COMMONWEALTH OF KENTUCKY
BEFORE THE KENTUCKY STATE BOARD ON ELECTRIC GENERATION AND TRANSMISSION SITING

In the Matter of:

Electronic Application of Golden Solar, LLC for Certificate of Construction for an up to 200 Megawatt Merchant Electric Solar Generating Facility in Caldwell County, Kentucky	))))	Case No. 2020-00243

Notice of Filing per 2/7/2023 Order

Please take notice that Golden Solar, LLC herewith submits publicly filed documents in accordance with paragraph 2 of the Siting Board's February 7, 2023, Order ("2/7/2023 Order") for which material denied confidential treatment is not redacted. The submitted documents have been prepared in accordance with 2/7/2023 Order (p.) paragraph 4.

Respectfully submitted,

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MISO Affected System Impact Study
For
Golden Solar LLC
LGE-KU Project LGE-GIS-2019-008

January 25, 2021
(Revision 0)

MISO
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Revision History

Date	Rev.	Description
01/25/2021	0	Study Report

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1. Executive Summary

This study report documents the Affected System Impact of **Golden Solar LLC** LGE-GIS-2019-008 (Study Project) in the LGE-KU generator interconnection queue on the Midcontinent Independent System Operator ("MISO") transmission system. The starting models for this study was MISO DPP 2018-APRIL Phase II Central models. Study unit was then added per information provided by LGE-KU and dispatched using MISO methodology. The results obtained in this Affected System analysis may change if any of the data or assumptions used in this affected system study on MISO or LGE-KU side is revised.

1.1. Study Project

Study Project is listed in Table 1-1 below.

Table 1-1 LGE-KU Generation Interconnection Study Project

Project	POI	MW	FUEL	State	Transmission Owner (TO)
LGE-GIS-2019-008	North Princeton 161kV	100	Solar	KY	LGE-KU

Steady state thermal, steady state voltage and stability, and short circuit screening was performed to identify any reliability criteria violations caused by the study project.

No thermal or voltage violations were identified in the 2023 summer peak and 2023 Summer Shoulder scenario. No stability violations were identified in the 2023 summer peak scenario**.** No Network Upgrades were identified from the steady state and stability analyses.

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for the study project mentioned in table above. Based on the screening results, MISO Transmission Owners are not planning to conduct additional studies.

2. Steady State Model Development and Study Assumptions

2.1. Base Case Models

The following MTEP base case load profiles were used for the study:

- 2023 Summer Peak
- 2023 Summer Shoulder

The study cases were built by adding and dispatching the appropriate queue projects to the MISO DPP 2018-April Phase II Central models (Study project is queued after MISO DPP 2018-April group). The details of study project are listed in Table 1-1. The study project was dispatched per MISO fuel type dispatch criteria to the entire LGE-KU footprint, where generators were scaled in proportion to the available reserve.

The results obtained in this analysis may change if any of the data or assumptions used to develop the study models is revised.

2.2. Monitored Elements

Under NERC category P0 conditions (system intact) branches were monitored for loading above the normal rating (PSS®E Rating A), and for NERC category P1-P7 conditions branches were monitored for emergency rating (PSS®E Rating B). Voltage limits were specified for system intact and contingent conditions as per applicable Transmission Owner Planning Criteria. The detailed list of monitored area is included in Table A-2.

2.3. Contingencies

The following contingencies were considered in the steady state analysis:

1) NERC Category P0 (system intact -- no contingencies)
2) NERC Category P1 contingencies
    a. Single element outages, at buses with a nominal voltage of 69 kV and above
    b. Multiple element NERC Category P1 contingencies
3) NERC Category P2, P4, P5, P7 contingencies
4) For all the contingencies and post-disturbance analyses, cases were solved with transformer tap adjustment enabled, area interchange adjustment disabled, phase shifter adjustment disabled (fixed) and switched shunt adjustment enabled.

The detailed list of contingency files is included in Table A-1.

2.4. Study Methodology

Non-linear (AC) contingency analysis was performed on the benchmark and study cases, and the incremental impact of the study projects was evaluated by comparing the steady state performance of the transmission system in the Bench and Study Cases. Analyses used PSS®E version 33.7.0 and TARA version 1801a.

