Large Loads, with similar performance modes; and the total potential magnitude of load loss considering the individual and collective tripping or customer-initiated load reduction of Large Loads during System Disturbances.
    c. Recommendations to TOs regarding any transmission protection coordination changes to transmission relays or modifications to Large Load fault interruption devices to ensure reliable isolation of system faults include:
        i. Recommendation on changes to protection and control settings of local protective devices.
        ii. Recommendations on changes to operation, protection, and control settings of the Large Loads to minimize customer-initiated load reduction during System Disturbances.

iii. Inclusion of Large Load entity input into the TO coordination of protection and control devices to identify how the Large Load can assist in the reliable isolation of system faults.

d. A process to determine the necessity to carry out special assessments such as electromagnetic transient (EMT) studies for a given interconnection request. For example, this process could be carried out by the TP and PC when Large Loads interconnect to areas with weak system strength, when the Large Loads interconnect to large grid connected generation sources, or when the Large Loads interconnect to areas electrically close to other sensitive dynamic active resources.

Recommendation 3: TOs should enhance their load commissioning activities to establish a comprehensive commissioning process that ensures operational readiness for Large Loads. This includes the following:

1. TOs should consult with RCs, TOPs, and BAs prior to commencing commercial operations for Large Loads to ensure the Large Loads are properly accounted for in operational modeling, forecasting, or other operational requirements.
2. TOs should require Large Loads to provide any updates to as-planned modeling information (e.g., as-designed, as-built) after the facility enters commercial operation and coordinate with TP and PCs to perform additional analysis post-commercial operation.
3. TOs should consider a model verification and validation process in the commissioning process to verify and validate the models. This process should include provisions for:
   a. Comparison of end-use customer facility loading (e.g., MVA of motor load, IT load, and cooling load) to measured recordings and nameplate of installed equipment
   b. Verification of power factor or other TO-identified power quality needs as seen at the point of interconnection.
   c. Provision of model updates and restudy based on a pre-determined threshold developed in consultation with the TO's TP and PC.
4. TOs should require that commissioning and model validation occurs at each phase of a Large Load project and not solely on initial energization for Large Loads that will phase in their total demand over multiple years.
5. TOs should consider including a performance validation process to verify that the Large Loads are adhering to the design criteria and interconnection requirements after energization and during

commercial operation. This process should include the same provisions as in item 3 above (Recommendation 3.3).

Recommendation 4: TOs should establish operating protocols and the necessary communication infrastructure to support reliable ongoing operations after Large Load facilities enter into commercial operations. This includes:

1. Establishing operating protocols in consultation with BAs, TOPs, and RCs to ensure their coordination with Large Loads, including:
    a. Establishment of common real-time communication protocols.
    b. Process(es) for providing operational load forecasts and notifications for Large Load major equipment status or behavior changes.
    c. Process(es) for contacting and coordinating with Large Loads during normal and abnormal operations.
    d. Process(es) for contacting and coordinating with Large Loads during post-Disturbance for System Contingencies and during System Emergency conditions.
    e. Collection of data to aid in post-hoc event analysis.
    f. Other unique operational protocols specific to the Large Load's design, behavior, and interconnection.
    g. Other reliability enhancing activities at the request of NERC or one of its Regions.
2. Coordination with the TOPs to develop the appropriate protocols and infrastructure to support operational situational awareness, including real-time monitoring capability of equipment status, loading, and access to installed electrical recording devices (e.g., the Large Load PMUs), as applicable.

Recommendation 5: TPs, RPs, and PCs should, in consultation with their appropriate regulatory bodies, identify and implement a process to include Large Loads into their Long-Term Transmission Planning Horizon Demand forecasts as well as their Near-Term Transmission Planning Horizon Demand forecasts.

END RECOMMENDATIONS

Reporting Instructions:

Initial acknowledgement of receipt is required by **September 16, 2025,** Midnight Eastern via the NERC Alert System. Reporting responses to the questions below are required to be submitted via the NERC Alert System by **January 28, 2026,** Midnight Eastern.

