

City of Tallahassee, Electric Utility

TAL Facility Connection Requirements

October 2007



Version	Date	Synopsis	Division	SME
Original	10/25/07	Original Approval		
Revision 1	08/27/12	Changed “City” to “TAL” Added Bookmarks reflecting the corresponding FAC001-0 reqmt. Added “Call-Outs” referencing applicable FAC001-0 requirements Incorporated “Attachment A, Application for Connection” Minor language edits for clarification		
Revision 2	01/01/16	Modified to conform to FAC001-2 and effective as of 01/01/16. Removed Bookmarks and “Call Outs”. Added “Division” and “Manager” to Revision Block.	Pow. Eng. Div.	Clint Smith
Revision 3	09/15/17	Added information requirements for PV generation to Exhibit A; Attachment A	Power Delivery	Wesley Infinger
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Revision 5	04/5/19	Added additional information request for Non-Synchronous Generator Facilities	Power Delivery	Wesley Infinger
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Revision 7	2/13/20	Revise document to add additional technical detail with new Exhibits. Incorporate recommendations per NERC Reliability Guideline – Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources. General revisions.	Power Delivery	Wesley Infinger
Revision 8	6/10/20	Added PSCAD Model Requirements for Inverter-Based Resources (IBR).	Power Delivery	Marc Rodriguez
Revision 9	7/20/20	Revise document to add Commissioning and Verification Study requirements.	Power Delivery	Marc Rodriguez
Revision 10	9/16/20	Added fusing requirements to section 1.2 System Protection and Coordination in Exhibit A	Power Delivery	Marc Rodriguez

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Exhibits

- A General Technical Guideline, Basis, & Requirements**
- B Additional Inverter-based Resource Requirements**
- C Connection Request**
- D Electromagnetic Transient Model Data Collection**

Attachments

- C.I Generating Facility Data

1.0 Acronyms and References

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Material
CRSI	Concrete Reinforcing Steel Institute
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electric Safety Code
NFPA	National Fire Protection Association
NRMCA	National Ready Mixed Concrete Association
UL	Underwriters Laboratories, Incorporated

NOTE: Florida Power Corporation is now Duke Energy Florida

2.0 Definitions

TAL	The City of Tallahassee, Electric Utility
Connection	A connection of generation, transmission or end-use facilities to the TAL System
Customer	Any person or entity desiring to connect new facilities or to upgrade existing facilities connected to the System
ECC	Electric Control Center
EPA	Environmental Protective Agency
EPAct	Energy Policy Act of 2005
FCR	Facility Connection Requirements
FERC	Federal Energy Regulatory Commission
FRCC	Florida Reliability Coordinating Council
NERC	North American Electric Reliability Council
OATT	Open Access Transmission Tariff
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl
PURPA	Public Utilities Regulatory Policy Act of 1978
System	TAL electric power system

3.0 Introduction

The City of Tallahassee, Electric Utility (“TAL”), as both a transmission and generator owner, has prepared the *Facility Connection Requirements* (“FCR”) document to identify the facility interconnection requirements for generation, transmission and end-use facility connections (“Connection”) to TAL electric power system (“System”) in order to avoid adverse impacts on the reliability of the Bulk Electric System (“BES”). (FAC001-3;R1.1; R1.2; R1.3) It addresses interconnection requirements for new Connections or material modifications of existing Connections and is applicable as noted below:

- To TAL as a Transmission Owner and to the interconnection Customer
- To TAL as a Generator Owner if it has a fully executed Agreement to conduct a study on the reliability impact of interconnecting a third party facility to TAL’s existing facility that is used to interconnect to the transmission system and to the interconnection Customer.

This document is written to comply with NERC (FAC-001-3) and PURPA (as amended by 2005 EPAct Subtitle E) Standards for Facility Connection Requirements, which requires entities responsible for the reliability of the interconnected transmission systems to maintain and make available a FCR document. The NERC standards require those entities seeking to add facilities or connect to the interconnected transmission system to comply with the FCR document. The NERC Planning Standards are posted on NERC’s web site (www.nerc.com/standards).

This FCR document reflecting TAL’s facility interconnection requirements is not intended to be a detailed manual but a general overview of procedural and technical requirements to be met in the design of a Connection. These requirements are written to establish a basis for maintaining reliability, power quality, and a safe environment for the general public, power consumers, maintenance personnel and the equipment. In addition to the specific requirements incorporated in this FCR, additional items that may include but not be limited to the following may be of consideration in the development of the interconnection requirements.

- Voltage level and MW and MVAR capacity or demand at point of interconnection
- Breaker duty and surge protection
- System protection and coordination
- Metering and telecommunications
- Grounding and safety issues
- Insulation and insulation coordination
- Voltage, Reactive Power (including specifications for minimum static and dynamic reactive power requirements), and power factor control
- Power quality impacts
- Equipment ratings
- Synchronizing of facilities
- Maintenance coordination
- Operational issues (abnormal frequency and voltages)
- Inspection requirements for new or materially modified existing interconnections
- Communications and procedures during normal and emergency operating conditions

This FCR document will be revised from time to time to reflect changes and/or clarifications in planning, operating, or interconnection policies. The FCR document is to be made available upon request or, in the event of a request to interconnect a third-party facility to an existing generating facility owned by TAL, within 45 calendar days of full execution of an Agreement to conduct a study on the reliability impact of interconnecting the third party's generator to TAL's existing generating facility. (FAC001-3; R2) The FAC001-3 Subject Matter Expert (SME) will keep records of requests for this FCR for the current audit cycle of FAC001-3. If no new records are generated during an audit cycle due to a lack of new/revised interconnections; then, upon request by an auditor to review records, the FAC001-3 SME may certify that no new/revised interconnections occurred during the current audit cycle.

This document references and incorporates certain NERC, FRCC, FERC, OATT, NESC, NEC, IEEE and TAL standards. There are specific requirements established by FERC, NERC and

FRCC for some types of Connections that may expand upon or supersede the procedures outlined in this document. In the event of a conflict between the requirements identified in this document and those in any of the aforementioned standards, it is TAL's intent that the applicable standard that provides for greater reliability of the Connection and System will be the governing standard. Throughout the document the phrase "industry standards" is used. This term refers to NERC, FRCC, FERC, OATT, NESC, OSHA, NEC, IEEE and TAL standards as well as electric utility industry best practices.

4.0 Basic Requirements

This section addresses the basic technical requirements that are common to generation facilities, transmission facilities and end-user facility Connections to the System. Some exceptions to these requirements may be made based on TAL's preliminary assessment of the Connection's potential system impacts. Generation resources with an aggregate capacity of 2.2MW or less that are classified as non-BES are not subject to the requirements of this FCR and shall be permitted per the requirements of TAL's Electric Service Manual. Additional technical guidance and requirements are included in Exhibits A and B.

General overviews of functional requirements are given in this section. This document is not intended to be a comprehensive design specification. This document references, and therefore is supported by other current, applicable industry standards. Specific design and construction of the electrical facilities are to be in accordance with these standards, which include, but are not limited to the following:

- NFPA 70 – NEC - National Electrical Code
- NESC – National Electrical Safety Code
- NEMA SG-6 – Power Switching Equipment
- ASTM – American Society of Testing Material
- AISC – American Institute of Steel Construction
- ACI – American Concrete Institute
- IEEE – Institute of Electrical and Electronic Engineers, Inc.

- UL – Underwriters Laboratories, Inc.
- EPA – Environmental Protective Agency
- ASME – American Society of Mechanical Engineers
- ASCE – American Society of Civil Engineers
- NFPA – National Fire Protective Association
- NRMCA – National Ready Mixed Concrete Association
- CRSI – Concrete SI – Concrete Reinforcing Steel Institute
- ANSI – American National Standards Institute
- ICEA – Insulated Cable Engineers Association
- PURPA – The Public Utility Regulatory Policies Act of 1978
- EPAct 2005 – The Energy Policy Act of 2005

All persons or entities desiring to connect new facilities or to upgrade existing facilities (“Customers”) shall complete and provide to TAL a Connection Request identified as either a Transmission Service Request (“TSR”) or a Generator Interconnection Service Request (“GISR”) as applicable to the type of interconnection requested. The Connection Request is attached hereto as Exhibit C.

All oil-filled equipment, including bushings, shall not contain polychlorinated byphenyls (PCB), and shall be labeled by the manufacturer as non-PCB. Certificates shall be provided to TAL certifying all oil-filled equipment as non-PCB. Oil-filled equipment may require an oil spill containment system to comply with EPA, state or local regulations.

All equipment that affects the performance of the System will meet or exceed TAL’s requirement for similar equipment, must coordinate with the System, and must be approved by TAL. Consideration will be given for forecasted system growth in the selection of equipment.

Final design of a Connection to the System shall be subject to TAL review and approval on an individual case-by-case basis.

5.0 Application for an Interconnection

TAL will permit any qualified Customer's generation, transmission or end-use facilities to connect with the System provided that there will be no adverse impacts on:

- The reliability of TAL's System and/or systems of interconnected neighboring electric utilities;
- The safe and efficient operation of the existing System and sub-transmission systems;
- Planned Connections with an earlier application date;
- The tax-exempt status of any bonds issued by TAL to finance facilities needed to provide the requested Connection; or
- The general public.

To establish a Connection with the System a Customer must first provide a Connection Request identified as either a TSR or a GISR to TAL as applicable to the type of Connection requested and obtain a queue assignment. TAL will evaluate all TSR's or GISR's, including those made by TAL, on an equal basis. The time and date at which TAL deems the Customer's TSR or GISR complete will be the official application date and determine the Customer's position in the queue. The queue position will be used to determine the order in which studies will be performed and may be a factor in the determination of cost responsibility.

Modifications to an application may be accepted prior to the start of the System Impact Study described later in this section. These changes may include minor reconfiguration of the requested Connection, reductions in facility size and other changes suggested by or acceptable to TAL. Other minor changes (modeling data, facility layouts and schedule delays) may be accepted after completion of the System Impact Study at the sole discretion of TAL.

After the System Impact Study is complete, the customer must provide to TAL a PS CAD EMTDC Model for all inverter-based resources (greater than 1 MVA) requesting connection to its electric transmission or distribution system. This file must be received prior to the Facility Study. Requirements for the PS CAD model are detailed in Exhibit D, Electromagnetic Transient Model Data Collection.

Any study fee requirements will be negotiated between TAL and the Customer prior to the execution of the requisite study agreements. To maintain its queue position the Customer must sign requisite study agreements and pay associated fees prior to study start.

A project is subject to restudy due to but not limited to any of the following scenarios: (i) changes in design that may arise from inability to site or construct facilities as originally proposed, (ii) new statutory or regulatory requirements that are effective before the completion of construction, or (iii) other circumstances beyond the control of the TAL that significantly affect the final cost of new facilities or upgrades.

Once the first study requirements have been submitted to the Customer, the Customer has thirty (30) calendar days to either sign and pay for the next required study or forfeit their queue position. Until all required studies are completed, the 30-day window will begin again after each study's results are reported to the customer. A project is subject to restudy if construction has not started within ninety (90) days of the Interconnect Agreement (IA) and Transmission Service Agreement (TSA) execution. (Note: A TSA is not required if the interconnected facility will serve TAL exclusively.) Construction, as applied herein, shall constitute the following minimum requirements: all project permits are issued, site control and stabilization measures are in place, a detailed construction schedule is available, and the plant constructor is under contract and has broken ground. A project is subject to loss of queue position if construction has not started within one (1) year of final interconnection study completion. A project is subject to loss of queue position if construction has not been completed within three (3) years of final interconnection study completion.

Once a project forfeit's its queue position, a ten (10) day cooling window will begin. During the cooling period, any new project that is submitted will be given queue priority. If a project drops out of the queue at any time, then the process will start over from the application phase. This may result in the previously completed study findings becoming invalid.

Customer's failure to adhere to these and other provisions of this FCR will be deemed by TAL as withdrawal of Customer's application and result in Customer's loss of queue position. A Customer that voluntarily withdraws its application or fails to meet the requirements of this FCR will forfeit its queue position and pay all costs incurred by TAL for work related to the application. All costs must be paid before any study data or results are provided to the Customer. Any funds remaining after said costs due TAL are deducted will be returned to the Customer.

6.0 Procedure for coordinated studies of new or materially modified facilities and their impacts on the interconnected transmission systems (FAC001-3; R3.1; R4.1)

The number, scope and procedures of the required studies will be negotiated between TAL and Customer dependent on the size, location and complexity of the requested Connection. Studies will consider without limitation all existing and future facilities (including those interconnected with neighboring systems) that may have an impact on the Connection request.

The scope and procedures for each study will in general be based on those described in the FERC pro forma open access transmission tariff (OATT), large generator interconnection procedure (LGIP) and small generation interconnection procedure (SGIP). A general description of the scope of these studies is provided below in the order that each may be performed.

Feasibility Study - a preliminary evaluation of the system impact and cost of interconnecting new facilities to the System. The study may consist of preliminary power flow and short circuit analyses and will provide a preliminary list of facilities and a non-binding good faith estimate of cost responsibility and a non-binding good faith estimated time to construct.

System Impact Study - a detailed evaluation of the system impact and cost of interconnecting new facilities to the System. The study is comprised of both steady state and dynamic studies with contingencies and may consist of power flow, short circuit, stability, power quality, and any other analyses as deemed necessary by TAL

to ensure reliability. The study will typically provide documentation of the assumptions upon which it is based; the results of the analyses; the requirements or potential impediments to providing the requested Connection; a list of the facility additions and/or modifications required to correct any problems identified in those analyses; a non-binding good faith estimate of cost responsibility; and a non-binding good faith estimate of the time required to construct new and/or modify existing facilities and implement the Connection.

Facility Study – specifies and estimates the cost of the equipment, engineering, procurement and construction work needed to implement the conclusions of the System Impact Study to interconnect a Customer’s facility with the System. The study will typically also identify the configuration of the Connection equipment including without limitation: the transformer, switchgear, meters, and other station equipment; the nature and estimated cost of any Connection facilities and network upgrades necessary to accomplish the Connection; and an estimate of the time required to complete the construction and installation of such facilities. Further analysis beyond that performed in the System Impact Study may be performed including without limitation further analysis of power quality and protection coordination requirements.