2.5. Study Criteria

A branch is considered a thermal constraint if the following conditions are met:

1) The generator has a larger than twenty percent (20%) sensitivity factor on the overloaded

facilities under post-contingent condition (see NERC TPL) or five percent (5%) sensitivity factor under system-intact condition, or
2) The overloaded facility or the overload-causing contingency is at generator's outlet, or
3) The megawatt impact due to the generator is greater than or equal to twenty percent (20%) of the applicable rating (normal or emergency) of the overloaded facility, or
4) For any other constrained facility, where none of the Study Generators meet one of the above criteria in 1, 2 or 3, however, the cumulative MW impact of the group of study generators is greater than twenty percent (20%) of the rating of the facility, then only those study generators whose individual MW impact is greater than five percent (5%) of the rating of the facility and has DF greater than five percent (5%) (i.e., power transfer distribution factor (PTDF) or outage transfer distribution factor (OTDF)) will be responsible for mitigating the cumulative MW impact constraint, or
5) Impacts on Affected Systems would be classified as Injection constraints based on the Affected Systems' criteria, or
6) Any other applicable Transmission Owner FERC filed Local Planning Criteria are met.

A bus is considered a voltage constraint if both of the following conditions are met:

1) The bus voltage is outside of the applicable normal or emergency limits for the post change case, and
2) The change in bus voltage is at least 0.01 per unit worse than the Base Case voltage for the same contingency

All generators must mitigate thermal injection constraints and voltage constraints in order to obtain unconditional Interconnection Service.

3. Stability Model Development and Study Assumptions

3.1. Base Case Models

Stability analysis was conducted on the study unit as listed in Table 1-1. The following dynamic package that reflect Summer Peak load condition for the year 2023 based on MISO DPP 2018-APR Phase II Central model package was used as the starting point.

- Study Case - Power Flow
  - APR18-PhaseII-2023SUM-Study-Final.pfb
- Study Case - Dynamic Model
  - MTEP18_dyrMaster_Clean_TSAT_freq_resp.dyr
  - DPP-APR18-MASTER-DYNAMICS.dyr
  - LGE-GIS-2019-008.dyr

The study project was added to the model using the information provided by LGE-KU and dispatched using MISO methodology.

3.2. Study Methodology

Stability analysis was performed for the Study Case to assess local and regional stability on the MISO transmission system. The list of faults scenarios on MISO facilities in the proximity of study project are shown in Table B-1. If any violations are identified for the Study Case, a Bench Case (case without study projects) will be created and the same fault scenario will then applied to the Bench Case to assess the impact of the study projects on the system transient stability.

3.3. Monitored Facilities and Study Criteria

Key generators and major substations were monitored in the general MISO region. Simulation results were interpreted and compiled against MISO planning criteria.

The following criteria were used to evaluate the simulation results:

- All on-line generating units are stable
- No unexpected generator tripping
- Post-fault transient voltage limits: 1.2 per unit maximum, 0.7 per unit minimum
- Post-fault steady-state voltage limits: 1.1 per unit maximum, 0.9 per unit minimum
- All machine rotor angle oscillations must be positively damped with a minimum damping ratio of 0.81633% for disturbances with a fault or 1.6766% for line trips without a fault
- Local Planning Criteria will apply if available

4. Thermal Analysis

The thermal analysis results for 2023 Summer Peak and 2023 Summer Shoulder case show that the study project LGE-GIS-2019-008 do not cause any thermal violations.

5. Voltage Analysis

The voltage analysis results for 2023 Summer Peak and 2023 Summer Shoulder case show that the study project LGE-GIS-2019-008 do not cause any voltage violations.

6. Stability Analysis

The stability analysis results for 2023 Summer Peak shows that the study project LGE-GIS-2019-008 did not adversely impact the system. The details pertaining to the stability analysis can be found in Appendix B. The stability plots are available upon request.

7. Short Circuit Analysis

A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases using PSS®E for the study project as shown in Table 1-1. The screening results were sent to MISO Transmission Owners to validate if additional short circuit analysis was warranted. Based on the screening results, MISO Transmission Owners are not planning to conduct additional short circuit studies.