A valid response in the NERC Alert System consists of the following three steps by the submitting entity:

1. Acknowledgement of Alert
2. Submission of Response
3. Approval of Response

The NERC Alert System contains menu options for each of the above commands that are available to authorized individuals upon login. **A response will not be considered valid until all three steps have been completed.**

All registered entities belonging to the TO, DP, TOP, RC, BA, TP, PC, and RP functional groups are required to acknowledge receipt of this alert and respond as applicable. For purposes of the NERC Alert System, the terms "Planning Coordinator" and "Planning Authority" are used interchangeably.

The questions below seek data pursuant to Section 800 of the ROP to support NERC's evaluation of actions taken in response to this alert and of risks to reliability presented by the identified issues.[6]

For questions asking about "Large Load" responses, please use the entity formal defined term. Where this does not exist, use the definition provided in this alert, reproduced below:

> **Large Load -** "Any commercial or industrial individual load facility or aggregation of load facilities at a single site behind one or more point(s) of interconnection that can pose reliability risks to the BPS due to its demand, operational characteristics, or other factors. Examples include, but are not limited to, data centers, cryptocurrency mining facilities, hydrogen electrolyzers, manufacturing facilities, and arc furnaces."

[6] *See* Section 810 of the ROP stating, "Members of NERC and bulk power system owners, operators, and users shall provide NERC with detailed and timely operating experience information and data."; *see also*, Section 804 of the ROP stating, "To carry out the reviews and assessments of the overall reliability of the interconnected Bulk Power Systems, the Regional Entities and other entities shall provide sufficient data and other information requested by NERC in support of the annual long-term and seasonal assessments and any special reliability assessments."

These questions are grouped by Registered Entity category. You only need to respond to the questions applicable to the entity category you are registered for.

The categories and the list of questions are as follows:

- TOs and DPs – Questions 1 to 44 (total of 44)
- TPs and PCs – Questions 45 to 67 (total of 22)
- RCs, BAs, TOPs – Questions 68 to 95 (total of 27)
- RPs – Questions 96 to 105 (total of 9)

All TOs and DPs are required to respond to the following questions:

1. In the free text field provide your definition of Large Loads including any MW or kV threshold or other operational characteristics about the load profile. Also indicate in this response other registered entities (e.g., BA, TOP, TP, or similar) that were consulted when defining Large Loads in your footprint. Enter "None" if your organization has not formally defined Large Loads.
2. In the free text field provide your experience in integrating Large Loads. Include in this response the number of years of experience in integrating Large Loads and other highlights or lessons learned as part of this experience.
3. Do you have Large Loads or are you expecting to integrate Large Loads by 12/31/2027 within your footprint? [Yes/No]
    a. If the answer is **yes**, enter the data as indicated in the supporting worksheet. Also, attach a .zip archive with all the Large Load Positive Sequence Phasor Domain models included. See additional submittal information at the bottom of this section of the Alert. Provide at minimum the loads that meet the formal definition in Question 1. If this formal definition does not have a size component, enter loads with a size of 20 MW or greater. If this formal definition does not exist, provide loads with a size of 20 MW or greater that meet the definition used in the Alert.
    b. If the answer is **no**, do not submit a worksheet or a .zip archive with Large Load modeling information.
4. In the free text field provide how you are contacting, interacting, or otherwise coordinating with Large Loads that are operational or nearly operational (i.e., 2 years or less) to collect information or resolve ongoing issues that arise.

5. In the free text field provide any challenges experienced while coordinating with operational Large Load entities for the process development and data submittals necessary to respond to this alert. Enter "Not Relevant" if your organization did not coordinate with Large Load entities to respond to this alert.
6. In the free text field provide any comments you wish to provide to help explain your answers to these questions.

Related to Recommendation 1

7. Have you established clear facility design, modeling, and performance criteria in your interconnection requirements for Large Loads? [Yes/No]

If the answer to Question 7 is "No", SKIP Questions 8–22.

