LCRA Transmission Services Corporation

Facility Connection Requirements

June 2020
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1.0 INTRODUCTION

LCRA Transmission Services Corporation (LCRA TSC) is a Transmission Service Provider in the Electric Reliability Council of Texas (ERCOT) system. LCRA TSC tariffs for the provision of electric service are filed at the Public Utility Commission of Texas (PUC) and consist of Wholesale Transmission Service, Wholesale Transformation Service and Wholesale Metering Service. LCRA TSC provides service on a non-discriminatory basis to any eligible Transmission Service Customer (Customer), as that term is defined in the PUC Substantive Rules. LCRA TSC facilities are wholly contained within ERCOT which is a single Balancing Authority Area.

LCRA TSC does not provide retail distribution system service and does not directly serve retail customers. The PUC substantive rules define a retail customer as the separately metered end-use customer who purchases and ultimately consumes electricity.

Customers directly connecting to LCRA TSC’s facilities are required to have an Interconnection Agreement, in accordance with LCRA TSC’s Wholesale Transmission Service and Wholesale Transformation Service tariffs. Transmission Service Requirements for generation and transmission interconnections, under the tariffs mentioned above, are addressed in PUC Substantive Rules §25.191, §25.195 and §25.198.

Parties requesting interconnection should contact the LCRA TSC Transmission Planning department at 1-800-776-5272.

2.0 FACILITY CONNECTION REQUIREMENTS

All interconnecting facilities, new or existing, requesting interconnection or interconnection upgrades to the LCRA TSC transmission system shall be planned, designed and operated in accordance with the Facility Connection Requirements, and any applicable requirements of ERCOT, the North American Electric Reliability Corporation (NERC), National Electric Code (NEC), the National Electric Safety Code (NESC), the Occupational Safety and Health Administration (OSHA) and PUC Substantive Rules.

LCRA TSC will provide an Interconnection Agreement to transmission and transformation Customers requesting a Point of Interconnection (POI) to LCRA TSC’s facilities. Generators are required to begin an interconnection request at ERCOT, where the request is processed in accordance with the ERCOT Generation Interconnection or Change Request Procedure.

Facility ownership, design, maintenance, and operational requirements shall be documented in an Interconnection Agreement. An Interconnection Agreement or related agreement may address any necessary financial security, contribution in aid of construction, or cost reimbursement requirements related to the facility interconnection request.
2.1 Requirements for All Interconnections

2.1.1 Interconnection Service Voltages and System Operating Limits

Transmission Service Voltages: 69-, 138- or 345-kV (nominal)
Transformation Service Voltages: 12.5- or 24.9-kV (nominal)

Operations Steady State System Voltage Limits:
- Normal Conditions: 95-105%
- Post-Contingency Conditions: 90-105%

Any power delivered onto or received from LCRA TSC’s transmission system must be three-phase, 60-hertz alternating current.

2.1.2 Planning for the Interconnection

The appropriate voltage level for interconnection is determined during the planning phase.

LCRA TSC performs transmission planning assessments on an annual cycle to analyze and evaluate the impact on system performance of all interconnected facilities and interconnection requests. Regional power flow cases developed by the ERCOT Steady State Working Group (SSWG) provide the base case system conditions (generation and load) for the steady state portion of the assessment. Stability studies for the assessment are conducted using cases and dynamics data developed by the ERCOT Dynamics Working Group (DWG).

Using the SSWG and DWG cases, LCRA TSC determines if the existing transmission system is capable of meeting the performance requirements established in the LCRA TSC Transmission Planning Criteria, ERCOT Planning Guides, and NERC Transmission Planning (TPL) Reliability Standards with the proposed load or generation interconnection.

When system assessments demonstrate the need for improvements to the existing transmission system, LCRA TSC coordinates with the owners of generation, transmission or load-serving facilities in the impacted area to develop the scope and technical requirements for the new or materially modified facilities. The project is then submitted for review in accordance with the requirements outlined in the ERCOT Protocol Section 3.11.4.