Commissioning and As-built Verification Study – After project commissioning, as-builts of construction documents, equipment manuals, commissioning reports, and field programmed operational setpoint parameters will be collected by the Customer and delivered to TAL. The Commissioning and As-built Verification Study will compare the constructed facility against the Customer supplied data used in studies completed prior to facility construction. All deviations will be restudied to verify that previous design analysis and requirements remain valid. If a deviation requires the revision of any of the previously agreed-upon connection requirements or the installation of additional facilities, then the Customer shall provide and satisfy accordingly.

Additional studies of the requested Connection's potential impact on the regional transmission systems may be required by FRCC and neighboring utilities including inclusion in the Load Flow Databank, Short Circuit Databank, and Dynamics databank to be run in the TPL Assessment, FRCC Long Range Study, and FRCC Extreme Event Study. A coordinated FRCC GISR Study will also usually be required to allow affected entities to identify any third-party impacts and possible mitigations, if necessary. The FRCC studies will be performed in accordance with FRCC procedures. Affected neighboring utilities will perform studies according to their own procedures.

Additional studies of the requested Connection's potential impact may be required based on the results of previous studies and TAL's system capabilities. A Transmission Service Agreement may also be required. To determine whether a TSA is required the Customer must identify the desired point(s) of delivery (POD) for the facility's output and the nature of transmission service desired. Possible PODs for the TAL transmission system include: TAL load, the TAL/DEF (Duke Energy Florida) interface, and/or the TAL/SOU (Southern) interface. Further, if a TSA is required, the Customer must advise what ancillary services may be required. Ancillary services include, but are not limited to:

1. Scheduling, System Control and Dispatch Service – To be provided directly by TAL (the Transmission Provider (TP)). This service is required to schedule the movement of power through, out of, within, or into a Control Area. It is a given that this service will be required.
2. Reactive Supply and Voltage Control Service - To maintain transmission voltages on the TAL's transmission facilities within acceptable limits, TAL's generation and non-generation resources capable of providing this service will have to be operated to produce (or absorb) reactive power.
3. Regulation and Frequency Response Service - To provide for the continuous balancing of resources (generation and interchange) with load and for maintaining scheduled Interconnection frequency at sixty cycles per second (60 Hz). This is

accomplished by committing generation whose output can be raised or lowered (predominantly using automatic generating control equipment) and by other non-generation resources capable of providing this service as necessary to follow the moment-by-moment changes in load.

4. Energy Imbalance Service - Provided when a difference occurs between the scheduled and the actual delivery of energy to a load located within a Control Area over a single hour. TPs must offer this service when the transmission service is used to serve load within its Control Area. A TP may charge a TC a penalty for either hourly energy imbalances.

If Regulation and Frequency Response Service is sought from TAL, then an Area Control Error (ACE) Analysis Study will be required.

In addition to the above, facility specific studies the extent of which is to be determined upon receipt of a TSIR or a GISR may be required for the interconnection of a third party generator to TAL's transmission system or to an existing TAL generating facility that is used to interconnect to the TAL's transmission system.

Once all requisite studies are completed, interconnection and operating agreements may be negotiated between TAL and Customer. These agreements will identify cost; operations, maintenance and reliability standard compliance responsibilities and liabilities; ownership allocations; a construction schedule for any needed facilities required to accomplish the requested Connection; and any special technical requirements. Construction of any facilities required to accommodate the requested Connection shall not begin until these agreements have been executed. Prior to the execution of the requisite interconnection and operating agreements, the Customer must demonstrate site control. The Customer's facility must be placed into commercial service no more than three (3) years later than the in-service date identified at the completion of the Facilities Study. Customer's failure to adhere to these and other provisions of this FCR will be deemed by TAL as withdrawal of Customer's application.

During the commissioning process, Customer shall submit the desired control system settings to TAL to review and comment prior to implementing them. The submission shall include a side-by-side comparison with the modeling data. Customer shall submit the finalized as-built modeling data after the plant has been commissioned and is in-service within 90 days after energization.

7.0 Procedure for Notification of FRCC and Others of Proposed Project

If the proposed project meets certain criteria established by the FRCC and TAL, TAL will contact the FRCC to set up any required joint studies. A review of the project will then be initiated per FRCC procedures. If the project does not meet the level of FRCC Review, TAL may still contact entities that may be impacted and have them review the project.

Attached for informational purposes as Exhibit D is the “Transmission Service and Generator Interconnection Service Request Regional Deliverability Evaluation Process” prepared by the FRCC. If applicable, once the project moves into the Facility Study stage (occasionally earlier) it will be added to the FRCC databank and the FRCC project schedule by either the Customer or TAL.

8.0 Procedures for notifying those responsible for the reliability of affected system(s) of new or of materially modified existing interconnections (FAC001-3; R3.2; R4.2)

Open communications will be maintained between TAL and Customer under both normal and emergency conditions. TAL’s Electric Control Center (“ECC”) and FRCC Reliability Coordinator are responsible for ensuring the safe and reliable operation of the System and regional electric system. TAL’s Electric Control Center shall notify the FRCC Reliability Coordinator of new or materially modified existing interconnections via email and send a record of this email to the FAC001-3 SME. The FAC001-3 SME will keep any such records for the current audit cycle of FAC001-3. If no new records are generated during an audit cycle due to a lack of new/revised interconnections; then, upon request by an auditor to review records, the FAC001-3 SME may certify that no new/revised interconnections occurred during the current

audit cycle. All facilities connected to the System will immediately comply with directives issued by these entities or their designees to ensure compliance with NERC, FRCC and TAL standards. Communications requirements specific to the Customer will be included in their interconnection and operating agreements.

9.0 Procedures for confirming with those responsible for the reliability of affected systems of new or materially modified interconnections are within a Balancing Authority Area’s metered boundaries. (FAC001-3; R3.3; R4.3)

TAL is a vertically integrated Electric Utility and is registered as the Balancing Authority for the area within its metered boundary. The FAC001-3 SME will verify with the System Integrated Planning via email record that the proposed new or materially modified transmission Facilities are within TAL’s Balancing Authority Area and that the results of any studies for approved new or materially modified interconnections demonstrate that system reliability may be maintained. The FAC001-3 SME will keep any such records for the current audit cycle of FAC001-3. If no new records are generated during an audit cycle due to a lack of new/revised interconnections; then, upon request by an auditor to review records, the FAC001-3 SME may certify that no new/revised interconnections occurred during the current audit cycle.

10.0 Documentation Requirements

TAL shall maintain and update the facility interconnection requirements reflected in this document as necessary to maintain compliance with current NERC, FRCC and TAL standards. Copies of this document will be provided within 5 business days upon request. (FAC001-3; R1)

All documentation associated with an interconnection request and the requirements of TAL's interconnection requirements shall be maintained for a minimum period of 3 years unless directed to maintain specific documentation for a longer period by an applicable regulatory body or unless specifically noted elsewhere in this FCR.

TAL Facility Connection Requirements - Exhibit A

General Technical Guideline, Basis, & Requirements

1.0 Voltage Level and MW and MVAR Capacity or Demand at Point of Interconnection

Generally, TAL limits its transmission facilities to 100% of the applicable thermal rating of facilities. In regards to the normal and contingency voltage criteria for TAL stations, it is provided below:

Voltage Level (kV)	V _{min} (p.u.)	V _{max} (p.u.)
All	0.95	1.05

There may be isolated cases for which TAL may have determined that it is acceptable to deviate from the general criteria stated above. There are several factors which could influence these criteria, such as the overall potential customers that may be impacted, the probability of an outage actually occurring, or transmission system performance, as well as others.

Generation Facilities: All synchronous generators connected to the TAL transmission system must maintain a network voltage or reactive power output as specified by the TAL system operator. During the study phase of projects to interconnect or modify generation facilities, the developer of the projects shall provide TAL the expected generator capabilities for model simulation for both summer and winter. TAL will evaluate a Large Generating Facility's ability to meet reactive power design requirements, over the voltage ranges specified below.

The Large Generating Facility power factor design limitation minimum requirement for a Unit shall be a reactive power capability sufficient to maintain a composite power delivery at the Point of Interconnection (for Synchronous generation), or the high-side of the Generation Substation (for Non-Synchronous generation) at a power factor of:

- (i) 0.95 leading when the Large Generating Facility is operating up to its maximum designed MW output and the voltage at the Point of Interconnection (for Synchronous generation), or the high-side of the Generation Substation (for Non-Synchronous generation) is in the range of 103%-107% of the nominal voltage; and

- (ii) 0.95 lagging when the Large Generating Facility is operating up to its maximum designed MW output and the voltage at the Point of Interconnection (for Synchronous generation), or the high-side of the Generation Substation (for Non-Synchronous generation) is in the range of 95%-103% of the nominal voltage.

The distinction between Synchronous Generation and Non-Synchronous Generation is only to provide Non-Synchronous Generation the flexibility to use static reactive devices to make up for losses that occur between inverters and the high-side Generation Substation.

For interconnection of solar photovoltaic (“PV”) generating plants: Solar PV generating plants with total inverter nameplate ratings greater than 20 MVA typically employ a “power plant controller” or “PPC” to regulate and control the individual PV inverters so that the site behaves as if it were a single generator connected at the Point of Interconnection. The PPC and inverters together must provide grid support, including automatic voltage regulation (AVR). Solar PV plants are variable generation resources and their maximum rated output is typically produced only for short durations at ideal ambient temperature and irradiance conditions. These conditions do not normally coincide with the time of the system peak; therefore solar PV sites typically operate at much lower than the nameplate output value, and can only be counted upon to provide 50-70% of nameplate real power output at the time of the system peak. For this reason, solar PV plants are typically “de-rated” for purposes of counting on them for reliable capacity.

All Synchronous generators connected to the TAL transmission system are to be equipped with automatic voltage regulators (AVR). Generators with MVA ratings larger than 10 MVA connected to the TAL transmission system shall operate with the generator’s AVR on and in the automatic voltage control mode to the extent practicable unless otherwise approved by the TAL system operator. The operator of the synchronous generator must notify the TAL System Operator as soon as practical, but within 30 minutes when a status or capability change occurs on any generator reactive power resources under the Generator Operator’s control, including the status of each AVR and power system stabilizer and the expected duration of the change in status or capability. In addition to verbal notification of the reason for operating with the AVR off, the AVR status should also be automatically telemetered to the TAL control center.

Owners of Synchronous generators with ratings larger than 10 MVA connected to the TAL transmission system shall provide the TAL System Operator with generator step-up transformer and auxiliary transformer tap settings and available ranges and must coordinate with Transmission Operations to optimize generating plant transformer tap settings. Generator step-up and auxiliary transformer tap settings shall be coordinated with TAL transmission systems voltage requirements. By carefully selecting transformer tap ratios, it is possible to optimize generating plant voltages and reactive capabilities for the expected range of transmission voltages. Updated information shall be provided when transformer changes are made. In the event that operating experience indicates that transformer ratio changes are desirable, TAL will provide the generating equipment owner with a detailed study that documents the technical justification for making a transformer tap change. TAL’s practice has been to select transformer ratios that will be acceptable for both summer high load conditions and spring/fall light load conditions so that seasonal adjustments are not necessary. As required by the NERC Reliability Standards, the generating equipment owners are expected to make these transformer tap changes during the next scheduled maintenance period.

Transmission Facilities: Entities interconnecting their transmission system with TAL's transmission system shall endeavor to supply the reactive power required on their own system, except as otherwise mutually agreed. Neither TAL nor the Transmission Customer shall be obligated to supply or absorb reactive electric energy at Interconnection (s) with a Balancing Authority (BA) area that is not a dynamic tie, or delivery points with another BA area that connects multiple distribution stations with 1 or more transmission lines on the customer side of the delivery point when to do so would interfere with service on their respective systems, would adversely affect any contractual rights and obligations between TAL and any entity, would limit the use of any of the respective interconnection facilities, or would require the operation of generation or reactive equipment not otherwise required.

End-User Facilities: The End-User should design and operate its load interconnections so that the load power factor measured at the point where the load power exits the TAL integrated transmission system is between 0.95 lagging and 0.99 leading as measured at the time of the yearly TAL transmission system summer peak load. The End-User loads or delivery points that are within close electrical/geographical proximity and/or are connected to a common transmission line may aggregate power factors (by summing delivery point kW and kVar values at the point where the power exits the TAL transmission system), such that the collective power factor for the aggregated delivery points at the time of the TAL transmission system summer peak load is compared to the power factor requirement. To the extent that TAL deems there are reactive issues at other times, these will be addressed on a case by case basis. Delivery point(s) Interconnections to the TAL transmission system shall operate in accordance with the transmission service agreement or Network Operating Agreement, as applicable.

TAL occasionally experiences unusually high loads outside of the summer period (e.g. 7 a.m. peak loads associated with winter cold fronts). Load serving entities should cooperate to the extent feasible with requests from the TAL System Operator to help support system voltage.

For transmission level delivery points, (Single distribution substation within TAL's BA area, or a delivery point that is a dynamic tie to another BA area with a single distribution station on the customer side of the delivery point.) the End-User shall adhere to the power factor requirements set forth herein except for: (1) temporary outages of equipment; (2) with TAL's written consent, which shall not be unreasonably withheld, consistent with Good Utility Practice; or (3) as may occur in the event of a higher than anticipated TAL transmission system summer peak load, i.e., TAL's summer peak load is higher than the forecasted summer peak load specified in the previous year's TAL Ten Year Site Plan . If the necessary reactive compensation and control to comply with the power factor requirements has not been provided, or TAL deems that documentation demonstrating use of due diligence to resolve the matter is unsatisfactory, best efforts shall be used to install, or to contract with others to have installed, the necessary equipment to meet the power factor requirements set forth herein within the shortest practicable time.

1.1 Breaker Duty and Surge Protection

Breaker duty and surge protection requirements are applicable to all generation facilities, transmission facilities and end-user facilities connected to the TAL system.

All circuit breakers and other fault interrupting devices shall be capable of safely interrupting fault currents for any fault they may be required to interrupt. AC high voltage circuit breakers are specified by operating voltage, continuous current, interrupting current, and operating time in accordance with ANSI/IEEE Standards C37 series, "Symmetrical Current Basis." These ratings are

displayed on the individual Circuit Breaker nameplate. Breakers are scheduled for replacement when they exceed 100% of ANSI C37 Guidelines for breaker duty ratings. There may be cases where adding generation will increase the available fault current above the present interrupting ratings of the existing breakers at a substation or stations. When this occurs, breaker upgrades are to be considered as part of the interconnection project. Application of circuit breaker duty rating shall be in accordance with ANSI/IEEE C37 standards.