8. Attach the relevant Large Load language in your interconnection requirements as a separate file.
9. Describe in the free text field a summary of the relevant Large Load language in your interconnection requirements. Include in this response the relationship to how a qualified change would require a restudy by the TP and PC for a given Large Load.
10. Enter the operational load ramp limits for normal operations in MW/min. Enter "N/A" if no operational load ramp limit is established.
11. Enter the operational load ramp limits for abnormal or post-Disturbance operations in MW/min. Enter "N/A" if no operational load ramp limit is established.
12. Enter in the free text field the design requirements for Large Loads to minimize and mitigate power oscillation interaction during normal operations. Enter "N/A" if no design requirements are in place.
13. Enter in the free text field the design requirements for Large Loads to minimize and mitigate power oscillation interaction in the recovery period following a System Disturbance. Enter "N/A" if no design requirements are in place.
14. Enter the TP-, PC-, RC-, or BA-provided maximum amount of load that can be disconnected (e.g., through tripping or customer isolation) from a single Contingency. Enter "Not provided" if no entity has provided this number or "not applicable" if no such number is included in the interconnection requirements.
15. Enter the implemented modeling requirements to meet TP and PC established modeling needs. Enter "Not defined" if no TP and PC requirements exist.

16. Describe how the Large Load entities supply data or models to meet the established TP or PC modeling needs. Enter “Unable to gather” if the Large Load entity does not provide you with the TP and PC needed information to meet their established modeling needs.
17. Describe the performance requirements for voltage ride-through, voltage recovery characteristics, or other voltage response data deemed necessary by TPs and PCs. Include in this response how this is acquired from the Large Load entities. Enter “Not defined” if there are no requested voltage data from TPs or PCs. Enter “Not available” if no data is provided.
18. Describe the performance requirements for frequency ride-through, frequency recovery characteristics, or other frequency response data deemed necessary by TPs and PCs. Include in this response how this is acquired from the Large Load entities. Enter “Not defined” if there are no requested voltage data from TPs or PCs. Enter “Not available” if no data is provided.
19. Select from the choices the recording devices required to be installed for Large Loads in your interconnection requirements. [Choice of high-resolution recording (e.g., PMU, DFR), low-resolution recording (e.g., SCADA scans), None.]
20. Describe the disturbance recording equipment for Large Load and where such devices are located in reference to the load’s Point of Interconnection. Include details for the device types, electrical locations (including any phase-to-phase differences), and sample rates. Enter “no monitoring devices” if no devices are required for Large Loads.
21. Describe the method to access and retrieve data from disturbance recording equipment at the Large Load. Enter “Not accessible” if devices are installed, but you are not able to access these recordings.
22. Describe how you review your interconnection requirements, change the requirements, and enforce any changes to these requirements for Large Loads. Enter “Not reviewed specifically” if this process is not done uniquely for Large Loads.
23. Describe any plans you have within 2 years to include revisions to address the issues raised in Recommendation 1. Enter “No plans” if you do not have plans to revise your Facility interconnection requirements. Include in this any coordination efforts among TPs, PCs, RCs, or BAs to enhance your Facility interconnection requirements.

Related to Recommendation 3

24. Have you established a Large Load commissioning process to help ensure operational readiness for Large Loads? [Yes/No]

If the answer to Question 24 is "No", SKIP Questions 25–29.

25. Enter how you are consulting with RCs, TOPs, and BAs in this commissioning process. Enter "Not coordinated" if this process does not exist.
26. Describe your process to verify on-site settings and verify the as-built model. Enter "Not performed" if this process does not exist.
27. Describe your process to validate performance of Large Loads to adhere to the design criteria and interconnection requirements after energization. Enter "Not performed" if this process does not exist.
28. Describe your process to update as-planned modeling information and coordinate with TPs and PCs to perform additional analysis during commercial operations of Large Loads. Enter "Not performed" if this process does not exist.
29. Describe your process to review performance and modeling at different points of time for multi-year load growth Large Load projects or as major equipment updates are made. Enter "Not performed" if this process does not exist.
30. Do you have processes to require Large Loads to provide and update modeling data based on design changes, upgrades, and disturbance-based model validation? [Yes/No]

If the answer to Question 30 is "No", SKIP Questions 31–33.

31. Do you have a process to update modeling data during commissioning? [Yes/No]
32. Do you have a process to update modeling data during normal operations? [Yes/No]
33. Do you have a process to update modeling data after a qualified change occurs? [Yes/No]

Related to Recommendation 4

34. Have you established operating protocols and the necessary communication infrastructure to support reliable ongoing operations for Large Loads? [Yes/No]
35. Have you coordinated with the BA, TOP, and RC to develop a method that allows for Real-Time monitoring capability of Large Loads? [Yes/No]

36. Describe the way you have consulted or plan to consult with BAs, TOPs, and RCs in respect to Questions 34 and 35. Enter "Not coordinated" if no such consultation has occurred.