8. Contingent Facilities

Table 8-1 describes transmission assumptions modeled in the studies that were deemed necessary to allow for the Interconnection Service of study unit. If the transmission assumptions are not completed or significantly modified, the Interconnection Service of study unit may be restricted until a re-study is performed to determine the applicable service level that results. In the event if any of the higher queued and/or same group study generators in MISO and/or LGE-KU were to drop out, then the Interconnection Customer may be subject to restudy. If there are no modifications to Table 8-1, study projects will be included in MISO's Annual studies to determine available injection until assumptions reach their expected In-Service Date.

No contingent facilities were identified for study project LGE-GIS-2019-008.

Table 8-1 Transmission Assumptions

MTEP ID	MTEP Cycle	Project Name	Project Description	Expected Completion Date	Status	PJM Conditional Projects
NA	NA	NA	NA	NA	NA	NA

9. Conclusion

The Affected System Impact Study did not identify Steady State thermal and voltage violations with the interconnection of LGE-GIS-2019-008 project on the monitored MISO transmission system. No stability violations were identified in the 2023 Summer Peak scenario. No Network Upgrades were identified from the steady state and stability analyses. A short circuit screening analysis was conducted by comparing three phase fault currents in the benchmark and study cases for study projects as shown in Table 1-1. Based on the screening results, MISO Transmission Owners are not planning to conduct additional short circuit studies. No contingent facilities were identified for study project.

The results obtained in this Affected System analysis may change if any of the data or assumptions used in this affected system study on MISO or LGE-KU side is revised.

Appendix A - Study Scenarios, Study Contingencies, and Monitored Area

Table A-1 Study Scenarios and Study Contingencies

Con File	Con Type
MISO18_2023_SUM_TA_P1_AMEREN.con	P1
MISO18_2023_SUM_TA_P1_ATC.con	P1
MISO18_2023_SUM_TA_P1_CENTRAL.con	P1
MISO18_2023_SUM_TA_P1_IOWA.con	P1
MISO18_2023_SUM_TA_P1_ITC-METC.con	P1
MISO18_2023_SUM_TA_P1_MINN-DAKS.con	P1
MISO18_2023_SUM_TA_P1_SOUTH.con	P1
MISO18_2023_SUM_TA_P1_P2_P4_P5_NoLoadLoss.con	P1,P2,P4,P5
MISO18_2023_SUM_TA_P2_P4_P5_P7_LoadLoss.con	P2,P4,P5,P7
AECI-AMMO.CON	P1-P2-P3-P6
AECI-EES.CON	P2-P3-P6
160303-KACY_P1.con	P1
160303-KACY_P2.con	P2
KCPL_P1.con	P1
KCPL_P2.con	P2
KCPL_P4.con	P4
KCPL_P5.con	P5
KCPL_P7.con	P7
2017 Extreme LG&E-KU.con	E2C
2017 P1 LG&E-KU.con	P1
2017 P2 LG&E-KU.con	P2
2017 P4 LG&E-KU.con	P4
2017 P7 LG&E-KU.con	P7
2020_RTEP_Bus_AC2-updated-3-4-19.con	
2020_RTEP_Line_FB_2017Aug-updated-3-4-19.con	
2020_RTEP_Single_2017Aug-Updated-3-4-19.con	
2020_RTEP_Tower_AC2-updated-3-4-19.con	
2021SUM_TA_TVA_s21_P1_MISO.con	P1
s21_P1_MISO.con	P1
s21_P2_MISO.con	P2
s21_P3_MISO.con	P3
s21_P4P5_MISO.con	P4-P5
s21_P6_MISO.con	P6
s21_P7_MISO.con	P7
EEI_EE Events_AA_TA_MTEP20.con	EE
EEI_P1 Events_AA_TA_MTEP20.con	P1

