Large Load Stability Studies Whitepaper

Dynamics Working Group

This whitepaper provides general recommendations for the stability study portion of the large load interconnection studies. Studies may deviate from these recommendations but should explain the reasoning. If uncertain, please reach out to LargeLoadInterconnection@ercot.com .

A. STUDY PROCESS

Large loads shall be studied per NERC reliability standards and ERCOT Planning Guidelines, including the TPL-001 requirements, FAC-002, and Planning Guide Section 4. Stability studies should:

1. Consider the latest SSWG and DWG cases, both Summer Peak and Off-Peak
2. Consider relevant NERC TPL-001 and ERCOT Planning Guide Section 4 contingencies
3. Include nearby loads with signed IAs at the time of the study commencement
4. Consider sensitivities on power-electronics loads like data center and crypto-mining that may fail to ride through voltage disturbances
5. Tabulate total load loss sometime after the fault is cleared for PGRR-122 [to become PG 4.1.1.2(f)]. For any relevant N-1-1 contingencies that were run, it is sufficient to consider the load loss for only the second event.
6. Consider potential impact to existing GTCs
7. Consult with neighboring TSPs on assumptions, impact, and results (ERCOT will facilitate coordination during the study kickoff meeting)

B. PLANNING CASES & ASSUMPTIONS

B.1. Case Selection

The study should use the latest peak and off-peak DWG cases corresponding with the load in-service date.

B.2. Study Area

Careful consideration is necessary for choosing the study area. For purpose of this whitepaper, “study area” is intended to approximately mean the area of focus for modeling nearby loads and the area for considering model updates to generation or transmission to ensure that the case reasonably represents anticipated future conditions when the load interconnects. TSPs should consult the study scope with their neighbors as needed to consider including dynamic devices, generation, signed load, contingencies and future transmission projects in neighboring regions that may impact the study results. ERCOT will facilitate inviting neighboring TSPs to the kickoff meeting for this discussion, however TSPs are also encouraged to consult with their neighbors as needed.

The following optional method may help inform whether the chosen area is sufficiently large for a stability study: Using a planning case, apply a three-phase fault at the proposed load POI and confirm that all buses which experience a significant voltage drop are included in the study area. (ERCOT has offered to provide voltage contour maps to help with this determination. Draft maps are posted on the Dynamic Studies page of the MIS (TOECEII credentials required).)

B.3. Load Modeling

Before the stability study can commence, the interconnecting load entity must provide to the TSP:

- Composite or user-defined load model(s) representing their facility, in PSS/e .dyr data format or equivalent,
- A completed large load stability survey as adopted by DWG
- Any other information required by the TSP

Nearby signed-IA large loads should be modeled along with the associated proposed transmission upgrades for the approved load amount. Nearby load that is not considered to be large loads should be modeled in a manner consistent with NERC Standards and DWG Procedure Manual requirements, i.e., generally using a composite load model representation.

B.4. Case Updates

Before starting a study, the TSP should consult with neighboring TSPs to consider if case updates are necessary, such as updates to modeled generation, signed load with any associated proposed transmission upgrades necessary to serve that load amount, or transmission topology. The case should also be updated to reflect expected system conditions at the time of the large load's in-service date to ensure the study results are accurate and relevant. ERCOT will facilitate inviting neighboring TSPs to the kickoff meeting.

B.4.1. Case Updates: Generation

Any new generation within the study area expected to be in service and meeting PG 6-.9 conditions at the time of the study should be modeled.

The study entity may consider adjustments within the study area to ensure that the case remains conservative, such as:

- Turn off any extra-ordinary dispatched generation
- Reduce IRR dispatch down to Resource Adequacy values in the Summer Peak cases

B.4.2. Case Updates: Transmission

TSPs should consider if any already-modeled transmission projects may be needed for serving the load but not be in service in time for the load interconnection and hence should be removed from the base case and/or considered in a sensitivity study, per TSP engineering judgment.

B.4.3. Case Updates: Load

TSPs should model loads with a signed interconnection agreement within the study area along with any associated proposed transmission upgrades necessary to serve that load amount.

B.5. Contingency Events

Studies should consider relevant TPL-001 and ERCOT Planning Guide Section 4.1.1 contingencies and justify contingencies not studied in stability. In addition:

- Test Generic Transmission Constraint contingencies and dispatch if load is proposed in the vicinity of an existing GTC and it is not clear whether the load addition will impact the existing GTC stability limit.

- A load-loss contingency, with or without a three-phase fault applied, the load under study is assumed to trip, per Planning Guide 4.1.1.2(c). Other electronic loads within the study area should be modeled with conservative trip settings unless the ride through capability

has been justified (DWG/LLWG will determine justification criteria). (refer to Section C.1 in this document).