If the answer to Question 34 is "No", SKIP Questions 37–43.

37. Describe the method used to collect disturbance recordings or other data to aid in post-hoc event analysis. Enter "N/A" if this does not exist.
38. Describe the method the Large Load entities provide operational load forecasts. Enter "N/A" if this does not exist.
39. Include the list of common Real-Time communication protocols used. Enter "N/A" if none exist.
40. Describe the process by which a Large Load entity notifies you, the BA, TOP, RC, or a combination of these entities of a major equipment status change. Enter "N/A" if this does not exist.
41. Describe the coordination process Large Loads will follow in normal operating conditions with BAs, TOPs, or RCs (E.g., telemetry via SCADA). Enter "N/A" if this does not exist.
42. Describe the coordination process Large Loads will follow in System Emergency operating conditions with BAs, TOPs, or RCs (E.g., telemetry via SCADA or operator calls). Enter "N/A" if this does not exist.
43. Describe the coordination process Large Loads will follow in the post-Disturbance period following a Contingency with BAs, TOPs, or RCs, (E.g., Operator calls). Enter "N/A" if this does not exist.
44. Describe any plans you have within 2 years to include revisions to address the issues raised in Recommendation 4. Enter "No plans" if you do not have plans to revise your operating protocols and the necessary communication infrastructure.

All TPs and PCs are required to respond to the following questions:

45. In the free text field provide your definition of Large Loads including any MW or kV threshold or other operational characteristics about the load profile. Also indicate in this response other registered entities (e.g., BA, TOP, TP, or similar) that were consulted when defining Large Loads in your footprint. Enter "None" if your organization has not formally defined Large Loads.
46. In the free text field provide your experience in integrating Large Loads. Include in this response the number of years of experience in integrating Large Loads and other highlights or lessons learned as part of this experience.

47. In the free text field provide how you are contacting, interacting, or otherwise coordinating with Large Load entities that are operational or nearly operational (i.e., 2 or less years) to collect information or resolve ongoing issues that arise.
48. In the free text field provide any comments you wish to provide to help explain your answers to these questions.

Related to Recommendation 1

49. Have you developed a list of detailed modeling data, settings, and parameters needed from Large Loads? [Yes/No]

If the answer to Question 49 is "No", SKIP Questions 50 and 51.

50. Describe how you distributed these requirements for detailed modeling data, settings, and parameters to TOs and DPs. Enter "Not distributed" if this process does not exist.
51. Describe how these model requirements discussed in Questions 49 and 50 address acceptable model types, structures, necessary parameter values, out of range parameters, and other reasonability checks on data. Enter "Not addressed" if this does not exist.
52. Describe any plans you have within 2 years to include revisions to address the issues raised in Recommendation 1. Include any plans to consult with TOs and DPs to establish your modeling data, settings, and parameter requirements as well as whether you plan to establish an independent set of model requirements for Large Loads.
53. Describe in the free text box how you are coordinating with TOs and DPs to establish performance-based post-Disturbance recovery requirements for Large Loads. Enter "Not coordinated" if this process does not exist.
54. Describe in the free text box how you are coordinating with TOs and DPs to establish protection coordination requirements for Large Loads. Enter "Not coordinated" if this process does not exist.
55. Describe in the free text box how you are coordinating with TOs and DPs to establish design requirements to minimize and mitigate power oscillation interactions during normal operations and in the recovery post-System Disturbance requirements for Large Loads. Enter "Not coordinated" if this process does not exist.
56. Do you have Large Loads on your system for which transient dynamic performance is unknown, including, but not limited to, voltage/frequency ride-through characteristics? [Yes/No]

Related to Recommendation 2

57. Have you established an interconnection and System-wide study process using steady state and dynamic models to assess reliability impacts of Large Loads in alignment with Recommendation 2? [Yes/No]

58. Have you established an interconnection and System-wide study process using short-circuit models to assess reliability impacts of Large Loads? [Yes/No]

If the answers to Questions 57 and 58 is "No", SKIP Questions 59–63.

59. Describe the accuracy of the models mentioned in Question 57 and 58 to reflect the Large Load facility in the post-Disturbance period, including its recovery performance. Include in this description the ability to assess any interaction with other loads or System protection devices. Enter "No models" if no Large Load models exist.