Con File	Con Type
EEI_P2 Events_AA_TA_MTEP20.con	P2
GLH_P2,4.con	P2-P4

Table A-2 Monitored Area

Area #	Voltage	Area ID	Area Name
356	100kV and above	AMMO	Ameren Missouri
357	100kV and above	AMIL	Ameren Illinois
295	69kV and above	WEC	Wisconsin Electric Power Company (ATC)
296	69kV and above	MIUP	Michigan Upper Peninsula (ATC)
694	69kV and above	ALTE	Alliant Energy East (ATC)
696	69kV and above	WPS	Wisconsin Public Service Corporation (ATC)
697	69kV and above	MGE	Madison Gas and Electric Company (ATC)
698	69kV and above	UPPC	Upper Peninsula Power Company (ATC)
207	69kV and above	HE	Hoosier Energy
208	69kV and above	DEI	Duke Energy Indiana
210	69kV and above	SIGE	Southern Indiana Gas & Electric Company
216	69kV and above	IPL	Indianapolis Power & Light Company
217	69kV and above	NIPS	Northern Indiana Public Service Company
314	69kV and above	BREC	Big Rivers Electric Corporation
333	69kV and above	CWLD	Columbia, MO Water and Light
360	69kV and above	CWLP	City Water Light & Power(Springfield)
361	69kV and above	SIPC	Southern Illinois Power Co.
362	100kV and above	EEI	GridLiance
218	69kV and above	METC	Michigan Electric Transmission Co., LLC
219	69kV and above	ITCT	International Transmission Company
600	69kV and above	XEL	Xcel Energy North
608	69kV and above	MP	Minnesota Power & Light
613	69kV and above	SMMPA	Southern Minnesota Municipal Power Association
615	69kV and above	GRE	Great River Energy
620	69kV and above	OTP	Otter Tail Power Company
627	69kV and above	ALTW	Alliant Energy West

Area #	Voltage	Area ID	Area Name
633	69kV and above	MPW	Muscatine Power & Water
635	69kV and above	MEC	MidAmerican Energy
661	69kV and above	MDU	Montana-Dakota Utilities Co.
680	69kV and above	DPC	Dairyland Power Cooperative

Appendix B - Stability Faults

Available on request

Interconnection System Impact Study

Requester: Golden Solar, LLC

#AS053 – Golden Solar

Study Performed By:

Interconnection Planning & Special Studies

FINAL

September 9, 2021

CRITICAL ENERGY INFRASTRUCTURE INFORMATION (CEII)
CONFIDENTIAL
BUSINESS SENSITIVE

Executive Summary

The Tennessee Valley Authority (TVA) conducted an Interconnection System Impact Study (SIS) at the request of Golden Solar, LLC to evaluate the impact of the proposed interconnection AS053. Golden Solar, LLC, has proposed to build a new 100 MW Solar plant to be located in Caldwell County, Kentucky. The Point of Interconnection will be the North Princeton 161 kV Substation, which is owned by LG&E.

The objective of the SIS is to identify all Adverse System Impacts on TVA's transmission system in order to maintain system reliability as a result of the Interconnection Request. The SIS will also determine the facility additions, modifications, and upgrades that are needed to maintain a reliable interconnection.

In addition to identifying all Adverse System Impacts on the TVA transmission system, TVA monitors its Local Power Companies (LPCs) as well as neighboring transmission systems for impacts. No Potentially Affected Systems were identified as a result of the proposed interconnection. LG&E performed a System Impact Study prior to TVA's Affected System Study.

Without and With Priors

The SIS included steady-state (thermal & voltage), short circuit analysis, and transient stability analysis.

- Steady-state loadflow analysis determined that the proposed interconnection will not cause thermal violations on the TVA transmission system.
- Short circuit analysis determined that the proposed interconnection will not cause any breaker duty issues on the TVA transmission system.
- Stability analysis determined that the proposed interconnection will not cause any stability issues on the TVA transmission system.

The study identified a need for the following system improvements:

Table ES-1: Direct Assignment Facilities & Required Network Upgrades

Direct Assignment Facilities	Cost Estimate ($k)
None	$0
Network Upgrades	
None	$0
Total	**$0**

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1.0 Introduction

The purpose of this SIS is to determine all Adverse System Impacts on TVA's transmission system caused by the AS053 Interconnection Request. This report identifies the Network Upgrades that are required for TVA system reliability.

The connection point for the proposed generation facility is at the North Princeton 161 kV Substation, which is located in Caldwell County, Kentucky and is owned by LG&E.

TVA's study

2.0 Model Development

The power flow models utilized in this study originated from the Eastern Interconnection Reliability Assessment Group (ERAG), Multi-Regional Modeling Working Group (MMWG) and the SERC Long Term Study Group (LTSG) 2020 series of power flow base cases. These models are created as part of the ERAG and SERC regional modeling process. The most up-to-date TVA load forecast and generation plans available at the time of case creation were used in the cases, including any projected transmission upgrades. Deviations from the normal generation dispatch may be made, if the request is found to be sensitive to local generation. All confirmed prior Interconnection Requests have priority over TVA's available transmission capacity. Offline generators that have existing Interconnection Rights on the TVA system may be dispatched at the output that was studied through the interconnection process in order to necessarily reflect those rights.