Substation bus arrangements shall be provided by LCRA TSC in accordance with project requirements or as specified by the LCRA TSC Transmission System Planning Criteria.
2.1.3 Breaker Duty and Surge Protection

LCRA TSC shall determine the maximum available short-circuit current at the POI and communicate that fault data to the Customer. LCRA TSC-owned circuit breakers and circuit switchers (interrupting devices) at the POI shall have ratings that meet or exceed the following requirements:

a. Gas and oil circuit breakers shall have an interrupting rating of be at least 110 and 120% respectively of the maximum available close-in fault at the point of application.

b. Circuit switchers shall have an interrupting rating of at least 110% of the maximum available close-in fault at the point of application.

Customer-owned circuit breakers and circuit switchers (interrupting devices) at the POI shall have ratings that allow for safe and reliable operation at all times under all fault conditions.

The Customer shall provide LCRA TSC with nameplate data for interrupting devices on an as-needed basis. LCRA TSC shall notify the Customer when anticipated available short circuit current exceeds the requirements stated above. The Customer is responsible for planning replacement or upgrade of customer-owned interrupting devices.

The Customer shall be required to install over voltage protection for its equipment.

The surge arrester must be coordinated with the basic insulation level (BIL) of the protected equipment to be effective. The recommended BIL for power system equipment is shown in the table below:

<table>
<thead>
<tr>
<th>Nominal System Voltage (kV)</th>
<th>12.5</th>
<th>24.9</th>
<th>69</th>
<th>138</th>
<th>345</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Insulation Level (kV)</td>
<td>110</td>
<td>150</td>
<td>350</td>
<td>650</td>
<td>1300</td>
</tr>
</tbody>
</table>

Surge arresters must be placed at the transformer terminals and additional arresters must be applied to protect other equipment in the station.

2.1.4 System Protection and Coordination

Project-specific requirements for system protection and coordination are determined during the conceptual design and detailed design phases, and documented in the engineering prints and relay coordination files.

General requirements for system protection and coordination are found in the ERCOT Nodal Operating Guides, see Section 6.2.
Fault clearing shall utilize high-speed, pilot-assisted schemes for transmission elements above 100-kV.

The Customer protection system equipment shall be provided to LCRA TSC to allow for overlapping zones of protection. Examples include, but are not limited to, Customer’s provision of transformer CTs for bus differential protection, Customer’s provision of breaker CTs for bus differential protection, etc.

### 2.1.5 Metering and Telecommunications

Project specific requirements for metering and telecommunications are determined during the design phase and documented in the Interconnection Agreement. General requirements are listed below.

ERCOT requirements for metering and telecommunications are found in the documents referenced below:

- ERCOT Settlement Metering Operating Guide
- ERCOT Nodal Operating Guides; Section 7; Telemetry and Communication
- ERCOT Nodal Protocols; Section 10: Metering

**Current Transformers**

All metering CTs must conform to 0.3% accuracy or better. Each CT shall be provided with factory test reports stipulating the ratios, accuracy class and burden. CTs should have a burden rating of at least 1.8 ohm, but may have lower burden ratings in special circumstances depending on physical, electrical and/or economical restraints.

**Voltage Transformers**

All voltage transformers shall conform to 0.3% accuracy class or better, and shall be provided with factory test reports stipulating ratio, accuracy class and burden. Voltage transformers should have a burden rating of at least Z (200 VA), but may have lower burden ratings in special circumstances depending on physical, electrical or economical restraints.

