TENNESSEE VALLEY AUTHORITY
TRANSMISSION RELIABILITY ENGINEERING

FACILITY CONNECTION REQUIREMENTS:
GENERATION AND TRANSMISSION

April 4, 2012 Revision 4

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## Revision Log

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1.0 INTRODUCTION

NERC Reliability Standard FAC-001: Facility Connection Requirements states the following purpose:

“To avoid adverse impacts on reliability, Transmission Owners must establish facility connection and performance requirements.”

As a registered Transmission Owner with NERC and SERC, TVA is required to document, maintain, and publish its facility connection requirements in accordance with FAC-001. FAC-001 touches on multiple aspects of the facility connection process; from planning studies, to facilities design, to operations and maintenance considerations. The TVA Bulk Electric System (BES) consists of transmission facilities with a nominal voltage rating of 100 kV and higher. All generation and transmission facility connections to the TVA BES, including TVA facilities, are expected to adhere to the connection requirements presented in this document and the appropriate reference materials.

2.0 GENERAL REQUIREMENTS

This document applies to all generation and transmission facilities which connect to the TVA BES. The facility connection requirements for generation and transmission facilities not presently connected, and for modifications of facilities already connected, are consistent in content and application, whether the facility is owned by TVA or another party. TVA’s facility connection requirements shall comply with all applicable codes, standards, federal and state regulations, environmental regulations, siting requirements, contracts, operating agreements, and FERC tariff requirements. Generation and transmission facility connections shall comply with all reporting requirements as specified in NERC reliability standards, SERC regional criteria, Interconnection Agreements, and other applicable standards, contracts, and documents. TVA reserves the right to take such actions as deemed necessary to ensure the reliability of the TVA BES.

3.0 GENERATION AND TRANSMISSION FACILITY CONNECTION REFERENCES

3.1 Reference A - TVA “Standard Large Generator Interconnection Procedures (LGIP)”

TVA has developed an interconnection process for generation which is described in detail in Reference A - “Standard Large Generator Interconnection Procedures (LGIP).” The following appendices are included in Reference A:

- Appendix 1 Interconnection Request
- Appendix 2 Interconnection Feasibility Study Agreement
- Appendix 3 Interconnection System Impact Study Agreement
Appendix 4  Interconnection Facility Study Agreement
Appendix 5  Optional Interconnection Study Agreement
Appendix 6  Interconnection Agreement

3.2  **Reference B - Typical “Interconnection Agreement Between TVA and a Generating Plant”**

TVA has developed a generic generation interconnection agreement which will be referred to as Reference B - "Interconnection Agreement Between TVA and a Generating Plant". The following exhibits are included in Reference A:

- Exhibit DT  Definition of Terms
- Exhibit IC  Interconnection Criteria
- Exhibit GP  General Provisions
- Exhibit FP  Facilities Provisions
- Exhibit FA  Facilities Arrangements
- Exhibit FC  Facilities Configuration
- Exhibit FM  Facilities Matrix
- Exhibit FPS  Facilities Payment Schedule
- Exhibit CSP  Contractor Signature Page
- Exhibit RD  Rate Difference

3.3  **Reference C - TVA-PSO-SPP-06.012 IPP, Distributed Generation, Interchange, Pseudo-ties, Dynamic Schedules, and TVA Generation Metering Requirements**

TVA has developed a document that addresses metering requirements which will be referenced in section 4.1.6 of this document, Metering and Telecommunications.

4.0  **GENERATION AND TRANSMISSION FACILITY CONNECTION REQUIREMENTS**

This document covers all generation and transmission facility connections to the TVA BES and addresses each sub-requirement of FAC-001 R2. The reference documents provide additional detail in addressing facility connection requirements. Certain facility connection requirements are agreed upon/determined during the Facility Study portion of the interconnection process.
4.1 Plans to Achieve System Performance throughout the Planning Horizon

TVA evaluates system performance throughout the planning horizon through regular studies that are performed to meet the requirements established in NERC Reliability Standards TPL-001 through TPL-004. New (or significantly changed) generation and transmission facility connections are initially studied based on the projected in-service year of the connection to assess the impacts on the existing BES infrastructure. These system impact studies evaluate BES performance during events described in NERC Reliability Standards TPL-001 through TPL-003, and as necessary TPL-004. Should exceedances of TVA planning criteria (designed to meet NERC Reliability Standards TPL-001 through TPL-004) occur on the BES as a result of the generation or transmission facility connections, a solution to remedy the criteria exceedance becomes a pre-requisite or parallel activity to the project that establishes the facility connection(s) of interest. Once a new generation or transmission facility connection has met the requirements of initial interconnection, the facility is incorporated into planning horizon models that facilitate the ongoing evaluation of system performance with the new facility integrated into the BES.