The short circuit models utilized in this study originated from the SERC Short Circuit Database Working Group (SCDWG) 2020 series of short circuit models. The most up-to-date transmission and generation plans, including prior Interconnection Requests were considered during the process of case creation.

The transient stability model used was based on the most recent SERC dynamically reduced base cases with an updated TVA system model. Studies were performed using a 2031 Summer Peak base case and a 2022 Light Load base. The most up-to-date load forecast, transmission, and generation plans available at the time of case creation were considered in the cases, including prior Interconnection Requests

A notice concerning assumptions made in the model development process is contained in Appendix A.

3.0 Study Criteria and Methodology

This study was conducted consistent with TVA SIS processes and practices. All studies performed in the SIS are designed to meet applicable reliability standards and TVA's planning practices and procedures. Information regarding contingencies, monitored elements, generation dispatch, and load profiles evaluated in this study are provided upon request.

The analysis of the Interconnection Request was conducted using a combination of software including PTI PSS/E, PowerWorld Simulator, and PowerGEM TARA.

4.0 Study Results With and Without Prior Requesters

The following sections summarize the facilities required for the interconnection based on the results of steady state studies.

4.1 With and Without Prior Requesters

The facilities associated with the conditions without the prior queued Interconnection Requests are summarized below.

4.1.1 Direct Assignment Facilities

4.1.1.1 Interconnection

There were no Direct Assignment Facilities on the TVA system identified as necessary in order to support the interconnection arrangement.

4.1.1.2 Fault Study

The short circuit analysis determined that the proposed interconnection will not cause any breaker duty issues on the TVA transmission system.

4.1.1.3 Stability

Stability analysis found no stability issues and no system enhancements are required for this interconnection to meet TPL stability requirements.

4.1.2 Network Upgrades

4.1.2.1 Loadflow

Steady-state loadflow analysis determined that the proposed interconnection will not cause thermal violations on the TVA transmission system.

4.2 Project Schedule

Not applicable.

5.0 Conclusion

In conclusion, there were no identified Direct Assignment Facilities or Network Upgrades needed on TVA's sytem for the generation interconnection of Golden Solar to LGE's system in Caldwell County, Kentucky as shown in Appendix B.

The SIS included steady-state (thermal & voltage), fault, and stabilty analysis.

The transmission path from the Generating Facility to the TVA transmission system contains non-TVA facilities. All results within this SIS assume these non-TVA facilities are in-place. It is the Interconnection Customer's responsibility to secure any necessary rights to utilize these non-TVA facilities.

In addition to identifying all Adverse System Impacts on the TVA transmission system, TVA monitors its Local Power Companies (LPCs) as well as neighboring transmission systems for impacts. TVA identified no potentially Affected Systems as a result of the proposed interconnection.

This SIS only evaluates the TVA reliability impacts of Golden Solar's interconnection to the LGE transmission system. This SIS does not evaluate or grant Transmission Service.

Table 5-1: Direct Assignment Facilities & Required Network Upgrades with and without Priors

Direct Assignment Facilities	Cost Estimate ($k)
None	$0
Network Upgrades	
None	$0
Total	**$0**

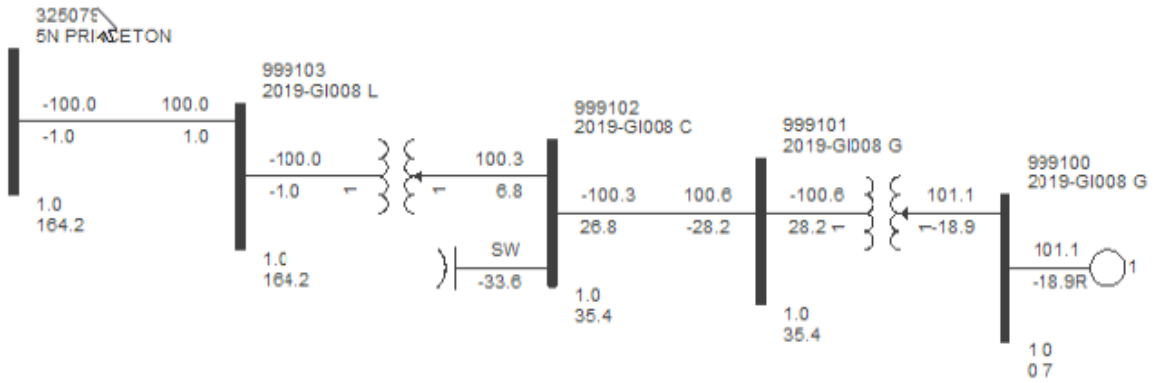
Appendix A: Notice Regarding Transmission Planning Study Information