Basic Surge Level (BSLs), surge arrester, conductor spacing and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan. TAL's standard is to shield substations and transmission lines from direct lightning strokes and to provide line entrance arresters at transmission line terminals. Surge arresters are also applied at major components and systems. Interconnection facilities to be constructed in areas with salt spray contamination or other type of contamination shall be properly designed to meet or exceed the performance of facilities not in a contamination area with regard to contamination caused outages.

1.2 System Protection and Coordination

Fuses 600V and greater will not be allowed for connections authorized under this document. Utility grade, transmission level protective relays and fault clearing systems are to be provided on the interconnected power system. All protective relays should meet or exceed ANSI/IEEE Standard C37.90. Adjoining power systems must provide for overlapping zones of protection between parties ensuring no gaps. Compatible relaying equipment must be used on each side of the point of ownership within a shared zone of protection. The design must provide coordination for speed and sensitivity in order to maintain power system security and reliability. Protection systems must be designed to isolate the minimum number of power system elements to remove the fault. Entities connecting to the TAL transmission system shall investigate and keep a log of all protective relay actions and misoperations as required by the FRCC in compliance with NERC Reliability Standards. The most current requirements for analysis and reporting of protection misoperations are available from FRCC staff.

System Protection and Coordination Requirements for Generation Facilities:

Generators connecting to the TAL transmission system are responsible for protecting those facilities from electrical faults and other hazardous conditions. Generator interconnections must be equipped with circuit breakers or other appropriate interrupting devices to protect those facilities. The generator owner must provide and own the primary circuit breaker or other interrupting device that protects the facility and disconnects it from the TAL transmission system. The primary purpose of this interrupting device is to protect the generating plant facility. The protection system design must provide coordination for speed and sensitivity in order to maintain power system security and reliability.

The generation and transmission protection systems must be coordinated so that power plant protection and related control elements are set and configured to prevent unnecessarily tripping the generator (for events external to the plant) prior to any transmission protection and related control systems acting first, unless the generator is in jeopardy by exceeding its design limits due to operating conditions, generator system faults, or other adverse potentially damaging conditions. The exchange of documentation and data is expected between TAL and the generation owner for the proper coordination of the protection systems functions. System Protection designs must be

coordinated between interconnection parties according to NERC Standard PRC-001. The NERC SPCS Technical Paper “*Power Plant and Transmission System Protection Coordination*”, dated Rev 1 July 2010, should be used as a reference for ensuring coordination between generator protection and transmission protection systems. It is available on the NERC web site at <http://www.nerc.com/filez/spctf.html>.

Protection systems must be designed with appropriate level of redundancy and backup to meet the requirements of the NERC TPL series of Standards. Generator Interconnection Facilities (GIF) connecting to the TAL transmission system are to have primary protective relaying that operates with no intentional time delay for 100% of the specified zone of coverage. For interconnection through a transmission circuit the protection system may require a communication channel where fiber optics is the preferred means of communication, or possibility a power line carrier system may be used. The design of the GIF protection system must consider redundant components (Current source, backup relaying, DC circuitry, DC source, breaker trip coil, etc.) to minimize the impact of failures to an acceptable level of performance and reliability. System Stability study results may require a second high-speed protection system. Local breaker failure protection schemes shall be applied at the bulk transmission level.

A power source for tripping and control must be provided at substations by a DC storage battery. The battery is to be sized with enough capacity to operate all tripping devices after eight hours without a charger. Alarms for undervoltage, open battery and battery charger failure must be provided for remote monitoring by the facilities owners who shall take immediate action to notify the System Operator and restore power to the protective equipment.

Mechanical and electrical logic and interlocking mechanisms are required between interconnected facilities to ensure safe and reliable operation. These include, but are not limited to, breaker and switch auxiliary contacts, undervoltage and synch-check relays, and physical locking devices. A transfer trip is required for many installations. It is used for backup protection and anti-islanding schemes. Fiber optics is the preferred means of communication.

Most synchronous generator AVR's are equipped with limiting controls that help protect the generator while also allowing the generator to support the grid during temporary excursions in transmission voltage. The AVR's control and limiting functions must coordinate with the generator's short time capabilities and protective relay settings. These limiting controls must be properly coordinated with generator protection and with the generator's short term voltage/reactive capabilities. Two common examples of these controls are the maximum excitation limiter (coordinates with overexcitation protection) and the minimum excitation limiter (coordinates with the loss of field relay). The generating equipment owner shall provide TAL's Transmission Services group with the AVR's control and limiter settings as well as the protection settings which coordinate with AVR control and limiting functions.

Generator frequency response is an important factor in control of the Eastern Interconnection. All new generators (including inverter-based non-synchronous generation) connected to the TAL transmission system with a nameplate rating greater than 10 MVA shall be equipped with a speed/load governing control (or equivalent frequency response output control) that has a droop characteristic not greater than 4%. It is understood that generator MW increase will be limited by its maximum output capability such that a 4% droop response may not be achieved with higher initial

power generation levels, depending on the magnitude of the frequency dip. Notification of changes in the status of the speed/load governing controls (or equivalent frequency response output controls) must be provided to the TAL System Operator.

Poorly damped power oscillations have occurred in the Florida transmission systems and can be a major concern if not properly addressed. The installation of new generating plants has the potential to aggravate existing modes of oscillation or create new modes. All new synchronous generators connected to the TAL transmission system with a nameplate rating greater than 10 MVA shall be equipped with a power system stabilizer (PSS). The PSS shall be an “integral of accelerating power” type. Technical evaluations of oscillatory stability will be conducted for the interconnection of new generating plants. New generators that cause a decrease in the damping of an existing mode of oscillation or cause a poorly damped mode of oscillation will be required to operate with the PSS in service. The determination of the PSS’s operational state shall be made by TAL and to the extent that the PSS is operated in the “on” state, the PSS settings shall be coordinated with TAL. Typically this coordination would be to provide TAL with preliminary power system stabilizer settings prior to the stabilizer’s field commissioning tests with the final settings provided after the field commissioning tests.

System Protection and Coordination Requirements for Transmission Facilities:

All bulk transmission power systems are to have primary protective relaying that operates with no intentional time delay for 100% of the specified zone of coverage. On transmission circuits, this is accomplished through the use of a communication channel. Protection systems must be designed with appropriate level of redundancy and backup to meet the requirements of the NERC TPL series of Standards. A second high-speed protection system may be required on some transformers, lines or busses. The design of the Transmission Facilities protection systems must consider redundant components (Current sources, backup relaying, DC circuitry, DC sources, breaker trip coils, etc.) to minimize single contingencies to an acceptable level of performance and reliability.

Backup protective systems should provide additional coverage for breaker and relay failure outside the primary zone. Specific breaker failure protection schemes must always be applied at the bulk transmission level. Specific relay failure backup must also be provided. Backup systems should operate for failures on either side of an interconnection point. Time and sensitivity coordination must be maintained to prevent misoperations.

The philosophy for the transmission line protection must be coordinated between TAL and the Transmission Facility for selecting the type of communication to be used and selecting compatible protective relaying. The exchange of substation one line configurations, equipment data, and relay settings is expected for the coordination of specified protections systems.

Relay protection shall be set to not limit under emergency loading conditions as defined in NERC Standard PRC-023. The design and settings must allow for emergency loading of transformers and lines without tripping.

A power source for tripping and control must be provided at substations by a DC storage battery. The battery is to be sized with enough capacity to operate all tripping devices after eight hours without a charger. An undervoltage alarm must be provided for remote monitoring by the facilities owners who shall take immediate action to restore power to the protective equipment.

A transfer trip communication system for backup protection and anti-islanding is required for some installations. Fiber optics is the preferred means of communication. Power line carrier is also used. Audio tone over phone line is the least preferred method because it may not meet requirements for speed and reliability.

System Protection and Coordination Requirements for End-User Facilities:

End Users are responsible for providing a reliable protective relaying scheme for their power transformer connected to the TAL transmission system. All faults on the transformers, bushings and transformer high-side arresters must be isolated by tripping a transformer high side fault interrupting device. Faults on the transformer high-side windings, high-side bushings, and transformer high-side arresters must be cleared by instantaneous relays with no intentional time delay. The purpose is to assure that a permanent failure in this zone would not result in a permanent outage of a transmission line segment. Faults in this zone must be coordinated with TAL remote relaying.

The application of any End-User protection systems operating a transmission line switch must be coordinated with and approved by TAL. The exchange of substation one line configurations, equipment data, and relay settings is expected for the coordination of specified protections systems. A power source for tripping and control must be provided at substations by a DC storage battery. The battery is to be sized with enough capacity to operate all tripping devices after eight hours without a charger. An undervoltage alarm must be provided for remote monitoring by the facilities owners who shall take immediate action to restore power to the protective equipment.

End-User Facilities shall also conform to the System Protection and Coordination Requirements of Transmission Facilities when such protection systems can affect the operation or reliability of the transmission network.

1.3 Metering and Telecommunications

Metering and Telemetry Requirements for Generation Facilities

All generating plants connected to the TAL transmission system must provide real time telemetered data for individual generators to the TAL system control center. The required data includes generator MW, MVAR, terminal voltage and switchyard high side voltages. MW and MVAR data should be Net output values (Gross generation minus Start-up and Auxiliary load). These generator output quantities shall be telemetered at a two second scan rate or faster. In addition, the status of individual generator circuit breakers and the status of the generators' automatic voltage regulator must be made available to the TAL control center, time tagged consistent with NERC PRC Standards.

Metering and Telemetry Requirements for Transmission Facilities and End–User Facilities

Required telemetry equipment should be installed at the station closest to the change of ownership. High accuracy (revenue) metering equipment, where required, may be located at the end of the transmission line or the station closest to the change of ownership and compensated to the point of change of ownership or point of interconnection. All inter-utility tie lines connected to the TAL transmission system must provide real time telemetered data to the TAL system control center. The required data includes MW, MVAR, and switchyard voltages. If the interconnection facilities are owned by the neighboring utility, and that utility does not own the instrument transformers or meters, a structure and a location for mounting metering transformers and recording devices is to be provided by the facility owner. The neighboring utility may not connect additional devices such as relays or

meters directly to potential or current transformer secondaries used for revenue metering without preapproval and due consideration of security and circuit loading.

Each installation needs to be evaluated separately for metering requirements because of the many possible contractual agreements and interconnection configurations. All metering devices are to be pre-approved by TAL prior to installation. In general, however, the following quantities are to be provided for each supply/delivery point. Megawatt-hours received, Megawatt-hours delivered, MegaVar-hours received, MegaVar-hours delivered, Three Phase Voltage, Three Phase Current, +/- Megawatts, and +/- Megavars. These quantities may need to be provided to various parties through various information/communication systems. Data access to primary and secondary metering is to be provided. Specific designs will be developed to meet those requirements. Dual ported remote terminal units (RTUs) accessed by both parties may be used, provided the appropriate security levels, reliability and redundancy issues are addressed and appropriate. Each piece of equipment such as a breaker, switch and other power system device shall have only one party responsible for control of the device for operations. Power for SCADA or metering communication equipment, if needed, is to be provided by the station battery. Office power systems and switching networks are not acceptable. Instrument transformers are to have an accuracy class of 0.3% or better with 0.15% being preferred. Metering accuracy CTs and PTs are to be installed as close to the delivery point as practical. Metering CTs and PTs should not be used to feed non-metering equipment such as protective relays. Metering CTs are not to be connected in parallel. Auxiliary CTs are not to be used in metering circuits. When more than one point is to be monitored, individual metering is to be used. The impedance of the CT and PT cable leads is to be kept low and not impose burdens above that of the instrument transformer rating.

Revenue meters are to have an accuracy class of 0.3% or better. Transducers are to be accurate to +/- 0.2% of full scale. Three element meters are to be used on all effectively grounded power systems. Both primary and backup revenue meters are to be provided. Current transformers used for revenue metering circuits must meet the accuracy standards, as specified under the American National Standards Institute (ANSI) Standard C57.13 for an accuracy class of 0.15 percent at all burdens. Current transformers shall have a thermal rating factor of 2.0. Voltage transformers used for revenue metering circuits must meet the accuracy standards, as specified in ANSI C57.13, of 0.15 percent accuracy with "W" through "Y" burden. Backup current transformers (CTs) and potential transformers (PTs) are not required. Revenue meters are to remain sealed during operation and following maintenance or calibration testing. All parties are to be notified prior to removing seals. Calibration testing is to be performed on an interval consistent with accepted industry practice. Maintenance is to include all associated parties. Test equipment must be certified and traceable to the National Bureau of Standards.

Metering must be designed in accordance with BAL-005 which specifies accuracy, sampling rates, synchronized readings and data sharing requirements.

1.4 Grounding and Safety Issues

Safety is of utmost importance. Strict adherence to established switching, tagging and grounding procedures is required at all times for the safety of personnel. Any work carried out within a facility shall be performed in accordance with all applicable laws, rules, and regulations and in compliance with Occupational Safety and Health Administration (OSHA), National Electric Safety Code (NESC) and good utility practice. Automatic and manual disconnect devices are to be provided as a means of removing all sources of current to any particular element of the power system. Only trained operators

are to perform switching functions within a facility under the direction of the responsible dispatcher or designated person as outlined in the National Electric Safety Code.

Grounding Requirements for Generation Facilities (Source Systems)

When various switching devices are opened on an energized circuit, its ground reference may be lost if all sources are not effectively grounded. This situation may cause overvoltages that can affect personnel safety and damage equipment. This is especially true when one phase becomes short circuited to ground. Therefore, the interconnected transmission power system is to be effectively grounded at all sources. This is defined as $X_0/X_1 < 3$ and $R_0/X_1 < 1$. Interconnected generators should provide for effective system grounding of the high side transmission equipment by means of a grounded high voltage transformer.

This requirement may be waived for sites less than 10 MVA where a special Electromagnetic Transients Program (EMTP) system study has determined the transmission system equipment insulation level in the area is rated to withstand the amplitude and duration of all overvoltages caused by neutral displacement. Also the source must be removed rapidly when any overvoltage condition occurs. This includes isolation of the ungrounded source for system faults simultaneously with other relaying systems within the protected zone. Since the source provides no ground fault current, relay protection devices must operate for zero current. Some switching operations may cause the loss of all remote ground sources by islanding a part of the system even under non-fault conditions. The protection scheme must also be able to quickly remove the generation under this situation before any adverse effects occur. Some form of communication with remote transmission stations is usually required in order to accomplish this.