60. Describe how the models mentioned in Question 57 and 58 are validated with as-designed, as-built, or as-studied parameters. Enter "Not validated" if no Large Load models are validated or do not exist.

61. Describe how the post-Disturbance Large Load frequency and voltage performance related to the included Large Load model(s). Include in this description the largest aggregate loss of load and the largest single load loss due to the most severe Contingency. Further explain any change to these losses expected in the next five years. Enter "Not performed" if you do not evaluate post-Disturbance Large Load frequency and voltage performance.

62. Describe how EMT studies are being conducted when a proposed Large Load is in the vicinity of generation or other facilities where there may be complex dynamic interactions. Include in this response any criteria used to determine if an EMT study is required. Enter "No EMT study" if no EMT study is performed.

63. Describe how you are coordinating with TOs and DPs for mitigation measures for identified poor performance. Include any coordination and recommendations on items such as transmission protection coordination changes or operational changes. Enter "Not coordinated" if this process does not exist.

64. Describe any plans you have within 2 years to include revisions to address the issues raised in Recommendation 2.

Related to Recommendation 3

65. Are you coordinating with TOs to perform additional analysis of Large Loads in the post-commercial operation period using updates to as-planned modeling information provided by Large Loads? [Yes/No]

Related to Recommendation 5

66. Are you identifying and implementing a process to include Large Loads into your Near-Term Planning Horizon Demand forecasts? [Yes/No]

67. Are you identifying and implementing a process to include Large Loads into your Long-Term Planning Horizon Demand forecasts? [Yes/No]

All RCs, BAs, and TOPs are required to respond to the following questions:

68. In the free text field provide your definition of Large Loads including any MW or kV threshold or other operational characteristics about the load profile. Also indicate in this response other registered entities (e.g., BA, TOP, TP, or similar) that were consulted when defining Large Loads in your footprint. Enter "None" if your organization has not formally defined Large Loads.

69. In the free text field provide your experience in integrating Large Loads. Include in this response the number of years of experience in integrating Large Loads and other highlights or lessons learned as part of this experience.

70. In the free text field provide any comments you wish to provide to help explain your answers to these questions

Related to Recommendation 1

71. In the free text field, describe your process or needs to include Large Loads into Undervoltage Load Shed, Underfrequency Load Shed, and Manual Load Shed plans. Indicate in this response how you have communicated this need and associated capability to TOs and DPs in your footprint. Enter "No shedding" if you do not see a need to include Large Loads into these programs.

72. Are you coordinating with TOs to integrate operational requirements in the TO interconnection requirements that need to be met by the Large Load to maintain reliability? [Yes/No]

If the answer to Question 72 is "No", SKIP Questions 73–76.

73. Describe the operational load ramp limits. Include in this response any post-Disturbance recovery load ramp limits and their values. Enter "No limits" if these limits do not exist.
74. Describe how these limits are imposed when the Large Loads enters service, exits service, or operates during normal operations. Enter "No limits" if these limits do not exist.
75. Describe how these limits are shared to TOs within your footprint. Enter "Not shared" if these limits are not shared to TOs.
76. Describe how these limits are shared to DPs within your footprint. Enter "Not shared" if these limits are not shared to DPs.
77. Do you have limitations on the maximum amount of load that could be disconnected (e.g., through tripping or customer-initiated reduction) or reconnected for a single System Disturbance from a reserve standpoint? [Yes/No]

If the answer to Question 77 is "No", SKIP Questions 78–80.

78. Describe how these disconnection or reconnection limits are imposed when the Large Loads enters service, exits service, or operates during normal operations. Enter "No limits" if these limits do not exist.
79. Describe how these limits are shared to TOs within your footprint. Enter "Not shared" if these limits are not shared to TOs.
80. Describe how these limits are shared to DPs within your footprint. Enter "Not shared" if these limits are not shared to DPs.

Related to Recommendation 3

81. Do you have processes in place with TOs to ensure Large Loads are properly accounted for in operational modeling, forecasting, or other operational requirements prior to energization and commercial operations? [Yes/No]
82. Do you have processes in place with DPs to ensure Large Loads are properly accounted for in operational modeling, forecasting, or other operational requirements prior to energization and commercial operations? [Yes/No]
83. If the answer to Question 81 or 82 is yes, describe how you account for Large Loads in your operational modeling, forecasting, or other requirements prior to Large Load energization and commercial operations.