**Metering Equipment**

LCRA TSC shall design, construct, operate and maintain wholesale meter packages that utilize metering accuracy instrument transformers, whether supplied by LCRA TSC or the Customer, as shown on LCRA TSC prints, and interval data recorder (IDR) meters that meet all requirements of the ERCOT Nodal Protocol Section 10, the Settlement Metering Operating Guide (SMOG) and the ERCOT Nodal Operating Guides. LCRA TSC shall have the right to install on Customer’s premises, metering equipment, communications equipment, and related appurtenances as required by LCRA TSC to provide a Wholesale Metering Service Point. The Customer shall allow LCRA TSC to utilize Customer’s available...
communications infrastructure, as determined by the Customer, to the extent necessary for carrying out the Agreement and without cost to LCRA TSC.

Any equipment installed by LCRA TSC is and shall remain the property of LCRA TSC and LCRA TSC shall be entitled to remove such equipment at the termination of the Agreement unless equipment is otherwise purchased by the Customer. LCRA TSC shall be entitled to abandon in place certain current transformers, switches, cables, conduits, etc. if the Customer and LCRA TSC agree in writing that removal of LCRA TSC’s equipment would place a significant burden on the Customer’s distribution delivery service (outages); and under such conditions the Customer would take responsibility for future removal and salvage without accounting of those items at its discretion and expense.

The Customer hereby grants LCRA TSC license and permission to enter upon the premises and easements of the Customer for the sole purpose of performing the work or any other activities associated with or contemplated by the Agreement, subject to the Customer’s physical security access practices and procedures. The Customer shall have the right to review test reports and to witness an audit or test carried out by the LCRA TSC for Wholesale Metering Service Points on the list.

**Communication and Telemetry Facilities**
Each Party shall provide, at its own expense, the necessary communication and telemetry facilities needed for the control, operation, and real-time monitoring of its transmission and/or distribution System.

For the Point(s) of Interconnection where LCRA TSC is the other Party’s Transmission Operator, the other Party shall provide as a minimum: Transmission Element status indication, Megawatts (MW), MegaVar (MVar), Kilovolts (KV), and Amps associated with its facilities. This is in order for LCRA TSC to conduct real-time monitoring of the Bulk Electric System as required by LCRA TSC, NERC Reliability Standards, and ERCOT Requirements. Should additional data not listed above be required, an additional data specification will be requested through written notice in accordance with Article IX of this Agreement. The periodicity and format for providing the above mentioned data is specified in the ERCOT Requirements. Each party shall provide all data necessary for real-time monitoring 60 days prior to new facility energization.

All communication and telemetry facilities required herein shall be selected, installed, tested, operated, and maintained by the Party owning such equipment in accordance with Good Utility Practice and the applicable ERCOT Requirements.

### 2.1.6 Supervisory Control and Data Acquisition (SCADA)

This section defines LCRA TSC’s SCADA policy and responsibilities for connecting Transmission and Generation Facilities to the LCRA TSC transmission system.
**SCADA Policy**
The LCRA TSC SCADA policy is to install a Remote Terminal Unit (RTU) at substations connected to the LCRA TSC transmission system. The RTU shall monitor the status and/or control transmission system switching devices, Customer load, transmission bus voltage and select alarms and indication. LCRA TSC does not monitor or control distribution equipment below 60-kV. The RTU shall be operated by the System Operations Control Center (SOCC) through an LCRA TSC provided communications system using LCRA TSC’s preferred RTU protocol: DNP.

**RTU Specification**
The RTU shall be installed in a climate-controlled environment (control house) and will require 125 VDC power and 120 VAC power. LCRA TSC will install a 24”x30”x84” RTU in a cabinet and a 24” wide Supervisory Interface Panel (SIP). For locations with a small point count, like a single transformer inline substation, LCRA TSC will not require the Supervisory Interface Panel. Both installations require front and back access. RTUs shall be capable of control (DO), status (DI), analog telemetering (AI) or interrogating select IEDs with a RS-232 connection by DNP protocol.

**LCRA TSC Responsibility**
LCRA TSC shall provide, install and maintain:
- An LCRA TSC RTU.
- Communication system between LCRA TSC SOCC and the RTU.
- Cable and conduit between LCRA TSC equipment and the RTU.
- Termination between LCRA TSC RTU and Customer SCADA cables.