Grounding Requirements for Transmission Facilities and End-User Facilities:

Each interconnection substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid and grounding system shall be designed to meet the requirements of ANSI/IEEE 80, IEEE Guide for Safety in AC Substation Grounding and ANSI/IEEE C2, National Electrical Safety Code. The transmission line overhead ground wire (OHGW) shall be connected to the substation ground grid.

If the interconnection substation is close to another substation, the two grids may be isolated or connected. Connected grids are preferred, since they are easier to connect than to isolate. If the ground grids are to be isolated, there may be no metallic ground connections between the two substation ground grids. There must also be sufficient physical separation to limit soil conduction. If the ground grids are to be interconnected, the interconnecting cables must have sufficient capacity to handle the fault currents, duration, and duty. TAL must approve any connection to an TAL substation ground grid.

All transmission line structures must be adequately bonded and grounded to control step and touch potential in compliance with the NESC, and to provide adequate lightning performance. All transmission lines should have a continuous ground wire, not relying on earth as the primary conductor, to transfer fault current between structures and to substations and plant switchyards. Any exceptions to a continuous ground wire shall be verified with a system study. All ground wires and bond wires must be adequately sized to handle anticipated maximum fault currents and duty without damage.

Transmission interconnections may substantially increase fault current levels at nearby substations and transmission lines. Modifications to the ground grids of existing substations and OHGWs of existing lines may be necessary. The interconnection studies will determine if modifications are required and the scope and cost of the modifications.

1.5 Insulation and Insulation Coordination

Insulation and Insulation Coordination requirements are applicable to all generation facilities, transmission facilities and end-user facilities connected to the TAL system.

Insulation coordination is the selection of insulation strength. Insulation coordination must be done properly to ensure electrical system reliability and personnel safety. Basic Surge Level (BSLs), surge arrester, conductor spacing and gap application, substation and transmission line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

TAL's standard is to shield substations and transmission lines from direct lightning strokes and to provide line entrance arresters at transmission line terminals. Surge arresters are also applied at major components and systems.

Interconnection facilities to be constructed in areas with salt spray contamination or other type of contamination shall be properly designed to meet or exceed the performance of facilities not in a contamination area with regard to contamination caused outages.

1.6 Voltage, Reactive Power, and Power Factor Control

An essential part of operating a transmission system reliably is the coordination of real and reactive power sources to maintain an adequate transmission voltage profile both for normal and contingency conditions. Reactive sources must be distributed throughout electric systems due to the large voltage drops associated with transmission of reactive power. Operators of transmission systems follow voltage control strategies to minimize the risk of exceeding equipment voltage limitations and the transmission grid's voltage stability limitations.

Specific voltage, reactive power and power factor control requirements for each type of Facility may also apply as indicated:

Generation Facilities: All generators connected to the TAL transmission system with ratings larger than 10 MVA shall maintain a voltage schedule at the point of interconnection as prescribed by the System Operator to the extent allowed by the capabilities and limitations of the generating plant equipment.

Non-Synchronous Generation above 10 kw: Interconnection Customer shall design the Large Generating Facility to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 0.95 leading to 0.95 lagging, unless the Transmission Provider has established a different power factor range that applies to all non-synchronous generators in the Control Area on a comparable basis. This power factor range standard shall be dynamic and can be met using, for example, power electronics designed to supply this level of reactive capability (taking into account any limitations due to voltage level, real power output, etc.) or fixed and switched capacitors, or a combination of the two.

Typical voltage schedules for generating plants are listed below.

Switchyard On Peak Off Peak

Nominal Voltage Scheduled Voltage Scheduled Voltage

115 kV 117 kV 115 kV

230 kV 240 kV 238 kV

The TAL System Operator or designated agents will advise generating plant operators of the current voltage schedule. This voltage schedule may change on an hourly basis depending on conditions in the power system.

When a generator's automatic voltage regulator is out of service, the operator of a synchronous generator shall use an alternative method to control the generator voltage and reactive output to meet the voltage or Reactive Power schedule directed by the TAL System Operator. When directed to modify voltage, the operator of a synchronous generator shall comply or provide an explanation of why the schedule cannot be met. The operator of the synchronous generator must contact the TAL System Operator when the generator cannot maintain the voltage at the point of interconnection as prescribed by the TAL System Operator for more than 30 minutes. The operator of the synchronous generator shall state the reason for deviating from the voltage schedule and provide the TAL System Operator with the generator's reactive limitations that exist at that time.

1.7 Power Quality Impacts

Power quality requirements are applicable to all generation facilities, transmission facilities and end-user facilities connected to the TAL system. Generation of harmonics should be limited to values prescribed by IEEE Standard 519 when measured at the Point of Interconnection ("POI"). Additionally, the TAL transmission system should not be subjected to flicker in excess of the levels specified in IEEE Standard 1453 and harmonic currents in excess of 5% of a transformer's rated current as stated in ANSI/IEEE Standard C57.12.00.

Since inverter-based generation resources are known to be a more significant source of harmonics and flicker than synchronous generators, the following requirements apply only to inverter-based generating plants:

1. A power quality meter must be permanently installed at the POI. As specified by IEEE 519 the meter must comply with the specifications of IEC 61000-4-7 and IEC 61000-4-30.
2. Power quality must be assessed and shown to be within applicable limits before commercial operations commence.
 - a. Must meet harmonic requirements from IEEE 519
 - b. Must meet IEEE 1453 system flicker limits and TAL's individual flicker limits as specified below:

The IEEE 1453 flicker limits represent the cumulative effect of all flicker sources; whereas, the individual flicker emission limits represent the flicker due only to the inverter-based generation. Flicker should be evaluated over a period of at least 1 week.

Flicker Quantity	IEEE 1453 System Flicker Planning Level	TAL Individual Flicker Emission Planning Level
Pst	0.8	0.35
Plt	0.6	0.25

Alarms for the following quantities must be provided [via communication to the TAL control center](#) as applicable limits are approached:

- a. Individual harmonic current distortion
- b. Total demand distortion
- c. Individual harmonic voltage distortion
- d. Total harmonic voltage distortion
- e. Short-term flicker
- f. Long-term flicker

Supporting data that trigger alarms should also be retained to the extent practical.

1.8 Equipment Ratings

Equipment rating requirements are applicable to all generation facilities, transmission facilities and end-user facilities connected to the TAL system. For facility and equipment ratings, reference TAL's FAC008 Rating Methodology document. Interconnection facility ratings shall be compatible with those of connected TAL facilities. Application of circuit breaker duty rating shall be in accordance with ANSI/IEEE C37 standards.

1.9 Synchronizing of Facilities

Generation Facilities: Prior to commercial operation, the owner of a synchronous generator with a rating larger than 10 MVA shall provide the TAL's Transmission Services group with documentation that describes the functional operation and settings for the AVR's control functions. In cases where the AVR has been set to regulate a voltage other than the generator's terminal voltage or it has been set to regulate a compensated terminal voltage, sufficient data shall be provided to allow the AVR to be modeled accurately.

Provision of Generator Test Data – One of the standard generator commissioning tests is to introduce a step change in the AVR's reference voltage with the generator running at synchronous speed but not connected to the transmission system. This is referred to the open circuit, step in voltage test and is used to confirm the AVR is functioning properly. Prior to commercial operation, the owner of a synchronous generator with a rating larger than 10 MVA is encouraged to provide TAL's Transmission Services group with open circuit, step in voltage test results. Recordings of the generator terminal voltage and generator field voltage magnitudes should be provided together with any calibration data necessary to equate the recordings with actual voltages. In situations where it is impractical to measure the generator field voltage (e.g. brushless excitation systems) alternate quantities with equivalent response characteristics can be provided. An estimate of the generator's field winding temperature during this test should also be provided.

Each generating facility shall provide a point of contact to the TAL System Operator. This contact person shall have the authority and capability to operate the facility according to the instructions of the TAL System Operator to ensure that the reliability of the transmission system is maintained. A

point of contact shall be reachable and available through telephone or other agreed upon means of communication at all times when the Facility is energized or in operation.

Operators of generating facilities must notify the TAL System Operator and obtain approval before synchronizing the facility to or disconnecting the facility from the TAL transmission system. Disconnection without prior approval is permitted only when necessary to prevent injury to personnel or damage to equipment. Permission to synchronize to the interconnected system must be requested of TAL system operator following any overhaul, unit trip or islanding. Generators must not energize a de-energized TAL transmission circuit unless such actions are directed by the TAL System Operator or are provided for in the interconnection agreement.

When restoring interconnected generation facilities, it is TAL's practice to energize in the direction from the TAL system toward the de-energized generation facility, except as designated for black-start units. Synchronization of a generator to the energized TAL system is accomplished within the generation facility using the appropriate synch breaker. The design at generation sites must consider the speed at which the TAL transmission system is restored through auto-restoration following system faults. The generation facility owner must protect their generators from out-of-synch closures under such conditions.

It is the responsibility of the generation facility owner to provide all devices necessary to protect the customer's equipment from damage by abnormal conditions and operations that might occur on the interconnected power system. The facility owner shall protect its generator and associated equipment from overvoltage, undervoltage, overload, short circuits (including ground fault conditions), open circuits, phase unbalance, phase reversal, surges from switching and lightning, over and under frequency conditions, and other injurious electrical conditions that may arise on the interconnected system.

Transmission and End-User Facilities: It is the responsibility of the facility owner to provide for the orderly re-energization and synchronizing of their high voltage equipment to other parts of the electric system. Appropriate operating procedures and equipment designs are needed to guard against out-of-synch closure or uncontrolled energization. Each owner is responsible to know and follow all applicable regulations, industry guidelines, safety requirements, and accepted practice for the design, operation and maintenance of the facility.

1.10 Maintenance Coordination

The maintenance of facilities is the responsibility of the owner of those facilities. Adjoining facilities on the interconnected power system are to be maintained in accordance with accepted industry practices and procedures. Each party is to have a documented maintenance program ensuring the proper operation of equipment. TAL will have the right to review maintenance reports and calibration records of equipment that could impact the TAL system if not properly maintained. TAL is to be notified as soon as practicable about any out of service equipment that might affect the protection, monitoring, or operation of interconnected facilities.

Specific maintenance coordination procedures for each type of Facility may also apply as indicated:
Generation Facilities: Notification of preliminary plans for overhauls and maintenance outages of generators must be submitted to the TAL generation coordinator by July 31st, unless otherwise agreed, for the upcoming year's outages. The plans must specify the start date of the outage, the

return to service date of the unit, and the generation capacity affected. For forced outages the length of time of the outage and the expected return to service date shall be reported as soon as the information is known. Changes in schedules either accelerating or delaying the forecasted return to service date of generation shall be reported as soon as they are known. Permission to synchronize to the interconnected system must be requested of TAL system operator following any overhaul, unit trip or islanding.

Generators connecting to the TAL transmission system must have a maintenance program for their protection systems. Documentation of the protection maintenance program shall be supplied to TAL, the FRCC, and NERC on request. Test reports as outlined in the maintenance program are to be made available for review by TAL and the FRCC. At intervals described in the documented maintenance program and following any apparent malfunction of the protection equipment, the entity shall perform both calibration and functional trip tests of its protection equipment.

Where stabilizing equipment is installed on generating equipment for the purpose of maintaining generator or transmission system stability, the generating equipment owner is responsible for maintaining the stabilizing equipment in good working order and promptly reporting to the TAL System Operator any problems interfering with its proper operation.

Transmission and End-User Facilities: In order to maintain the reliability of the TAL transmission system and meet FERC requirements for posting of Available Transmission Capability (ATC), planned maintenance outages of plant and transmission equipment must be coordinated. Maintenance of facilities interconnected to the TAL transmission system shall be done in a manner that does not place the reliability and capability of the TAL transmission system at risk. Planned maintenance must be coordinated and scheduled with the TAL System Operator.

Entities connecting to the TAL transmission system must also have a maintenance program for their protection systems. Documentation of the protection maintenance program shall be supplied to TAL, the FRCC, and NERC on request. Test reports as outlined in the maintenance program are to be made available for review by TAL and the FRCC. At intervals described in the documented maintenance program and following any apparent malfunction of the protection equipment, the entity shall perform both calibration and functional trip tests of its protection equipment.

1.11 Operational Issues (abnormal frequency and voltages)

All control areas within the FRCC region are responsible for maintaining voltage and frequencies within agreed upon limits. All operators of facilities interconnected to the transmission systems in the FRCC Region are required to communicate and coordinate with their control area operator. During emergency conditions, the facility operator shall raise or lower generation, adjust reactive power, switch facilities in or out, or reduce end user load as directed by the control area operator. Within the FRCC Region, the Reliability Coordinator has overall responsibility for the secure operation of the interconnected transmission systems. All control area operators must communicate and coordinate with and follow the directions of the Reliability Coordinator. All facility owners are expected to follow the procedures and guides contained in the FRCC Handbook. The FRCC Handbook is posted electronically at <https://www.frcc.com/RC/SitePages/Home.aspx>. (Link requires FRCC.com account with appropriate permission level.)

Operational procedures are established in accordance with NESC, OSHA, FRCC and NERC requirements. Each party shall designate operating representatives to address: lines of communications, maintenance coordination, actions to be taken after de-energization of interconnected facilities, and other required operating policies. All parties are to be provided with current station operating diagrams. Common, agreed upon nomenclature is to be used for naming stations, lines and switches. Updated diagrams are to be provided when changes occur to interconnected facilities.

Generation Facilities: All generators connected to the TAL transmission system must be able to withstand certain temporary excursions in voltage, frequency, reactive and real power output without tripping. This coordination is required to support the grid and avoid cascading events in the Florida peninsula. Documentation of the generator protection and controls that could respond to these conditions by tripping the generator shall be provided to TAL and the FRCC's Operating Committee (OC). In the event the generating equipment owner cannot correct or mitigate these potential generator trip conditions, a request for a waiver may be made to the OC. A waiver may be justified in certain special circumstances such as low adverse reliability consequences from generator tripping. The ability of a generating unit to stay connected and synchronized with the transmission system during system disturbances is known as voltage ride-through capability (also called low voltage ride-through, or "LVRT"). Protective relays, control systems, critical power supplies, electrical contactors and other sensitive auxiliary equipment must be considered when assessing the ability to meet this requirement. The most critical types of disturbances include three-phase faults and single line to ground faults. Voltage may drop to zero volts at the switchyard bus for some types of faults. The following ride-through design requirements apply to all generators (greater than 10 MW) that wish to interconnect to the TAL transmission system.