84. Describe any plans you have within 2 years to include changes intended to address the issues raised in Recommendation 3.

Related to Recommendation 4

85. Are you consulting with or have you consulted with TOs and DPs to establish operating protocols for Large Loads? [Yes/No]

If the answer to Question 85 is "No", SKIP Questions 86–92.

86. Include the list of common Real-Time communication protocols used for Large Loads. Enter "N/A" if none exist.
87. Describe the method used by the Large Load entities to provide operational load forecasts. Enter "N/A" if this does not exist.
88. Describe the method used to collect disturbance recordings or other data to aid in post-hoc event analysis. Enter "N/A" if this does not exist.
89. Describe the coordination process Large Loads will follow in normal operating conditions (e.g., telemetry via SCADA). Enter "N/A" if this does not exist.
90. Describe the coordination process Large Loads will follow in System Emergency operating conditions with you (e.g., telemetry via SCADA or operator calls). Enter "N/A" if this does not exist.
91. Describe the coordination process Large Loads will follow with you in the post-Disturbance period following a Contingency (e.g., System Operator calls). Enter "N/A" if this does not exist.
92. Describe the process by which a Large Load notifies you of a major equipment status change. Enter "N/A" if this does not exist.
93. Are you consulting with or have you consulted with TOs and DPs to ensure the necessary Real-Time communication infrastructure and monitoring capabilities are in place? [Yes/No]
94. If the answer to Question 93 is yes, describe Real-Time communication infrastructure and monitoring capabilities. Include details for the device types, electrical locations (including any phase-to-phase differences), and sample rates. Enter "N/A" if this does not exist.
95. Describe any plans you have within 2 years to include revisions to address the issues raised in Recommendation 4.

All RPs are required to respond to the following questions:

96. In the free text field provide your definition of Large Loads including any MW or kV threshold or other operational characteristics about the load profile. Also indicate in this response other registered entities (e.g., BA,

TOP, TP, or similar) that were consulted when defining Large Loads in your footprint. Enter "None" if your organization has not formally defined Large Loads.

97. In the free text field provide your experience in integrating Large Loads. Include in this response the number of years of experience in integrating Large Loads and other highlights or lessons learned as part of this experience.
98. Do your reserve margin/energy adequacy studies account for the intra-minute variability or ramping of Large Loads? [Yes/No]
99. Do your reserve margin/energy adequacy studies account for the loss (and delayed reconnect) of aggregate load under the most severe Contingency? [Yes/No]
100. In the free text field provide any comments you wish to provide to help explain your answers to these questions

Related to Recommendation 5

101. Are you identifying and implementing a process to include Large Loads into your Near-Term Planning Horizon Demand forecasts? [Yes/No]
102. Are you identifying and implementing a process to include Large Loads into your Long-Term Planning Horizon Demand forecasts? [Yes/No]
103. If your answer to Question 101 or 102 is yes, describe your method of including Large Loads into your Near-Term Planning Horizon and Long-Term Planning Horizon Demand forecasts. Enter "N/A" if this process does not exist.
104. If your answer to Question 101 or 102 is yes, describe how you validate your demand projections annually, or more frequently, for Large Loads. Enter "No validation" if this process does not exist.
105. If the answer to Question 101 or 102 is no, describe any plans you have within 2 years to include revisions to address the issues raised in Recommendation 5.

For TOs and DPs, use the "Add Additional Document" link on the NERC Alert System response web page to submit the completed worksheet and a .zip archive of the requested modeling information. There should be one Data Submission Worksheet completed for each entity and one .zip archive containing all Positive Sequence Phasor Domain models.

Additional Information:	Primary concerns include the following: • Interconnection requirements, specifically for Large Loads • Modeling requirements, specifically for Large Loads References on Large Load performance resulting from System Disturbances include the following: • *Characteristics and Risks of Emerging Large Loads* • *Incident Review: Considering Simultaneous Voltage-Sensitive Load Reduction* • *Large Loads Frequently Asked Questions*
Contact:	For clarification or content-related questions, contact: Engineering Group Engineering@nerc.net For login/account/registration issues, contact: nerc.alert@nerc.net

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