This information has been derived utilizing power flow models of projected future system conditions. These planning models incorporate many assumptions concerning loads, transmission system configuration, generation dispatch, firm transactions, and other information pertinent to building power flow models. TVA uses available information about transmission and generation additions and upgrades that may subsequently change. The system models external to TVA were either obtained from the applicable control area, or from the most recent SERC base cases. TVA is not responsible for the information provided by others in the development of these models. The cases represent TVA's best effort in developing power flow models for use within TVA as a starting point for interconnection studies, at the point in time when the analysis is done. TVA retains the right to update the models as additional information becomes available or as additional possible scenarios are needed. The decision to use the study or underlying assumptions for any particular purpose other than to obtain the requested Interconnection Rights is the sole responsibility of the user.

Scheduling and cost estimates provided in this report do not include time or money to resolve unforeseen issues such as those that may be identified during TVA's review of environmental impacts as required by the National Environmental Policy Act (NEPA).

Appendix B: Interconnection Arrangement (from LGE/KU's SIS report)

One Line Diagram for the proposed GI-2019-008 Solar GI Request
Point of Interconnection



Appendix C: Definitions

Glossary of Terms

Adverse System Impact – The negative effects due to technical or operational limits on conductors or equipment being exceeded that may compromise the safety and reliability of the electric system.

Affected System – An electric system other than TVA's transmission system that may be affected by the proposed interconnection.

Direct Assignment Facility – Any additions, modifications, or upgrades that are necessary to physically and electrically interconnect the specified Generating Facility, and are solely for the benefit of the specified Generating Facility.

Direct Transfer Trip (DTT) – Used by TVA to provide remote primary protection for power equipment or remote backup protection for a failed breaker.

ERAG – Eastern Interconnection Reliability Assessment Group

Facilities Study – Process in which TVA (with input from requester) further refines project scope, schedule and cost estimates (± 20%).

Generating Facility – Interconnection Customer's device for the production of electricity identified in the Interconnection Request, but not including the Interconnection Customer's Interconnection Facilities.

Interconnection Customer – Any entity, including TVA, that proposes to interconnect its Generating Facility with TVA's transmission system.

Interconnection Facilities – All facilities and equipment between the Generating Facility and the Point of Interconnection, as well as any other modifications, additions or upgrades that are necessary to physically and electrically interconnect the Generating Facility to TVA's transmission system. Interconnection Facilities are sole use facilities and shall not include Network Upgrades.

Interconnection Request – An Interconnection Customer's request, to interconnect a new Generating Facility, or to increase the capacity of, or make a material modification to the operating characteristics of, an existing Generating Facility that is interconnected with TVA's transmission system.

Interconnection Right – A right to interconnect a specified Generating Facility into TVA's transmission system, contingent upon completion of all required system additions, modifications, and upgrades to accommodate the maximum capacity of the specified Generating Facility.

In-Service Date – The date upon which the Interconnection Customer reasonably expects it will be ready to begin use of TVA's Interconnection Facilities to obtain back feed power.

MMWG – Multi-Regional Modeling Working Group

NERC – North American Electric Reliability Corporation or its successor organization.

Network Upgrades – Any additions, modifications, and upgrades that are required to accommodate the specified Generating Facility, and to enhance either the capacity or the reliability of TVA's transmission system.

SCDWG – Short Circuit Database Working Group

SERC – SERC Reliability Corporation - a regional entity with delegated authority from NERC for the purpose of proposing and enforcing reliability standards.

SIS – Interconnection System Impact Study