All generators (greater than 10 MW that wish to interconnect to the TAL transmission system must comply with the voltage and frequency ride-through requirements of the latest revision of NERC PRC-024. (See frequency capability and voltage ride-through curves at <http://www.nerc.com/pa/Stand/Reliability%20Standards/PRC-024-2.pdf>) Note that although NERC applies the PRC-024 ride-through requirements only to the main generator protective relays, TAL applies the same requirement parameters to all protective relays, control systems, critical power supplies, electrical contactors, and other sensitive auxiliary equipment that could cause the generator to trip. Rotating type generating plants are required to be designed to remain on-line, with no more than a 5% change in real power output from the pre-disturbance output following system disturbances. (Unless the generator is directly connected to the faulted element, in which case clearing the fault disconnects the generator from the system.) Additionally, inverter-based generating plants are required to be designed to remain on-line, continue gating, and producing both active and reactive current (at no less than 80% of pre-fault levels) while in the PRC-024 No Trip Zones (see PRC-024-2 attachment 1 & 2) For high-voltage ride-through ("HVRT") events, the reactive current may decrease as necessary to bring voltages within applicable limits.

Notification Procedures for Operational Issues with Abnormal Frequency and Voltage

TAL has established the following information and notification procedures for generation, transmission and end-user facilities to facilitate the coordination of operational issues regarding abnormal frequency and voltages.

Owners of synchronous generators with ratings larger than 10 MVA connected to the TAL transmission system shall notify the TAL System Operator of changes in the status of the speed/load (frequency) governing controls for the turbine. The TAL System Operator shall be made aware of nonfunctioning, partially functioning or blocked governor controls when these conditions are expected to persist for five days or more.

Transmission and End-User Facilities: The operator of facilities interconnecting to the TAL transmission system must not perform any switching that energizes or de-energizes portions of the TAL transmission system or that may adversely affect the TAL transmission system without prior approval of the TAL System Operator. Operators of facilities interconnecting to the TAL transmission system must notify the TAL System Operator before performing any switching that would significantly affect voltages, power flows or reliability in the TAL transmission system. Interconnections between TAL's transmission system and other transmission systems are normally operated in parallel unless otherwise agreed. However, if any operating condition or circumstance creates an undue burden on the TAL Transmission System, TAL shall have the right to open the interconnection(s) to relieve its system of the burden imposed upon it. Prior notice will be given to the extent practical. Each party shall maintain its system and facilities so as to avoid or minimize the likelihood of disturbances that might impair or interrupt service to the customers of the other party. The TAL System Operator shall be notified prior to any maintenance work on a transmission interconnection. Industry and OSHA switching and safety procedures shall be strictly adhered to when maintenance is being performed on an interconnection.

1.12 Inspection Requirements for Existing or New Facilities

Inspection requirements for existing or new facilities are applicable to all generation facilities, transmission facilities and end-user facilities connected to the TAL system. There are situations where some equipment that is owned by TAL is located within the Customer's facility. This is often required for data acquisition or metering. In these cases, installed equipment owned by TAL will be clearly identified as such on the appropriate station drawings, on the reference documents and at the site. Site access is to be provided to TAL employees where TAL equipment is located within the Customer's existing or new facility for installation, maintenance and inspections. Also, industry standard inspection rights provisions are typically negotiated into TAL's interconnection agreements.

1.13 Communication and Procedures During Normal and Emergency Operating Conditions

Communication requirements during normal and emergency operating conditions are applicable to all generation facilities, transmission facilities and end-user facilities connected to the TAL system. Operational procedures are established in accordance with NESC, OSHA, Florida Reliability Coordinating Council (FRCC) and NERC requirements. Each party shall designate operating representatives to address: lines of communications, maintenance coordination, actions to be taken after de-energization of interconnected facilities, and other required operating policies. All parties are to be provided with current station operating diagrams. Common, agreed upon nomenclature is to be used for naming stations, lines and switches. Updated diagrams are to be provided when changes occur to interconnected facilities.

Interconnections between TAL's transmission system and other transmission systems are normally operated in parallel unless otherwise agreed. However, if any operating condition or circumstance creates an undue burden on the TAL Transmission System, TAL shall have the right to open the interconnection(s) to relieve its system of the burden imposed upon it. Prior notice will be given to

the extent practical. Each party shall maintain its system and facilities so as to avoid or minimize the likelihood of disturbances that might impair or interrupt service to the customers of the other party. The TAL System Operator shall be notified prior to any maintenance work on a transmission interconnection. TAL switching and safety procedures shall be strictly adhered to when maintenance is being performed on an interconnection.

The operator of facilities interconnecting to the TAL transmission system must not perform any switching that energizes or de-energizes portions of the TAL transmission system or that may adversely affect the TAL transmission system without prior approval of the TAL System Operator. Operators of facilities interconnecting to the TAL transmission system must notify the TAL System Operator before performing any switching that would significantly affect voltages, power flows or reliability in the TAL transmission system.

Responsibilities during Emergency Conditions - All operators of facilities interconnected to the transmission systems in the FRCC Region are required to communicate and coordinate with their control area operator. During emergency conditions, the facility operator shall raise or lower generation, adjust reactive power, switch facilities in or out, or reduce end user load as directed by the control area operator. Within the FRCC Region, the Reliability Coordinator has overall responsibility for the secure operation of the interconnected transmission systems. All control area operators must communicate and coordinate with and follow the directions of the Reliability Coordinator.

1.14 Remote Trip Control

Remote trip control by TAL of the Generator's main breaker(s) will be required. The Remote Terminal Units, RTU(s) or other communications equipment shall be in compliance with TAL's specifications and be compatible with the TAL's Supervisory Control and Data Acquisition system.

1.15 Disconnect Switch or Device

A manual, visible, lockable, gang-operated, disconnecting switch shall be installed and located on both sides of the Point of Interconnection. The Disconnect Switch shall be rated for the voltage and current requirements of the installation. The Basic Insulation Level (BIL) of the Disconnect Switch shall coordinate with that of TAL's equipment. The Disconnect Switch shall meet applicable UL, ANSI and IEEE standards, and shall be installed to meet all Applicable Laws. The Disconnect Switch or device shall be lockable in the open position with a standard TAL "Circle" padlock.

The Disconnect Switch(es) located on either side of the Point of Interconnection may be opened by TAL's personnel at any time for any of the following reasons:

- A. To eliminate conditions that constitutes a potential hazard to TAL's personnel or the general public.
- B. Pre-emergency or emergency conditions on TAL's System.
- C. A hazardous condition is revealed during an inspection by TAL.
- D. Protective device tampering.

After notice to the responsible party, the Disconnect Switch located on either side of the Point of Interconnection may be opened by TAL for the following reasons:

- A. Maintenance, construction, and repairs of TAL's System.
- B. Generator owner has failed to make available records of verification tests and maintenance of its protective devices.
- C. Generator's System interferes with TAL's equipment or equipment belonging to TAL's customers.
- D. Generator's System is found to adversely affect quality of service of TAL's customers inconsistent with Good Utility Practice.

Following disconnection of the Generator as a result of a voltage or frequency excursion, the Generator shall remain disconnected until the service voltage and frequency have recovered to TAL's acceptable voltage and frequency limits for a minimum of five (5) minutes. The IC shall incorporate this function as a block close logic of the IC's protective relay (i.e., logic variable timer initiated by return of acceptable voltage and/or frequency).

Temporary disconnection shall continue only for so long as reasonably necessary under Good Utility Practice. The Parties shall cooperate with each other to restore the Generator and/or TAL's System to their normal operating state as soon as reasonably practicable following a temporary disconnection.

2.0 Functional Requirements

General overviews of functional requirements are described in this section. Detailed, project specific requirements will be developed as part of the Interconnection Feasibility and System Impact Studies and other documents such as the NERC Reliability Standards, the FRCC Standards, or the National Electrical Safety Code. This section applies to all interconnections with the TAL system made at 69 kV or greater where generation is installed behind the interconnection point and is capable of operating in continuous parallel with the TAL transmission system. It also applies to incremental additions of generation intended to serve TAL native load. TAL generators, co-generators, qualifying facilities, merchant plants, and non-utility generators are also covered under this section.

2.1 Configuration

Generating plants connected to the TAL transmission system are designed to minimize the impacts of the maintenance or unplanned outages of a generator, line, transformer, circuit breaker or bus. The potential adverse effects of maintenance and equipment outages must be considered in the design of the generating plant and its interconnection to the TAL transmission system.

Three source terminal interconnection configurations are to be avoided within the TAL transmission system. This is due to problems associated with protective relay coverage from infeed, sequential fault clearing, outfeed or weak source conditions, reduced load flow, and automatic reclosing complications. Extensive studies are necessary to evaluate all possible implications when considering three terminal line applications.

New interconnections to the TAL transmission system may require one or more TAL transmission circuits to be looped through the new facility. The design and ratings of the new facilities and the transmission loop into them shall not restrict the capability of the transmission circuits or impair TAL's contractual transmission service obligations.

Transmission Relay / Breaker Requirements:

Rotating type and inverter based generation interconnections greater than 10 MW must connect to the transmission system with transmission level relaying at the transmission point of interconnection. Unit Size Design and Single Event Generation Loss Criterion.

The Single Event Generation Loss (Single Event) criterion represents a limit on the amount of generation (MW) that can be lost due to a single event within a 30 minute time period. The criterion does not limit plant or unit size, but does represent a limit to the individual generator size. For purposes of the Single Event criterion, a Single Event is defined as the MW output reduction following the unexpected failure or outage of: (1) a single piece of generating plant equipment, or a single component of that generating equipment; or (2) a single human action, that results in a reduced MW output for the generating site. The design of the generating facilities, including consideration of operational modes and normal maintenance, must not allow any MW reduction that is larger than the Single Event criterion's value. Once an event is initiated and 30 minutes has elapsed, subsequent MW reduction beyond the Single Event criterion's value would not be included as part of the Single Event. It is important to note that what determines if something initiates a Single Event is the equipment, component, or single human action that causes the Single Event, not the number of generating units or actual synchronous generators involved at a given site. Redundant systems and key pieces of equipment, the loss of which can affect the ability of the generating plant or unit to withstand an event and maintain the amount of MWs lost below its Single Event Generation Loss value, shall be monitored and alarmed so that Operations will be aware of the degraded state and can take appropriate action.

The electrical location of the generation also impacts the Single Event criterion, i.e. the Single Event value is site specific, based on studies performed prior to interconnection, or subsequent studies requested to modify a specific site's Single Event value. In general, the Single Event value for plant sites and units in the TAL area is greater than 10 MWs. Plant sites and units with less than 10 MWs of connected generation meet the criterion without any special design that would limit generation loss. For plant sites and units larger than 10 MWs, the Single Event value is established as part of the interconnection process and must be adhered to for the plant and unit design. The Single Event design value will not change for that plant site and unit unless such value is revised following system studies to ensure reliability. Units and plant sites that are larger than 10 MW (or their site specific Single Event value) must include in their design configuration, schemes which will prevent MW generation loss larger than their site specific Single Event design value, and all Single Event design schemes must be tested to demonstrate their effectiveness in preventing a MW loss larger than the Single Event design value, prior to the unit or plant site being given approval by TAL Transmission or the FRCC to operate at total output greater than its Single Event design value.

Units and plant sites that are larger than 10 MW (or their Single Event value) must also include procedures and protocols to be followed to inform TAL's System Operator immediately, and reduce unit or plant output to a level at or below the Single Event value, when a condition is detected that places the unit or plant outside of its design modes and could potentially experience a Single Event with a MW loss larger than its Single Event value. Such procedures and protocols will be reviewed and agreed upon by TAL Transmission and the plant or unit operators.

Presently, the largest site specific Single Event design value for generation connected to TAL is 375MVA at the Hopkins Plant, for the loss of the entire output of the Hopkins Unit 2A Combined Cycle generator, based on studies performed for the unit.

Requests to modify existing plant or unit designs to increase their Single Event design value must be submitted as a modification under the Large Generator Interconnection Procedures for appropriate system studies to be performed on a case by case basis. Once the system studies to ensure reliability are complete and the findings are implemented, TAL Transmission will grant approval to modify plant site and unit designs for a larger Single Event design value, and, if applicable, the interconnection agreement will be revised to reflect such changes. Increases in the Single Event design value which would result in an increase in the largest Single Event value within the FRCC will be reviewed by the FRCC and the SERC Reliability Corporation (SERC), as applicable, prior to the request for an increase in the Single Event design value being approved by TAL.

2.2 Islanding

It is the responsibility of the Transmission Planner and Planning Coordinator to ensure safety and quality of service within its boundaries. TAL ensures this through equipment design, operating procedures, protective relay settings and a variety of automatic and manual processes. Under an island condition, a portion of load becomes separated from the rest of the Peninsular Florida transmission systems and is served by a local area generation site. It is the responsibility of TAL to ensure that even under an island condition, power quality is maintained to its customers. Therefore, TAL does not allow generation to island with TAL load where TAL does not have control over the generator voltage, frequency, protective relays, and operating procedures. Thus, when an island situation occurs, the generation must be separated from the TAL load except under temporary and controlled conditions. This ensures the quality of service and orderly restoration to TAL customers. Without such provisions the resynchronization between two separated power systems becomes uncontrolled.

For an unintentional island in which the Generator energizes a portion of TAL's System through the PCC, the Generator shall detect the island, cease to energize TAL's System and trip within 2 seconds of the formation of an island.

2.3 Generator Testing

1. Prior to commercial operation, the generating equipment owner should provide TAL with open circuit, step-in voltage test results. Recording of generator terminal voltage and field voltages should be clearly labeled so that initial and final values can be identified in physical units.
2. Periodic testing of real and reactive power shall be conducted in accordance with applicable NERC Reliability Standards including but not limited to MOD-025-2 and reported to TAL's Transmission Services group.

Generating equipment owners shall test the AVR and stabilizer (if applicable) control and limit functions of their units at least every five years. An initial test result shall be provided to TAL prior to commercial operation and every five years thereafter. Documentation of the testing shall be provided to TAL's operating representative as specified in the interconnection agreement. The initial test results shall include documentation of the settings AVR control and limit functions. Typical AVR limit functions are; maximum and minimum excitation limiters and volts per hertz limiters. Documentation of the generator protection that coordinates with these limit functions shall also be

provided. Typical generator protection of this type includes overexcitation protection, loss of field protection.