4.1.1 Procedures for Coordinated Joint Studies of New Facilities and their Impacts on the Interconnected Transmission Systems

Due to the interconnected nature of electric power systems, the interconnection of a new generation or transmission facility to the TVA transmission system may, during the course of studies, be determined to have an impact on distributors of TVA power, TVA’s directly-served customers, or other neighboring systems. If such an impact is indicated by TVA’s studies, TVA shall share the results of such studies with any Affected Systems. Typical studies which are considered include, but are not limited to, power flow, short circuit, and stability analysis.

TVA will notify the Interconnection Requestor of any Affected Systems that are identified during any study conducted by TVA concerning the interconnection of the new generation or transmission facility to the TVA transmission system. The Interconnection Requestor shall then cooperate with any Affected Systems identified by TVA. TVA shall participate in any coordination necessary to assist the Interconnection Requestor or Affected System in determining impacts to the interconnected transmission system. The coordination may include participating in necessary meetings, providing applicable data or study results, and/or any other coordination necessary to ensure the reliability of the interconnected transmission system. For more information, see the following:

Reference A, Section 3.4 - Coordination with Affected Systems
Reference A, Appendix 3 - Interconnection System Impact Study Agreement (Items 8 & 9)
Reference B, Section BA-5.2 - Impacts on Neighboring Systems
4.1.2 Procedures for Notification of New or Modified Facilities to Others (those responsible for the reliability of the interconnected transmission systems) as Soon as Feasible

Due to the interconnected nature of electric power systems, the interconnection of a new or modification of an existing generation or transmission facility to the TVA transmission system may, during the course of studies, be determined to have an impact on distributors of TVA power, TVA’s directly-served customers, or other neighboring systems. If such an impact is indicated by TVA’s studies, TVA shall share the results of such studies with any Affected Systems. TVA shall hold the interconnection of the generation or transmission facility contingent upon the completion of any required studies by an Affected System. If TVA determines there are no impacts to the interconnected transmission system of any third party, TVA will incorporate the new or modification of an existing generation or transmission facility into planning horizon models that are available to those responsible for the reliability of the interconnected transmission system, for ongoing evaluation of the performance of the interconnected transmission system. For more information, see the following:

Reference A, Section 3.4 - Coordination with Affected Systems
Reference A, Appendix 3 - Interconnection System Impact Study Agreement (Items 8 & 9)
Reference B, Section BA-5.2 - Impacts on Neighboring Systems

4.1.3 Voltage Level and MW and MVAR Capacity or Demand at Point of Connection

Entities seeking to interconnect to the TVA transmission system must specify the approximate location of the proposed point of interconnection and the desired interconnection voltage level. TVA owns and operates bulk transmission facilities in the following voltage categories: 115 kV, 161 kV, 230 kV, 345 kV, and 500 kV. The proximity of the interconnecting facility to existing TVA facilities will influence the interconnecting voltage level. A transmission to transmission interconnecting facility shall be capable of meeting the MW and MVAR requirements of the interconnected transmission system, while maintaining safe, reliable operation of the facilities interconnected. Upon Interconnection Request generator owners seeking to connect to the TVA transmission system shall provide equipment parameters to include MW and MVAR capacity of the interconnecting generator. The facility shall be operated at a power factor within the range of 0.95 lagging to 0.95 leading at the point of interconnection to provide optimum support to the voltage level specified by TVA. The interconnecting generator shall be capable of providing the amount of MVAR capacity needed at the point of interconnection to allow for operation within the desired power factor range. For more information, see the following:

Reference A, Section 3.2.1 - Initiating an Interconnection Request
Reference A, Appendix 1 - Interconnection Request
Reference A, Attachment A to Appendix 1 - Interconnection Request Data Sheets
Reference B, Section BA-8.4 - Point of Interconnection and Conditions of Delivery
4.1.4 Breaker Duty and Surge Protection

All current carrying elements shall have adequate short circuit capabilities. All interrupting devices shall have ratings high enough to be capable of interrupting the maximum available fault current. All new relays and devices shall be coordinated with existing system protection. The short circuit data necessary for modeling the interconnecting generation or transmission facility shall be provided to TVA upon Interconnection Request. The existing and planned future fault current levels shall be determined during the Interconnection System Impact Study utilizing the short circuit data provided at the time of Interconnection Request. The facility owner shall be responsible for any new facilities or required changes in existing facilities due to increased fault currents. For more information, see the following:

Reference A, Appendix 3 - Interconnection System Impact Study Agreement
Reference B, Exhibit IC, Sections I, V
Reference B, Exhibit IC, Appendix - Applicable Codes, Standards, Criteria, and Regulations

4.1.5 System Protection and Coordination

The safety of the general public shall be considered at all times. System protection shall be designed and operated in a manner which will provide for the minimization of equipment damage, equipment outage time, system outage area, and system voltage disturbances. The protective system shall provide adequate protection during both normal and abnormal conditions. The interconnecting facility owner and TVA shall establish the appropriate system protection and coordination for the new or modification of an existing generation or transmission facility during the Facility Study portion of the interconnection process. The system protection and coordination schemes established shall be acceptable to TVA. TVA shall specify RTU protocols and other communication channels during the Facility Study portion of the interconnection process. The facility owner and TVA shall coordinate on remote trip schemes, underfrequency load shedding schemes, undervoltage load shedding schemes, and special protective systems, regardless of Balancing Authority Area status. Allowable operating modes for the generating facility (parallel and/or islanding) shall be coordinated with TVA. For more information, see the following:

Reference B, Exhibit IC, Section V
Reference B, Exhibit IC, Appendix - Applicable Codes, Standards, Criteria, and Regulations
Reference B, Exhibit FP, Section FP-2.3
4.1.6 Metering and Telecommunications

Typical metering data requirements include MW, MWh, MVAR, MVARh, and kV. TVA shall inform the facility owner of the design requirements including loss compensation, bi-directionality, metering accuracy, ancillary equipment specification, provisions for maintenance and calibration, data protocol, mode of data transmission, and provisions for maintaining continuity and meeting reliability criteria during the Facility Study portion of the interconnection process. TVA shall have appropriate metering on all points of interconnection and all metering schemes installed shall be consistent with TVA-PSO-SPP-06.012 IPP, Distributed Generation, Interchange, Pseudo-ties, Dynamic Schedules, and TVA Generation Metering Requirements. For more information, see the following:

Reference B, Section BA-7.1
Reference B, Exhibit FP, Section FP-1.3
Reference C

4.1.7 Grounding and Safety Issues

All new facilities require a grounding study. The facility shall be effectively grounded up to the interconnection point. The facility owner is responsible for all aspects of the proper grounding system of the facility including personnel safety considerations, design, construction, testing, and maintenance. If the facility’s grounding system will be connected to TVA’s grounding system, the design requirements including compatibility, transmission line shielding, arrester application, and cathodic protection will be addressed during the Facility Study portion of the interconnection process. The facility owner shall be responsible for any required changes to existing TVA grounding facilities. For more information, see the following:

Reference B, Exhibit IC, Section IV.B
Reference B, Exhibit IC, Appendix - Applicable Codes, Standards, Criteria, and Regulations

4.1.8 Insulation and Insulation Coordination

All new facilities require the appropriate level of insulation. The facility owner is responsible for all aspects of insulation of their facility including personnel safety considerations, design, construction, testing, and maintenance. Insulation coordination between TVA and the facility owner will be addressed during the Facility Study portion of the interconnection process. For more information, see the following:

Reference B, Exhibit IC, Appendix - Applicable Codes, Standards, Criteria, and Regulations
4.1.9 Voltage, Reactive Power, and Power Factor Control

For an interconnecting generator, the voltage schedule at the point of interconnection will be established by TVA. For transmission to transmission interconnections, both parties will have close coordination with respect to voltage level, and if TVA determines unacceptable voltage or reactive variations occur at the point of interconnection either a joint study or disconnection may be necessary. Continuous reactive capability of the facility shall not be limited by internal plant system design (e.g., transformer rating/taps/impedance, cooling systems, generator/exciter rating) and all interconnected transmission equipment shall have tap ranges and self-regulation available to accommodate the transmission system’s reactive power flow requirements. The facility shall be operated at a power factor within the range of 0.95 lagging to 0.95 leading at the point of interconnection to provide optimum support to the voltage level specified by TVA and shall operate within the continuous reactive capability of the generator. For more information, see the following:

Reference B, Sections BA-6.5, BA-8.5, BA-9
Reference B, Exhibit IC, Section IV.C

4.1.10 Power Quality Impacts

Power quality studies, such as voltage flicker, harmonic distortion, temporary overvoltage, etc., may be performed at any time by TVA to ensure that the proposed facility connection will not compromise or degrade the power quality of existing customers. Studies may identify additional equipment or operating ranges and limits necessary to meet power quality standards. The facility shall be operated in such a manner that the electrical connection to TVA shall meet the requirements for voltage level, power factor, harmonics, and other electrical characteristics that TVA specifies in the Interconnection Agreement. If the interconnecting facility fails to meet these power quality requirements, TVA shall have the right to disconnect the facility. For more information, see the following:

Reference B, Sections BA-8.4 and BA-8.5
Reference B, Exhibit IC, Section IV.A

4.1.11 Equipment Ratings

The interconnecting facility shall provide TVA the facility equipment ratings at the time the Interconnection Request is made and update facility equipment ratings when new information is available. No later than 90 days following the commercial operation date, the interconnecting generator shall provide TVA with the actual manufacturers’ data, including any test reports and nameplate data for installed facilities.
TVA’s general design parameters and practices will be addressed during the Facility Study portion of the interconnection process. TVA may at its discretion review the design and specifications of the facility. Any special requirements due to atmospheric, geological, seismic, or environmental conditions are the responsibility of the facility owner. The facility owner shall be responsible for any changes to the existing transmission system made necessary by the facility. For more information, see the following:

Reference A, Appendix 1 - Interconnection Request
Reference A, Attachment A to Appendix 1 - Interconnection Request Data Sheets
Reference B, Sections BA-6.9 and BA-6.10
Reference B, Exhibit IC, Section V
Reference B, Exhibit IC, Appendix - Applicable Codes, Standards, Criteria, and Regulations

4.1.12 Synchronizing of Facilities

Prior to synchronization, a start-up and test schedule must be submitted to TVA for the facility. TVA reserves the right to inspect the facility prior to synchronizing testing, and monitor start-up testing. Upon inspection, TVA reserves the right to delay the initial synchronization date due to issues that would cause TVA to disconnect the facility. For more information, see the following:

Reference B, Sections BA-6.3, BA-6.6, and BA 6.7
Reference B, Exhibit IC, Section V.A
Reference B, Exhibit FP, Article FP-5 - Review, Inspection, and Approval of Facilities

4.1.13 Maintenance Coordination

Following the execution of the Interconnection Agreement, TVA and the facility owner shall appoint representatives to an Operating Committee. Each party shall notify the other party of its appointment in writing. Each representative shall be responsible for working with the day-to-day operations of his or her respective facilities or system. The Operating Committee representatives shall mutually develop written operating procedures no later than 30 days prior to the scheduled initial synchronization. The Operating Committee shall schedule maintenance of the generation and/or transmission facilities of the parties.

Facility owners of transmission to transmission interconnected facilities must participate in monthly meetings for coordinating transmission system outages.

Planned maintenance outages shall be coordinated with the Reliability Coordinator for the TVA Balancing Authority and should specify both time and duration. Notification is desired even when clearances are not required. All maintenance work should be performed at a level that ensures the reliability of the interconnected transmission system. For more information, see the following:

Reference B, Sections BA-6.4 and BA-7.1
Reference B, Exhibit FP, Sections FP-1.5 and FP-2.7
4.1.14 **Operational Issues (Abnormal Frequency and Voltages)**

The Facility electrical output to TVA at the point of interconnection shall be in the form of 3-phase, alternating current at a frequency of 60 Hz, and at a voltage schedule specified by TVA. TVA may disconnect the facility from the TVA transmission system at any time that the limits on voltage and frequency are not maintained and are materially and adversely affecting TVA or a third party. For more information, see the following:

Reference B, Sections BA-6.4, BA-6.5, BA-8.4, and BA-8.5
Reference B, Exhibit IC, Sections IV and V

4.1.15 **Inspection Requirements for Existing or New Facilities**

Technical specifications and design drawings for the proposed facility shall be provided to TVA for TVA’s review, inspection, and acceptance. The technical specifications and design drawings shall be consistent with good engineering practice and shall specify the equipment to be used as to manufacturer, model, type, technical specifications, and other pertinent information. For more information, see the following:

Reference B, Sections BA-6.3, BA-6.9, and BA-6.10
Reference B, Exhibit IC, Section II.D
Reference B, Exhibit FP, Section 2.5
Reference B, Exhibit FP, Article FP-5

4.1.16 **Communications and Procedures During Normal and Emergency Operating Conditions**

Following the execution of the Interconnection Agreement, TVA and the facility owner shall appoint representatives to an Operating Committee. Each party shall notify the other party of its appointment in writing. Each representative shall be responsible for working with the day-to-day operations of his or her respective facilities or system. The Operating Committee representatives shall mutually develop written operating procedures no later than 30 days prior to the scheduled initial synchronization.