**Customer Responsibility**
The Customer shall provide, install and maintain:
- Analog load values per transformer – MW, MVar, Amps.
- Analog values for customer owned transmission lines – MW, MVar, Amps, and kV.
- Analog values from the IED via DNP utilizing RS-232 connection(s) as an option.
- SCADA control and status for LCRA TSC’s use per the interconnect agreement for Customer-owned and remotely switched equipment directly connected to LCRA TSC transmission system.
- Cables from the Customer panel(s) to the LCRA TSC RTU SIP.
- Inter-control house cabling, including fiber connectivity between patch panels.
- Schematics and wiring diagrams for Customer equipment connected to the LCRA TSC’s RTU.
- 120 VAC and 125 VDC power sources for LCRA TSC RTU.
**Synchrophasor Measurement Unit (PMU)**

LCRA TSC may provide, install and maintain, as required by ERCOT Market Rules, the following equipment:

- PMU.
- Communication system between LCRA TSC SOCC and the PMU.
- Cable and conduit between LCRA TSC equipment and the PMU.

2.1.7 **Grounding and Safety Issues**

Project specific requirements for grounding and safety issues are determined during the detailed design phase and documented in the engineering prints. Although the below information guides the user with certain design criteria, every grid is unique and must be designed as such.

LCRA TSC substations are designed to meet the following grounding requirements:

- Ground Potential Rise shall be less than 5,000 Volts.
- Ground Grid Resistance shall be less than 1 ohm.
- Step Potential within limits as specified by most current IEEE Std 80.
- Touch Potential within limits as specified by most current IEEE Std 80.
- All structures and equipment in the substation shall be properly grounded to the ground grid per IEEE Std 80 and IEEE Std 142.

The grounding conductor size is specified by the following table:

<table>
<thead>
<tr>
<th>kA</th>
<th>Grid Conductor</th>
<th>Tail Conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>80kA</td>
<td>500MCM CU</td>
<td>750 MCM CU</td>
</tr>
<tr>
<td>63kA</td>
<td>4/0 CU</td>
<td>500 MCM CU</td>
</tr>
<tr>
<td>40kA</td>
<td>4/0 CU</td>
<td>4/0 CU</td>
</tr>
</tbody>
</table>

Structure/Equipment Ground Conductor (Copper Clad) Table:

<table>
<thead>
<tr>
<th>kA (kV)</th>
<th>Tail Conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 kA (345-kV)</td>
<td>Bundle 19 No. 7 AWG</td>
</tr>
<tr>
<td>63 kA (138/345-kV)</td>
<td>19 No. 5 AWG</td>
</tr>
<tr>
<td>40 kA (138-kV)</td>
<td>19 No. 7 AWG</td>
</tr>
</tbody>
</table>
LCRA TSC shall be notified by interconnecting party of any new or modified structures and/or equipment to be installed in or adjacent to an LCRA TSC substation.

If LCRA TSC adds equipment in the facility owner’s substation/facility, LCRA TSC shall coordinate with the facility owner or their agent on grounding and safety issues to ensure grounding meets industry standards.

Transmission and Generation Facility connections to the LCRA TSC transmission system shall meet the most current version of the following industry standard:

- National Electric Code (NEC)
- National Electric Safety Code (NESC)
- IEEE Std 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

Transmission lines connecting to an LCRA TSC facility are required to have proper overhead shields and adequate structure grounding for at least 1 mile out of the substation. Transmission line structure grounding, as stated in the Transmission Line Engineering Standards Design document, is defined below:

- 10 ohms maximum grounding resistance at each structure is optimum.
- Where 10 ohms is not practical, attempt to obtain 20 ohms maximum grounding resistance.
- Where 20 ohms is not practical, perform an adequate analysis of the grounding systems and lightning performance for the entire transmission line and determine grounding resistance requirements for individual structures or groups of structures along the entire length of line.