2.4 Inverter-based Generation and Other Variable Resources

Variable resource and inverter-based generation owners, operators and vendors must familiarize themselves with the intent and purpose of NERC's Modeling, Data and Analysis (MOD) Standards, and the additional technical requirements listed in Exhibit B - Additional Inverter-based Resource Requirements. The variable resource and inverter-based generator manufacturers should support the development of detailed 3-phase models required for special power system studies. It is the developer of variable resource and inverter-based generator projects' responsibility to work with the vendors to provide TAL with all required data to complete interconnection studies, including load flow, short-circuit and dynamic stability models in Siemens PTI PSS/e format.

2.5 Phasor Measurement Device Unit Requirements

A phasor measurement unit, or "PMU", is a device which measures the electrical wave forms on the electricity grid in real-time, using a common time source for synchronization. TAL collects and utilizes data from phasor measurement devices, which include the standalone PMU device, or relays and digital fault recorders (DFRs) with phasor measurement capabilities from individual generators. Synchrophasor measurement devices (PMUs), with a measurement rate of at least 30 points per second are required to be installed at the low voltage side of all new generator interconnections 10 MW or larger. The cost of the PMU installation and maintenance will be the responsibility of the interconnection customer. TAL and the interconnection customer will negotiate responsibility for the communication system which should be capable of carrying the phasor measurement data to a phasor data concentrator (PDC), and then transport the information continuously to TAL; as well as storing the data locally for a minimum period of 30 days.

2.6 Transmission

This section addresses the technical requirements for connecting new transmission lines to the TAL transmission system as well as for new and existing delivery points. The TAL planning process is designed to ensure that TAL's transmission system will have sufficient capability for TAL to meet the expected loads at distribution substations/delivery points, and to fulfill TAL's contractual obligations with other entities to receive and deliver power. A utility/customer may elect to connect to TAL through a "delivery point" interconnection or an "interconnection point" interconnection. A "delivery point" is a point of interconnection between TAL's transmission system and another entity's system or facilities which ultimately delivers the power to individual customers' loads. Two characteristics may be generally used to distinguish delivery points from interconnections: i) the protective schemes of the integrated transmission system are designed to either entirely or partially suspend service to a delivery point by disconnecting a transmission facility that serves such delivery point from the transmission system; ii) power normally flows only in one direction across the delivery point (i.e., from the transmission system to the delivery point), and thus the protective schemes at the delivery point may be designed taking into account this characteristic.

An "interconnection point", in contrast, is a point of interconnection between two entities' respective transmission systems. Interconnection points are normally operated in parallel with the transmission systems such that it is possible for power to flow in either direction. Protection systems for interconnection points are designed to prevent and/or minimize the possibility of an event within one of the systems affecting or cascading into the other system.

This section applies to all utility-to-utility (entity) type interconnections with the TAL system made at 69 kV or greater. This includes interconnections used for power interchanges as well as delivery point type interconnections used to deliver power to end users detailed, project specific requirements will be developed as part of a System Impact Study, a Facilities Study or are referenced in other documents such as the NERC Planning Standards or the National Electrical Safety Code.

2.7 Structures

Transmission and substation structures for facilities connected to the TAL transmission system shall be designed to meet the *National Electrical Safety Code* (NESC). Substation structures shall be designed to comply with American Society of Civil Engineers (ASCE) Manual 113, *Substation Structure Design Guide*. Substation bus systems shall be designed to comply with ANSI/IEEE Standard 605, *IEEE Guide for the Design of Substation Rigid-Bus Structures*. In addition, structures connected to the TAL transmission system shall be designed to meet the load requirements as specified by ASCE 7-05, *Minimum Design Loads for Buildings and Other Structures*, when the outage of these structures would interrupt power flow through the TAL transmission system or interrupt service to TAL customers.

The NESC requires the use of the Extreme Wind Loading Criteria (EWL) for facilities that exceed 60 feet above ground or water level – normally transmission level structures. EWL is calculated using the wind speeds shown in Figure 250-2(d) of the NESC for Florida.

2.8 Configuration

The interconnection point between utilities is typically through a transmission line or lines. The change of ownership is usually at a transmission line structure. The neighboring utility must have an effectively grounded transmission system.

Three source terminal interconnection configurations are to be avoided within the TAL transmission system. This is due to problems associated with protective relay coverage from infeed, sequential fault clearing, outfeed or weak source conditions, reduced load flow, and automatic reclosing complications. Extensive studies are necessary to evaluate all possible implications when considering three terminal line applications.

Some new interconnections to the TAL transmission system may require one or more TAL transmission circuits to be looped through the new facility. The design and ratings of the new facilities and the transmission loop into them shall not restrict the capability of the transmission circuits or impair TAL's contractual transmission service obligations.

Long taps to feed connected load directly tied to a transmission line are to be avoided. This presents coverage problems to the protective relay system due to infeed. Power line carrier signals can also be lost due to odd quarter wavelength sections.

Any interconnection configuration should not restrain TAL from taking an TAL transmission line out of service for just cause. TAL shall not be forced to open a transmission line for an adjacent interconnected generator or transmission line to obtain an outage. Manual switching or clearing electrical faults within the non-TAL facility shall not curtail the ability of TAL to transmit power or serve its customers.

Reliable station and breaker arrangements will be used when there are new or substantial modifications to existing TAL switching stations affecting transmission lines rated at or above 69kV. In general, TAL transmission switching stations are configured such that line and transformer, bus and circuit breaker maintenance can be performed without degrading transmission connectivity. This generally implies a breaker and a half or double breaker, double bus configuration. A ring bus may be used when a limited number of transmission lines are involved.

2.9 Point of Interconnection

The point of interconnection is to be clearly described. Usually the change of facility ownership and the point of interconnection are the same point.

An interconnection junction box may be required to connect control circuits and signals between the parties at a point of demarcation. Fiber optics is the preferred means of interconnection of control circuits. Metallic control cables will present problems if the distances are great, ground potential rise during faults can cause failures when these signals are needed the most. Long cable voltage drops can make control systems unreliable or produce inaccurate signal levels and therefore are to be avoided.

Metering equipment should be provided as close to the interconnection point as practicable. The interconnecting facility must be connected to the TAL system through a primary interrupting device. Facilities interconnecting to the TAL transmission system that are not solely operated and controlled by the TAL System Operator must have an isolating device installed at the point of interconnection. This isolating device, typically a disconnect switch, must be capable of physically and visibly isolating the facilities from the TAL transmission system. This isolating device must be lockable in the open position by TAL and must be under the ultimate control of the TAL System Operator.

2.10 Transmission Reclosing

It is TAL's practice to automatically and manually test its transmission lines following breaker operations for system faults. This is required to minimize customer outage time and maintain system stability. Automatic reclosing typically occurs after the protective relays have issued a trip signal to the breakers on 230kV lines and below. A second automatic reclose may be initiated at some locations after receiving a TRIP-CLOSE-TRIP indication from the breaker. Manual reclosing and sectionalizing may also occur. Interconnected facilities must not interfere with TAL's ability to quickly restore transmission lines following temporary or permanent system faults.

Automatic reclosing on lines originating at TAL generation sites is usually accomplished by hot line synch-check permissive. The remote end of the line from an TAL generator should be equipped with a dead line permissive for automatic reclosing. Any party wishing to interconnect with TAL must consider the implications of automatic reclosing in their design.

Automatic reclosing on interconnected transmission lines between utilities is handled on a case-by-case basis. Transmission interconnections between utilities may be restored from either direction depending upon a reclosing practice agreed to by the utilities involved.

2.11 Separations

There are several controlled islanding special protection systems installed on the Peninsular Florida transmission systems. These special protection systems have been coordinated with the utilities

involved and with the FRCC underfrequency load shedding program. Depending upon the location of the transmission interconnection, it may be necessary to install special relaying or transfer trip equipment.

Interconnections to the TAL transmission system which introduce the possibility of TAL load being isolated with non TAL generation must be evaluated to assure safety and quality of service. When there is a potential for TAL load to become islanded with non-TAL generation, a special protective isolation scheme may be required.

2.12 Unbalance Phases

Unbalance currents and voltage are to be controlled by each party on their respective side of the interconnection. However, it should be realized that switching devices, such as breakers and switches, are three phase devices and can fail with only one or two poles closed. It is the responsibility of the facility owner to protect their own equipment such as generators or transformers from damaging negative sequence currents or voltage.

2.13 Delivery Point (End-User) Auto-Restoration

End user facilities are energized in the direction from TAL to the load. Owners of interconnected load facilities are to be aware of TAL's automatic reclosing practices. TAL's standard high speed reclosing, after the protective relays initiate a trip signal to the breakers, should be taken into account by end users with sensitive control systems or large motors. Ride-through capability and heavy motor inrush currents should be assessed in the design stages of the facility.

2.14 Delivery Point (End-User) Load Shedding Programs

Entities responsible for load serving delivery points shall implement and maintain an underfrequency load shedding program designed and coordinated with TAL and the FRCC. TAL has the right to require entities responsible for load serving delivery points to implement an emergency load shedding program to the extent that such a program is required and utilized by TAL to assure transmission integrity under adverse conditions. The amount of load to be interrupted by emergency load shedding programs will be distributed comparably among TAL's and other entities' customers in the applicable region.

2.15 Delivery Point (End-User) Generation

Delivery point interconnections usually do not have generating facilities that operate in parallel with the TAL transmission system. Customers wishing to install generating facilities to be operated in parallel with TAL must notify TAL in writing prior to the commencement of any work. No generation shall be operated in parallel with the TAL transmission system without prior written approval of TAL.

2.16 Delivery Point (End-User) Parallel Operation

The distribution and transmission facilities behind the designated delivery point with TAL's transmission system shall be operated as a radial system only. Operation in a mode which would tie two or more delivery points together in a manner which would cause the system behind the delivery points to be operated as a parallel network to the TAL transmission system is prohibited without the express written permission of TAL. The installation of such protective equipment may be required by TAL to ensure that parallel operation is automatically interrupted within the time frame allowed by TAL's standard.

2.17 Balancing Authority Areas

Facilities owners shall follow good utility practice to avoid creating oversupply imbalances or undersupply imbalances. The facility owner shall contract for or have available to it resources within its Balancing Authority Area that are capable of supplying in real time any deviations between power schedules and the actual power interchange with the TAL Transmission System by the facility.

2.18 Reliability and System Security

Generating facilities connected to the Peninsular Florida Transmission Systems must follow all applicable FRCC and NERC Operating Standards. A number of constrained transmission interfaces have been identified within the Peninsular Florida Transmission Systems. Power transactions may need to be curtailed when a threat to one of these interfaces is identified by the FRCC's Reliability Coordinator. The maintenance of lines, breakers and transformers at plant sites larger than 10 MW may require a reduction in the output level of the plant in order to maintain security of the TAL transmission system.

TAL designs and operates its transmission system to meet FRCC and NERC Planning and Operating Standards. The planned transmission system with its expected loads and transfers must be stable and within applicable ratings for all category P0 through P7 contingency scenarios¹. The effect of Extreme Event contingencies on system stability is evaluated when changes are planned in the transmission system. The design of new transmission interconnections should take into account and minimize, to the extent practical, the adverse consequences of Extreme Event contingencies.

Higher probability Extreme Event contingencies, when they occur in combination with forecasted demand levels and firm interchange transactions, must not result in uncontrolled, cascading interruptions. While controlled interruption of load and/or opening of transmission circuits may be needed, the system shall be within its emergency limits and capable of rapid restoration after operation of automatic controls.

The power system must be stable for single line to ground faults with the failure of a protection system component to operate. This includes clearing of a system fault with the simultaneous failure of a current transformer, protective relay, breaker, or communication channel. Three phase faults with the failure of a protection system component to operate are to be considered in all design alternatives with adverse consequences to system stability minimized.

TAL transmission circuits are protected with primary system relays that provide no intentional time delay when clearing faults for 100% of a line. A second high-speed relay system with communications and no intentional time delay is required if a failure of the primary system can result in instability when a fault is cleared by time delay backup protection. This can be the case for an end of line fault on a short line combined with a failed relay. Likewise, two independent high-speed protection systems may be required for bus protection if backup clearing results in instability.

2.19 Ferroresonance

Ferroresonance occurs on the power system under certain system configurations that may damage high voltage equipment. This phenomenon is usually caused when PT's are tied to a bus or line stub that may be energized through breakers having capacitors in parallel with the main contacts. Since

interconnection facilities may contain shared equipment, such as metering PT's and high voltage breakers, care should be used to avoid configurations that could cause ferroresonance.

Generators facilities shall be configured such that they would limit the probability of a resonance event. The associated Interconnection facility protection systems shall be equipped for fast operation on the rapid, and often severe, voltage rise associated with resonance.

TAL Facility Connection Requirements - Exhibit B

Additional Inverter-based Resource Requirements

1.0 General

The requirements of this exhibit are based on NERC Reliability Guideline – Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources published September 2019 and TAL’s previous Interconnect Agreement’s used for inverter based generation plants. TAL reserves the right to waive or amend the requirements of this Exhibit per the results of system studies or prudent Standard Utility Practice.

1.1 Nameplate Rating and Listing

The inverter(s) nameplate rating shall be the aggregate sum, expressed in MWac, of the manufacturer's rated electric energy output of each of the installed inverters comprising the Generator at reference conditions of 50 degrees Celsius and a power factor of 1.0 and must be listed and in compliance with Underwriters Laboratories ("UL") Subject 1741, Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Systems. Utility-Interactive inverters that pass the test of the UL 1741 standard will be, by definition, "non-islanding" inverters and will comply with all elements of the Institute of Electrical and Electronics Engineers ("IEEE") Standard 1547 interconnection standard. The National Electrical Code requires that all utility-interactive photovoltaic systems use listed inverters that pass UL 1741 standard.

PV modules and panels must be listed and be in compliance with UL Standard 1703, Standard for Safety: Flat-Plate Photovoltaic Modules and Panels. PV modules also must be in compliance with IEC 61215.

1.2 Momentary Cessation

Newly interconnecting inverter-based resources must continuously inject current within the “No Trip Zone” of the currently effective version of PRC-024. Momentary cessation will only be approved as a special exception based on system studies performed to mitigate potential local reliability or controls-related stability issues.

1.3 Phase Jump Immunity

If inverters may trip on instantaneous changes in phase (either due to fault events or line switching events). System studies shall identify possible worst-case phase jumps at the point of interconnection (POI) of the interconnecting resources. Inverter-based resources shall not trip for identified credible contingency events per the applicable system studies.