The generation and transmission facility operators shall communicate and cooperate with the transmission reliability coordinator for the TVA Balancing Authority to support recovery efforts during emergency conditions. This may include, but is not limited to the following: switching operations, VAR support, adjustments in real or reactive generation net output, tripping of generating unit(s), starting of generating unit(s) including black start units, implementation of emergency communication procedures, and transmission facility restoration efforts. For more information, see the following:

Reference B, Sections BA-6.4, BA-7.1, BA-7.2, BA-7.7, BA-8.1, and BA-8.4
4.1.17 Provision for Future Changes

Facility owners are required to notify TVA before making any modifications or changes to the facility which may affect system operations or reliability. When TVA receives such notification, TVA shall determine if there is a need to conduct new or additional impact studies. All studies shall be performed in accordance with the procedures described in Reference A. For more information, see the following:

Reference B, Exhibit FP, Sections FP-1.7, FP-2.4
Reference B, Exhibit GP, Section 10.14

4.1.18 Generation Control

Facility owners and TVA shall coordinate on the facility design requirements for load following capability, AGC, reactive power output, minimum operating capability, remote control functions, generation control system settings, load shedding, and black start capability. All generators shall be operated at a frequency of 60 Hz. New generators shall have an underfrequency relay to disconnect the generator from the transmission system during frequency decline conditions. The settings for this underfrequency relay shall be lower and slower than TVA's underfrequency load shedding relay settings. The facility operator is responsible for coordination with TVA's Balancing Authority operator. For more information, see the following:

Reference B, Article BA-7
Reference B, Exhibit IC, Section IV

4.1.19 Supervisory Control and Data Acquisition (SCADA)

TVA’s typical data requirements include the status of all interrupting devices, MW flow, MVAR flow, and voltage at the point of interconnection. TVA shall inform the facility owner of the design requirements including communication protocol, mode of data transmission, control functionality, and provisions for maintaining continuity and meeting reliability criteria during the Facility Study portion for the interconnection process. For more information, see the following:

Reference B, Section BA-7.1
Reference B, Exhibit FP, Section FP-1.3

5.0 DEFINITION OF TERMS

Affected System shall mean an electric system other than TVA’s transmission system that may be affected by the proposed interconnection.

Balancing Authority Area shall mean the collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority. The Balancing Authority maintains resource balance within this area.
**Balancing Authority** shall mean the responsible entity that integrates resource plans ahead of time, maintains, load-interchange-generation balance within a Balancing Authority Area, and supports Interconnection frequency in real time.

**Bulk Electric System (BES)** shall mean the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are generally not included in this definition.

**Facility Study** shall mean a study conducted by TVA or, at TVA’s discretion, a third party consultant for the Interconnection Requestor to determine a list of facilities (including interconnection facilities and network upgrades as identified in the Interconnection System Impact Study), the cost of those facilities, and the time required to physically and electrically interconnect the Facility with TVA’s transmission system. The Facility Study shall ensure the interconnecting facility will be compliant with all NERC reliability standards, Interconnection Agreements, and other applicable standards, contracts, and documents.

**Interconnection Agreement** shall mean the form of interconnection agreement applicable to an interconnection request pertaining to an interconnecting Facility.

**Interconnection Requestor** shall mean any entity, including TVA, which proposes to interconnect a generation or transmission facility with TVA’s transmission system.

**Interconnection Request** shall mean an Interconnection Requestor’s request to interconnect a new Facility, or to increase the capacity of a generation Facility, or to make a modification to an existing Facility that is interconnected with TVA’s transmission system.

**Interconnection System Impact Study** shall mean an engineering study that evaluates the impact of the proposed interconnection on the safety and reliability of TVA’s transmission system and, if applicable, an Affected System.

**Operating Committee** shall be a group made up of representatives from Interconnection Requestors and TVA to coordinate operating and technical considerations of the interconnected facilities.

**Transmission Owner** shall mean an entity that owns, leases or otherwise possesses an interest in the portion of the transmission system at the point of interconnection and may be a party to the Interconnection Agreement to the extent necessary.