### 2.1.8 Insulation and Insulation Coordination

All structures and equipment in the substation shall be properly designed to meet clearances per ANSI C37.32. The minimum substation Basic Insulation Levels (BIL) required within a LCRA TSC substation are shown below per the National Electrical Safety Code C2-2017, Table 110-1 & Figures 110-1 and 110-2:

Where an impenetrable fence is used, the safety zone clearance can be modified to account for the protection offered by the barrier. The sum of the height of the impenetrable barrier (H) and the distance from that point to the closest energized part (R1) must be greater than or equal to the sum of the dimension R and 1.5 m (5 ft.):

\[
R1 + H \geq R + 1.5 \text{m (5 ft.)}
\]

where,

- \( H \) = Height of impenetrable barrier
- \( R1 \) = Distance between point at height \( H \) and the closest energized part
- \( R \) = Dimension from table 110-1
Table 110-1: BIL Values for kV Classes

<table>
<thead>
<tr>
<th>Nominal voltage between phases</th>
<th>Typical BIL</th>
<th>Dimension “R”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>m</td>
</tr>
<tr>
<td>151–7200</td>
<td>95</td>
<td>3.0</td>
</tr>
<tr>
<td>13 800</td>
<td>110</td>
<td>3.1</td>
</tr>
<tr>
<td>23 000</td>
<td>150</td>
<td>3.1</td>
</tr>
<tr>
<td>34 500</td>
<td>200</td>
<td>3.2</td>
</tr>
<tr>
<td>46 000</td>
<td>250</td>
<td>3.3</td>
</tr>
<tr>
<td>69 000</td>
<td>350</td>
<td>3.5</td>
</tr>
<tr>
<td>115 000</td>
<td>550</td>
<td>4.0</td>
</tr>
<tr>
<td>138 000</td>
<td>650</td>
<td>4.2</td>
</tr>
<tr>
<td>161 000</td>
<td>750</td>
<td>4.4</td>
</tr>
<tr>
<td>230 000</td>
<td>825</td>
<td>4.5</td>
</tr>
<tr>
<td>230 000</td>
<td>900</td>
<td>4.7</td>
</tr>
<tr>
<td>345 000</td>
<td>1050</td>
<td>5.0</td>
</tr>
<tr>
<td>345 000</td>
<td>1175</td>
<td>5.3</td>
</tr>
<tr>
<td>345 000</td>
<td>1300</td>
<td>5.5</td>
</tr>
<tr>
<td>500 000</td>
<td>1550</td>
<td>6.0</td>
</tr>
<tr>
<td>500 000</td>
<td>1800</td>
<td>6.7</td>
</tr>
<tr>
<td>765 000</td>
<td>2050</td>
<td>7.1</td>
</tr>
</tbody>
</table>

*For current industry recommended values, refer to the latest revision of the National Electric Safety Code.
Surge Arrester and BIL Coordination

The arrester rating must be selected such that the maximum continuous power system voltage applied to the arrester is less or equal to the arrester’s continuous voltage capability. An arrester of the minimum practical rating is preferred for its
greatest margin of protection of the equipment. A minimum of 15% margin between arrester protective level and 83% of the equipment basic insulation level (BIL) is recommended.

### 2.1.9 Power Quality Impacts

**Voltage Fluctuations and Flicker**
Voltage fluctuations may be noticeable as visual lighting variations (flicker) and can damage or disrupt the operations of electronic equipment. IEEE Standard 519 provides definitions on limits on acceptable levels of voltage fluctuation. Load or system connections to the LCRA TSC system shall comply with the limits set by IEEE 519. If it is determined that the new connection is the source of the fluctuations, the necessary equipment to control the fluctuations to the limits identified in IEEE 519 is the responsibility of the Customer.