1.4 Capability Curve

Newly interconnecting inverter-based resource owners shall provide a “composite capability curve” that includes the overall active and reactive capability of the resource as measured at the Point of Measurement (POM). This includes a complete P-Q graph (or table of data representing these data points) at nominal voltage. Note that the reactive capability within the curve should be “dynamic” per FERC Order No. 827. The capability curve of each type of individual inverter

shall be provided. This curve data will be used to verify aggregate capability in planning models.

1.5 Active Power-Frequency Controls

Dynamic active power-frequency response performance of inverter-based resources shall be provided to meet the performance guidelines of NERC Reliability Guideline: BPS-Connected Inverter-Based Resource Performance,²³ per the recommended dynamic response characteristics in Appendix A, Item 3.3.

1.6 Fast Frequency Response (FFR)

The interconnection study will identify system needs for FFR. Newly interconnecting inverter-based resource owners shall provide all infrastructure upgrades required to satisfy the identified FFR system needs.

1.7 Frequency Ride Through and Clearing

The frequency ride-through requirements shall be met at the point of interconnection, and shall conform to IEEE 1547. The Generator shall cease to energize TAL's System and trip within the indicated clearing time when the system frequency is within the range specified as set forth in IEEE 1547.

1.8 Voltage Ride Through

Generator shall remain connected to the system and operating at normal expected output during and following transmission system faults including three phase faults with a clearing time not exceeding 16 cycles. The voltage ride-through requirements shall be met at the Point of Interconnection, and shall conform to IEEE 1547(current revision) Distributed Energy Resources (DER) response. The performance required of the DER during voltage disturbances shall meet voltage ride through requirements for DER of IEEE 1547 (current revision).

1.9 Transient Overvoltage

The Generator shall not cause the fundamental-frequency Line-to-Ground voltage on any portion of TAL's System to exceed 138% of its nominal Line-to-Ground fundamental-frequency voltage for duration of exceeding one fundamental frequency period. The Generator shall not cause the Line-to-Line fundamental-frequency voltage on any portion of TAL's System to exceed 138% of its nominal Line-to-Line fundamental-frequency voltage for a duration exceeding one fundamental frequency period or 17mS. The Generator shall not cause any transient over-voltage excursions or rapid voltage changes outside the limits specified by IEEE 1547.

1.10 Reactive Power-Voltage Control

Performance for newly interconnecting generating resources must align with FERC Order No. 827. Additional requirements may be needed for BPS reliability needs based on specific system characteristics. System studies shall whether large or small disturbance behavior for voltage response is required. Requirements for the time in which voltage support shall be provided will be added to the Interconnect Agreement.

1.11 Reactive Current-Voltage Control

Newly interconnecting inverter-based resource owners shall provide dynamic voltage support through their reactive current-voltage controls for large disturbance events when voltage falls outside the continuous operating range of the inverters (and local inverter controls take over). Requirements for magnitude and timing of reactive current injection, and the prioritization between reactive and active current will be added to the Interconnect Agreement.

1.12 Reactive Power at No Active Power Output

Newly interconnecting inverter-based resource owners shall exchange reactive power with the BPS (to provide voltage control) when no active power is generated.

1.13 Inverter Current Injection during Fault Conditions

The Interconnect Agreement will define required inverter behavior during and immediately following fault events in coordination with the small disturbance active and reactive current controls. This required behavior will include the magnitude of the current, the phase relationship of current with respect to voltage, and the timing of current injection. These requirements will be based on detailed system studies (likely electromagnetic transient (EMT) studies), establishing fault current requirements for newly interconnecting inverter-based resources since this response is dominated by the controls programmed into the inverter.

1.14 Return to Service Following Tripping

The Interconnect Agreement will define required performance of inverter-based resources following a tripping event. This performance may include automatic reconnection after a predefined period of time or may include manual reconnection by TAL. Ramp rates during return to service conditions will be specified as well. Following “system black” conditions, inverter-based resources should not attempt to automatically reconnect to the grid (unless directed by the TAL) so as to not interfere with blackstart procedures.

1.15 Balancing

Newly interconnecting inverter-based resource owners shall provide the capability to limit active power ramp rates (in both directions) to mitigate any significantly large power swings over a short period of time, depending on weather when applicable. This is a balancing ramp rate typically expressed in terms of percentage output change per minute. Inverter-based resources will be required to receive automatic generation control (AGC) dispatch signals at the discretion of TAL.

1.16 Monitoring

Newly interconnecting inverter-based resource owners shall provide data recording and real-time monitoring requirements for inverter-based resources to effectively monitor resource performance and provide information necessary to perform event analysis. This includes capturing high resolution data available at the POI, some inverter-level high speed data, and sequence of events recording.

1.17 Operation in Low Short-Circuit Strength Systems

The system studies will identify whether the proposed plant will operate in an area with low short circuit strength. Newly interconnecting inverter-based resource owners shall provide all infrastructure upgrades required to meet the operational requirements for a plant located in an area with low short circuit strength.

1.18 Fault Ride-Through Capability (FRT)

Generating resources may be required to have FRT capability for all expected (studied) credible contingency events unless the plant is consequentially isolated due to the fault, the plant is part of a remedial action scheme, or the plant is allowed to trip by exception from the Transmission Planner based on system studies. These requirements are applied during the FAC-002 interconnection studies process.

1.19 Grid Forming

Newly interconnecting inverter-based resources shall include grid forming inverter capability if required by TAL; however, the inverters shall not be operated as grid forming unless expressly directed by TAL as a result of the requirements of a system study. If TAL does not require grid forming capability, then the inverters shall be provided with anti-islanding capability.

1.20 System Restoration and Blackstart Capability

During system restoration, inverter-based resources shall not unexpectedly automatically reconnect during the system restoration process. The inverter-based resource operator shall coordinate and receive instruction from TAL prior to returning to service.

Inverter-based resources are not required to have blackstart capability; however, if they do, that information shall be provided to TAL as part of the interconnection process.

1.21 Protection Transformers

Transformers used for the interconnection protection scheme shall be relay class.

1.22 Protection Settings

The Interconnection Agreement will include Protection Setting requirements for Inverter-based resources. In effort to maintain continuity of service during external system faults and provide reliable service during normal operations, TAL will impose the requirements of a Bulk Electric System (BES) installation for the purposes of protection & control device settings and coordination. Additional requirements include the following:

- Breaker functions including trips, status, alarms, block close, etc. will be sent and received via redundant remote input/output relays; These devices shall be powered by a continuously charged and monitored station battery bank.
- Inverter based protection and controls shall be coordinated with equipment limitations and any protective relay schemes within the overall plant and/or TALs system per PRC-019.

- Volts per Hertz-ANSI Device # 24: Shall be set to provide equipment protection as necessary and coordinate with PRC-024 curve, Eastern Interconnection. Should equipment protection concerns necessitate mis-coordination with these curves, then documentation shall be provided identifying the equipment limitation.
- Under Voltage-ANSI Device# 27: Shall be set to provide equipment protection as necessary and coordinate with PRC-024, Eastern Interconnection. Should equipment protection concerns necessitate mis-coordination with these curves, then documentation shall be provided identifying the equipment limitation.
- Over Voltage-ANSI Device# ,59: Shall be set to provide equipment protection as necessary and coordinate with PRC-24, Eastern Interconnection. Should equipment protection concerns necessitate mis-coordination with these curves, then documentation shall be provided identifying the equipment limitation.
- Under Frequency-ANSI Device# 81U: Shall be set to provide equipment protection as necessary and coordinate with PRC-024, Eastern Interconnection. Should equipment protection concerns necessitate mis-coordination with these curves, then documentation shall be provided identifying the equipment limitation.
- Over Frequency-ANSI Device# 810: Shall be set to provide equipment protection as necessary and coordinate with PRC-024, Eastern Interconnection. Should equipment protection concerns necessitate mis-coordination with these curves, then documentation shall be provided identifying the equipment limitation.
- Phase Overcurrent, time and/or instantaneous -ANSI device# 50/51P(51V/51C): This element protects both the Generator and TAL's facilities from overloads or faults during parallel operation. Activation of this relay causes immediate tripping of the generator breaker and immediate shutdown of the inverter. Settings shall be coordinated with equipment and/or conductor ratings to prevent damage. Additionally, this protection shall be coordinated with other overcurrent relays as required and meet PRC-025 setting criteria as applicable to these elements. For load responsive elements that trip instantaneously or with a time delay of less than 0.25 seconds, the requirements of PRC-026 shall apply.
- Generator Ground Overcurrent, time and instantaneous - ANSI device 50/51G: Activation of this relay causes immediate tripping of the associated breaker. Settings shall be coordinated with equipment and/or conductor ratings to prevent damage. Additionally, this protection shall be coordinated with other overcurrent relays, including TALs transmission system, as required.
- Lockout Relay w/ manual reset - ANSI device # 86 (virtual): All generator electrical protective devices shall utilize any necessary outputs of a microprocessor based protective relay to latch any protection trips and block close the associated breaker. Manual reset by on-site personnel is required and can only be accomplished after all protective trips have been cleared (i.e. target reset).
- Auxiliary Trip Inputs: The Generator main breaker shall be equipped with auxiliary trip inputs and made available to TAL at the Point Of Interconnection for purposes of initiating a Direct Transfer Trip (DTI).

- Auxiliary Trip Outputs: The Generator main breaker shall be equipped with auxiliary trip outputs and made available to TAL at the Point of Interconnection for purposes of initiating a Direct Transfer Trip (DTI)
- Auxiliary Outputs: 52a (open contact when breaker is open) and 52b contacts (closed contact when breaker is open) shall be made available to TAL at the Point of Interconnection for purposes of communicating the collector breaker(s) and capacitor status to TAL.
- Surge Arrestors: All three phases of the load side of the Generator main circuit breaker shall be equipped with metal oxide type surge arrestors. These arrestors shall be sized in accordance with accepted standards to the appropriate maximum TAL interconnection circuit voltage.
- All interface protection and control equipment shall operate as specified independent of the calendar date and be powered by a continuously charged and monitored stationary battery.
- A failure of Generator Owner's interconnection protection equipment, including loss of control power, shall result in the disconnection of the generation from TAL's System. To facilitate this disconnection, Generator Owner shall transmit Generator Owner's relay failure or Generator Owner's loss of control power status to TAL via analog communication. After receipt of the Generator Owner's failure status, TAL's protection system will disconnect the Generator Owner's generator from TAL's System after a period of time. TAL will coordinate the period of time with the Generator Owner; however, the final setting of the period of time will be per TAL's discretion.
- The Generator Owner should be aware that the listed minimum protective functions are designed to primarily protect TAL's personnel and circuits, and that total protection of Generator may require additional protective functionality.
- Protection scheme circuitry, potential and current sensing shall not be connected into the revenue metering circuitry.

In addition to the above requirements, TAL may require additional protection and control devices and operating parameters on the part of the Generator Owner as may, in its sole judgement, be necessary for the safe operation of TAL's System. TAL shall specify and provide settings guidance for those relays that TAL designates as being required to satisfy protection practices. Any protective equipment or setting specified by TAL shall not be changed or modified at any time by Generator Owner without written consent from TAL.

Additional Protection Clarification:

- PRC-024 sets minimum performance requirements. (Note: inverter protection shall be set at the limits of equipment safety and reliability.)
- Tripping on calculated frequency shall be based on an accurately calculated and filtered measurement over a time window and shall not use an instantaneously calculated value.
- Inverter overvoltage protection shall be set as high as possible within equipment limitations.

- The PRC-024 curve uses a filtered RMS voltage measurement and shall not be applied for transient, sub-cycle overvoltages.
- Expected performance during successive fault events will be specified within a predefined period of time
- Any dc reverse current protection and phase lock loop (PLL) loss of synchronism shall not result in inverter tripping. Tripping within the PRC-024 “No Trip Zone” will be allowed for inverter faults that can lead to failure.
- Inverter rate-of-change-of-frequency (ROCOF) protection shall be disabled unless an equipment limitation exists that requires the inverter to trip on high ROCOF.

1.23 EMI & RF Compliance

PV systems often include high-speed switching semiconductor circuits to convert the voltage. Switching circuits inherently produce electromagnetic radiation at harmonics of the switching frequency. Electromagnetic interference (EMI) or radiofrequency (RF) emissions can emanate from PV systems and impact nearby communications. For this reason, the inverter systems shall be FCC Part 15 Class A compliant and maintain a setback distance of 250-500 feet from communication equipment. TAL may periodically verify ongoing adherence through the use of field measurements taken at the Point of Common Coupling or other suitable location as determined by TAL.

1.24 Geo Magnetic Disturbance Monitoring

Newly interconnecting inverter-based resource owners shall make the Generator Ground Overcurrent analog value available to TAL at the revenue meter location. TAL may run communications to this location and bring this information back via SCADA for Geo Magnetic Disturbance monitoring.

1.25 Power Quality

Harmonics must be managed and mitigated because of the potential they have to cause problems such as telecommunication interference, increased network losses, increased thermal heating in transformers and rotating machinery, mis-operation of protective relays and User equipment, and resonant over-voltages. The Generator owner shall be responsible for adhering to the limits of Total Demand Distortion (TDD) and Individual Harmonic Distortion (IHD). The maximum harmonic limits for electrical equipment shall be in accordance with IEEE 519 - 2014. Harmonic current while serving balanced linear loads shall not exceed the limits as set forth with IEEE 1547. To this end, TAL may periodically verify ongoing adherence through the use of field measurements taken at the PCC or other suitable location as determined by TAL.

**TAL Facility Connection Requirements - Exhibit C
Connection Request**

1. The undersigned interconnection Customer submits this Connection Request to interconnect its generating facility with the transmission system of the City of Tallahassee (“TAL”), a TSR, or to interconnect its generating facility to one of TAL’s existing generating facilities that is used to interconnect to the transmission system and the interconnection Customer, a GISR.

2. This Connection Request is for (check one):
 A TSR
 A GISR

3. This Interconnection Request is for (check one):
 A proposed new generating facility.
 An increase in the generating capacity or a material modification of an existing generating facility.