The report should indicate NERC TPL-001 / ERCOT PG Section 4 contingency categories were studied, identify the contingencies causing instability, include the full contingency set in the Appendix, and tabulate the maximum load loss of all events studied.

B.5.1. Loads Proposed Within or Near an Existing GTC

For large loads requesting interconnection near an existing Generic Transmission Constraint, specifically for situations where the impact of the new load on the stability constraint is unclear, the interconnection TSP should perform a screening in the interconnection stability study to determine the impact. Export GTCs may be affected by load ride through failures and import GTCs may be affected by the burden of serving the additional load.

The TSP should set up a case matching the limiting GTC flow and apply the relevant GTC contingencies and report whether the system remains stable with the new load addition. An unstable result indicates the new load may impact the stability constraint.

For further information on existing stability constraints, the TSP can consult posted GTC methodology documents or reach out to OperationsStabilityAnalysis@ercot.com.

C. DYNAMIC LOAD MODEL ASSUMPTIONS

The TSP should require that the load customer provide necessary modeling data. Large loads should be represented by model fitted to reproduce load dynamic behavior. Composite load model can be used to model the large load under study and any nearby loads, per DWG manual Section 3.4.4. The TSP is responsible for distributing the load model.

DWG is rolling out a load survey which consists of a standardized questionnaire posted at the DWG public website. The stability report should include the survey responses from the load customer.

C.1. Load Tripping Assumptions and Tripping Sensitivities

At the current time, the ride through capability of many large loads is not well documented. Specifically for large load interconnection studies, the following method is suggested to address uncertain ride through capability:

Where ride through capability is uncertain, the TSP should generally run a sensitivity on the ride through capability. For example:

1. All TPL and PG 4 contingencies, in the stability study, the load under study and all nearby loads should be modeled to ride through voltage disturbances (i.e., disable the model trip settings). This is to ensure that the transmission system is designed to be capable of supporting the load should it ride through.

2. The TSP should perform a sensitivity to check total load loss for PGRR-122 [to become PG 4.1.1.2(1)(f)], to check for export GTC stability constraints, and to check for over-voltage criteria violations where the load under study and nearby large loads are considered to trip per available information:

a. For Power Electronic Loads where the load customer has justification for their ride through assumptions, the load may be modeled as provided.

b. For Power Electronic Loads (e.g. datacenter / crypto) where the trip protection settings are in doubt, these loads can be conservatively assumed to trip for a voltage drop below 0.75 pu for 20 ms or longer and not recover back online during the simulation. This assumption originates from the Information Technology Industry Council (ITIC) curve / Computer & Business Equipment Manufacturer's Association (CBEMA) curve and thus far appears generally supported by field observations.

D. STUDY SENSITIVITIES

Consideration of the following sensitivities is recommended:

1. For loads partnered with a co-located generation resource, consider a sensitivity rerunning critical P1 and P7 contingencies with the co-located resource completely offline in the Summer Peak case

2. A sensitivity on the load ride through capability if uncertain.

The results of the co-located resource offline sensitivity will be used to identify situations where it may be beneficial to discuss opportunities for the load customer and resource owner to self-coordinate.

E. CRITERIA

Stability studies shall consider reliability standards including NERC FAC-002, NERC TPL-001, ERCOT Planning Guide Section 4, and the DWG Procedure Manual.

E.1. Pre-Existing Violations

Because planning cases are designed to identify future transmission needs with conservative load assumptions, cases will at times contain contingency overloads or voltage violations before the large load is added to the case. The TSP should attempt to resolve any violations within the study area as practical where the load is observed to have a significant impact on the violation. (TSPs can reach out to ERCOT to discuss this one further.)

E.2. DELIVERABLES

The stability study report should be written in narrative document format and generally include:

☑ A description of the type of load, size, name, and interconnection location (e.g., datacenter, electrolyzer, etc.). Include the ERCOT LLI number if available.

☑ A description of the basis for the load model (e.g., "Provided by the load customer.")

☑ A table listing the following percentages for the load under study per the model utilized:

Category	Percentage
Motor A – Low Inertia Induction (compressor)	
Motor B – High Inertia Induction	
Motor C – Low inertia induction (CF pumps)	
Static Load	
Electronic Load	

- ☑ Once the new DWG load survey has been implemented, attach the completed survey by the load customer to the report
- ☑ Confirm the TSP has reviewed the provided load survey
- ☑ The energization year and ramp schedule
- ☑ List nearby large loads that were modeled
- ☑ Indicate if composite load models were used for the studied large load, and study area load
- ☑ Indicate whether the load is interconnecting within any existing GTCs and list the GTCs
- ☑ The results of any GTC impact analysis
- ☑ The dynamic stability study cases utilized, including any updates to the cases
- ☑ Indicate the contingency with the maximum load loss amount (MW).
- ☑ Whether the load is co-located with a generation resource and the results of a sensitivity considering the generation resource offline.