3. The type of interconnection service requested, per FERC Pro-Forma (check one):
 Energy Resource Interconnection Service
 Network Resource Interconnection Service

4. Check here only if Interconnection Customer requesting Network Resource Interconnection Service also seeks to have its generating facility studied for Energy Resource Interconnection Service

5. Interconnection Customer must provide the following information:
 - a. Address or location of the proposed new generating facility site (to the extent known) or, in the case of an existing generating facility, the name and specific location of the existing generating facility

- b. The following information;
- MW _____ Gross _____ Net
 - MVAR _____ Gross _____ Net
 - MVA _____ Gross _____ Net
 - Volts _____ Generator _____ Conn. Pt.
- c. Maximum summer MW at ____ degrees C and Maximum winter MW at _____ degrees C of the proposed new generating facility or the amount of megawatt increase in the generating capacity of an existing generating facility;
- d. Single-line diagram reflecting interconnection point, metering, equipment (generation, transformation, breakers, switches, capacitor banks, grounding, etc.) relaying instrumentation (instrument transformers, relays, etc.) and a geographical drawing reflecting the proposed location of the generating facility, the proposed electrical facilities and interconnection point between the proposed generating facility and TAL's electrical system;
- e. Proposed construction schedule of the proposed generating facility and the interconnection facilities including station service and permitting and the proposed commercial operation date (Day, Month, and Year);
- f. Evidence of site control (attach to the Connection Request). For site control you will need to provide executed and recorded documentation showing that you either own the land or have an exclusive option to buy the land (for a reasonable period of time).
- g. Technical Data (set forth in Attachment A to this exhibit) must be received before the initiation of any of the studies identified in the FCR can be initiated.
- h. The nature of transmission service desired, either: TAL load, the TAL/DEF (Duke Energy Florida) interface, and/or the TAL/SOU (Southern) interface.
- i. If transmission service is required to either the TAL/DEF (Duke Energy Florida) interface, and/or the TAL/SOU (Southern) interface, then the customer shall specify what ancillary services are requested.

6. This Connection Request must be executed (below) by an officer of the Customer's organization and submitted to:

City of Tallahassee
Electric Department
General Manager
2602 Jackson Bluff Road
Tallahassee, Florida 32304

7. Representative of Interconnection Customer to contact:

Name: _____

Phone: _____

Email: _____

8. This Interconnection Request is submitted by:

Name of Interconnection Customer: _____

By (signature): _____

Name (type or print): _____

Title: _____

Date: _____

Date Received by City of Tallahassee: _____

By: _____
TAL Representative

Date Connection Request Completed: _____

By: _____
TAL Representative

TAL Facility Connection Requirements - Exhibit C - Connection Request

Attachment I - Generating Facility Data

Unit Ratings

MVA _____ °F _____ Voltage _____

Power Factor _____

Speed (RPM) _____ Connection (e.g. Wye) _____

Short Circuit Ratio _____ Frequency, Hertz _____

Stator Amperes at Rated MVA _____ Field Volts _____

Max Turbine MW _____ °F _____

Combined Turbine - Generator – Exciter Inertia Data

Inertia Constant, $H =$ _____ kW sec/kVA

Moment-of-Inertia, $WR^2 =$ _____ lb. ft.²

Reactance Data (Per Unit – Rated KVA)

	Direct Axis	Quadrature Axis
Synchronous – saturated	X_{dv} _____	X_{qv} _____
Synchronous – unsaturated	X_{di} _____	X_{qi} _____
Transient – saturated	X'_{dv} _____	X'_{qv} _____
Transient – unsaturated	X'_{di} _____	X'_{qi} _____
Subtransient – saturated	X''_{dv} _____	X''_{qv} _____

Subtransient – unsaturated	X''_{di}	_____	X''_{qi}	_____
Negative Sequence – saturated	$X2_v$	_____		
Negative Sequence – unsaturated	$X2_i$			
Zero Sequence – saturated	$X0_v$			
Zero Sequence – unsaturated	$X0_i$			
Leakage Reactance	Xl_m	_____		

Field Time Constant Data (Sec)

Open Circuit	T'_{do}	_____	T'_{qo}	_____
Three-Phase Short Circuit Transient	T'_{d3}	_____	T'_q	_____
Line to Line Short Circuit Transient	T'_{d2}			
Line to Neutral Short Circuit Transient	T'_{d1}			
Short Circuit Subtransient	T''_d	_____	T''_q	_____
Open Circuit Subtransient	T''_{do}	_____	T''_{qo}	_____

Armature Time Constant Data (Sec)

Three Phase Short Circuit	T_{a3}	_____
Line to Line Short Circuit	T_{a2}	_____
Line to Neutral Short Circuit	T_{a1}	_____

NOTE: If requested information is not applicable, indicate by marking "N/A."

Armature Winding Resistance Data (Per Unit)

Positive	R_1	_____
Negative	R_2	_____

Zero R_0 _____

Rotor Short Time Thermal Capacity I_2^2t _____

Field Current (at Rated kVA, Armature Voltage and PF) _____ amps

Field Current (at Rated kVA and Armature Voltage, 0 PF) _____ amps

Three Phase Armature Winding Capacitance _____ microfarad

Field Winding Resistance _____ ohms _____ °C

Armature Winding Resistance (Per Phase) _____ ohms _____ °C

Curves

Provide Saturation, Vee, Reactive Capability, Capacity Temperature Correction curves. Designate normal and emergency Hydrogen Pressure operating range for multiple curves.

Generator Step-up Transformer Data Ratings

Capacity Self-cooled (Maximum Nameplate)

_____ / _____ kVA

Voltage Ratio(Generator Side/System side/Tertiary)

_____ / _____ / _____ kV

Winding Connections (Low V/High V/Tertiary V (Delta or Wye))

_____ / _____ / _____

Fixed Taps Available _____

Present Tap Setting _____

Impedance

Positive Z_1 (on self-cooled kVA rating) _____ % _____ X/R

Zero Z_0 (on self-cooled kVA rating) _____ % _____ X/R

Excitation System Data

Provide appropriate PSS/e excitation system and power system stabilizer (PSS) models for computer representation in power system stability simulations and the corresponding excitation system and PSS constants for use in the model.

Governor System Data

Provide appropriate PSSE model of governor system for computer representation in power system stability simulations and the corresponding governor system constants for use in the model.

Wind Generators, PV and Bulk Electric Storage

Number of generators to be interconnected pursuant to this Connection Request:

Elevation: _____ Single Phase _____ Three Phase

Inverter manufacturer, model name, number, and version:

List of adjustable set points for the protective equipment or software:

Provide appropriate PSS/e model for steady-state and dynamic power flow models.

Induction Generators

Field Volts: _____

Field Amperes: _____

Motoring Power (kW): _____

Neutral Grounding Resistor (If Applicable): _____

I_2^2t or K (Heating Time Constant): _____

Rotor Resistance: _____

Stator Resistance: _____

Stator Reactance: _____

Rotor Reactance: _____

Magnetizing Reactance: _____

Short Circuit Reactance: _____

Exciting Current: _____

Temperature Rise: _____

Frame Size: _____

Design Letter: _____

Reactive Power Required In Vars (No Load): _____

Reactive Power Required In Vars (Full Load): _____

Total Rotating Inertia, H: _____ Per Unit on KVA Base

Non-Synchronous Generating Facility Data

General Data

Generating Facility Name: _____

Total Generating Facility Gross Output: _____

Generating Facility Aux Load: _____

Anticipated Losses between Generating Facility and POI: _____

Requested MW at POI: _____

Power factor at rated output: _____

Location plan including street address and/or longitude and latitude. (Provide as attachment(s).)

One-line diagram of the plant and station facilities. (Provide as attachment(s).)

(The one line diagram shall include, as applicable, the distribution lines connecting the various groups of solar arrays, capacitor banks, step-up transformers, disconnect switches, distribution conductors, substation transformers and capacitor banks from the solar panels to the Point of Interconnection.)

Equipment Manufacturer Datasheets(Provide as attachment(s).)

Inverter Data

- a) Number of Inverters: _____
- b) Nameplate Rating (each Inverter): _____ kVA at _____ °C and at _____ AC rated voltage.
- c) Inverter AC terminal voltage operating range: _____
- d) Inverter Manufacturer and Model #: _____
- e) Provide inverter active and reactive power curves (P-Q diagrams): _____
- f) Provide inverter technical specification sheet, if available.
- g) Provide with this form the dynamic modeling data, including plant volt/var control function model and active power/frequency control function model, in a Siemens/PTI PSS/E standard model. If a user-written model is submitted in place of a standard model, it must include the model characteristics, including block diagrams, values and names for all model parameters, and a list of all state variables. All of the associated files, including source code, for dynamic modeling should be in PSS/E version 33, and must be shareable on an interconnection-wide basis to support use in the interconnection-wide cases.¹

- h) Isc max current during fault detection
- i) Duration of Isc max

- j) Isc max after fault detection
- k) Ilv max current for low voltage ride through (LVRT).

Reactive Power Compensation Devices (beyond the inverters built-in reactive capability).

- a) Type of reactive compensation device(s): Static or Dynamic
- b) Static reactive device type: Fixed or Switched
 - Number and size of each: _____ × _____ (MVar)
- c) Dynamic reactive control device (e.g. SVC, STATCOM): _____
 - Control range at rated MW output: _____ MVar (lead and lag)
- d) Provide with this form the dynamic modeling data in a Siemens PTI PSS/E standard model. If a user-written model is submitted in place of a standard model, it must include the model characteristics, including block diagrams, values and names for all model parameters, and a list of all state variables. All of the associated files, including source code, for dynamic modeling should be in PSS/E version 33 and it must be shareable on an interconnection-wide basis to support use in the interconnection-wide cases.²

Describe the overall plant reactive power control strategy: _____

Short Circuit Current Contribution of the Generating Facility.

Maximum Three Phase Fault Current contribution at the inverter AC terminals:
_____ (pu) of Rated Current

TAL Facility Connection Requirements - Exhibit D Electromagnetic Transient Model Data Collection

Background

TAL requires a PS CAD EMTDC Model for all inverter-based resources (greater than 1 MVA) requesting connection to its electric transmission or distribution system. Due to increasing penetration of inverter-based resources (IBR), traditional load flow and transient analysis may no longer be sufficient to ensure system reliability. EMT studies are required to analyze IBR performance in weak grids, control interactions, islanding performance, and ride-through capability. PS CAD model requirements are shown below:

Please fill out Project Name and Model Name

Project Name	
Model Name / Number of Turbine or Inverter	

1. PSCAD Model Requirement

Model Accuracy Features

In order to be sufficiently accurate, the model provided for each facility shall:

Item	Description	Check
1	Represent the full detailed inner control loop of the power electronics. The model cannot use the same approximations classically used in transient stability modeling, and should fully represent all fast inner controls, as implemented in the real equipment. It is preferred and recommended to create models which embed the actual hardware code into a PSCAD component whenever possible. If the model is assembled using standard blocks available in the PSCAD master library, approximations are usually introduced, and specific implementation details for important control blocks may be lost. In addition, there is a risk that errors will be introduced in the process of manually assembling the model. NOTE: For this type of manually assembled model, (not using a direct “real code” embedding process), validation is recommended.	
2	Incorporate a full IGBT representation (preferred), or may use a voltage source interface that mimics IGBT switching (i.e. a firing pulse based model). A three phase sinusoidal source representation is not acceptable. Models manually translated from MATLAB (i.e. block-by-block) or control block diagrams are often unacceptable because the method used to model the electrical network and interface to the controls may not be accurate, or portions of the controls (such as protection) are omitted. Note, however, that Matlab may be used to generate C code which is used in the real control	

	hardware, and if this approach is used by the developer, the same C code may be directly used to create an extremely accurate PSCAD model of the controls. The controller source code may be compiled into DLLs or binary if the source code is unavailable due to confidentiality restrictions.	
3	Represent plant level controllers as they are implemented in the real controls, such as automatic voltage regulation. Parameters typically requiring site-specific adjustment should be made user-accessible. For example, the plant level controller should provide access to regulation gains and droop settings.	
4	Represent all pertinent control features as they are implemented in the real controls (e.g. customized PLLs, ride-through controllers, etc.)	
5	Represent machine slip of Type III (DFIG) wind generation as appropriate for the power dispatch.	
6	Represent SSO mitigation and/or protection including the ability to enable and disable SSO mitigation/protection, if applicable	
7	Represent dynamic reactive devices including automatically controlled capacitor and reactor banks, if applicable.	
8	Represent all pertinent electrical and mechanical configurations, such as filters and specialized transformers. Mechanical features (such as gearboxes, pitch controllers, etc.) should be included in the model if they impact electrical performance.	
9	Have all pertinent protections modeled in detail. Typically this includes various over-voltage and under-voltage protections (individual phase and RMS), frequency protections, DC bus voltage protections, and overcurrent protection. There may be others.	
10	Accurately reflect behavior throughout the valid (MW and MVA _r) output range from minimum power through maximum power.	

Model Usability Features

In order to allow study engineers to perform system studies and analyze simulation results, the model provided for each facility shall:

11	Have pertinent control or hardware options accessible to the user (e.g. adjustable protection thresholds or real power recovery ramp rates). Diagnostic flags (e.g. flags to show control mode changes or which protection has been activated) should be accessible to facilitate analysis and should clearly identify why a model trips during simulations.	
12	Be capable of running at timesteps anywhere in the range from 5 μs to 10 μs. Most of the time, requiring a smaller time step means that the control implementation has not used the interpolation features of PSCAD, or is using inappropriate interfacing between the model and the larger network. Lack of interpolation support introduces inaccuracies into the model at higher time steps.	
13	Include documentation and a sample implementation test case. Access to technical support engineers is desirable.	

14	Be capable of initializing itself. Models shall initialize and ramp to full output without external input from simulation engineers.	
15	Accept external reference values. This includes real and reactive power reference values (for Q control modes), or voltage reference values (for V control modes).	
16	Allow protection models to be disabled. Many studies result in inadvertent tripping of converter equipment, and the ability to disable protection functions temporarily provides study engineers with valuable system diagnostic information.	
17	Allow the active power capacity of the model to be scaled. This is distinct from a dispatchable power order, and is used for modeling different plant capacities or breaking a lumped equivalent plant into smaller composite models.	

Model Efficiency Features

In order to improve study efficiency, model compatibility, and enable studies which include the model to be performed as efficiently as possible, the model provided for each facility shall:

18	Be compiled using Intel Fortran compiler version 9 or higher. Intel Fortran version 12 or higher is preferred. The model should not be dependent on a specific Fortran version to run.	
19	Use PSCAD version 4.5.3 or higher. The model should not be dependent on a specific PSCAD version to run.	
20	Initialize as quickly as possible (for example <5 seconds) to user supplied terminal conditions.	
21	Support multiple instances of its own definition in the same simulation case.	
22	Support the PSCAD “snapshot” feature.	
23	Support the PSCAD “multiple run” feature.	
24	Allow replication in different PSCAD cases or libraries through the “copy” or “copy transfer” features.	