**Harmonics**
Harmonics can cause telecommunications interference, increase thermal heating in transformers, disable solid state equipment and create resonant overvoltage. In order to protect equipment from damage, harmonics must be managed and mitigated. The new connection shall not cause voltage and current harmonics on the LCRA TSC system that exceed the limits specified in IEEE Standard 519. Harmonic distortion is defined as the ratio of the root mean square (rms) value of the harmonic to the rms value of the fundamental voltage or current. Single frequency and total harmonic distortion measurements may be conducted at the connection point or other locations in the LCRA TSC system to determine whether the new connection is the source of excessive harmonics. If it is determined the new connection is the source of the harmonic voltage and currents, the necessary equipment to control the harmonics to the limits identified in IEEE 519 is the responsibility of the Customer.

**Voltage Transients**
Measures shall be taken to mitigate switching transients and their impact on surrounding systems.

**Phase Unbalance**
Unbalanced phase voltages and currents can affect protective relay coordination and cause high neutral currents and thermal overloading of transformers. To protect LCRA TSC and Customer equipment, the contribution from the new facilities at the connection point shall not cause a voltage unbalance greater than 1% or a current unbalance greater than 5%. Phase unbalance is the percent deviation of one phase from the average of all three phases.

System problems, such as a blown transformer fuse or open conductor on a transmission system, can result in extended periods of phase unbalance. It is the Customer’s responsibility to protect any of their connected equipment from damage that could result from such an unbalanced condition.
**Power Factor**

Generation entity reactive power must meet the requirements of the ERCOT Generation Interconnection or Change Request Procedure and ERCOT requirements.

### 2.1.10 Equipment Ratings

Customers shall make the ratings of their equipment or lines known to LCRA TSC for each POI. The owner of facilities shall make known their Facility Ratings to the operator of their Facilities. Reference NERC FAC-008.

The interconnection is preceded by an assessment of the capability of the existing transmission system to support the interconnection. This assessment will be used to determine the required minimum ratings for transmission facilities impacted by the proposed interconnection. Consideration of the life of equipment and long-term planning needs may result in equipment ratings above what is required to serve the requested interconnection.

The criteria for determining the required ratings for station equipment is provided below.

1. During any new transmission line project, all station equipment related to that line shall be designed such that the continuous rating of all station equipment is greater than or equal to the continuous rating of the new line. During any transmission line upgrade project, station equipment related to that line shall be upgraded as necessary such that the continuous rating of all station equipment allows for operating conditions described in 2.

2. Station equipment (circuit breakers, circuit switches, wave traps, jumpers, connectors, current transformers, relays, relay settings, etc.) connected in series with the conductor shall be upgraded (independent of a conductor upgrade) if either of the following two conditions are met:
   a. The continuous rating of the station equipment is less than or equal to 50% of the continuous rating of the conductor; or
   b. The loading through the station equipment during normal or single-contingency conditions is greater than or equal to 80% of the continuous rating of the station equipment.

Planned loading on autotransformers during normal, single or multiple contingency conditions shall be limited to 100% of the auto-transformer’s maximum megavoltampere (MVA) rating as specified by the manufacturer.

Planned transmission line loading shall be such that NESC line-to-ground clearances will be maintained for all anticipated normal and contingency conditions. Transmission system power flow shall not exceed 100% of the conductor thermal rating.
2.1.11 Operational issues (abnormal frequency and voltages)

Each Party shall, at each POI and at its own risk and expense, design, install, or cause the design and installation, (including all apparatus and necessary protective devices) on its side of the POI, so as to reasonably minimize the likelihood of voltage and frequency abnormalities, originating in the system of one Party, from affecting or impairing the system of the other Party, or other systems to which the system of such Party is interconnected.

Under-frequency load shedding and generator under-frequency relay settings must be maintained for prospective transfers consistent with ERCOT Nodal Operating Guides in order to maintain the dynamic stability of the interconnected system. See Section 2.6 of the ERCOT Nodal Operating Guides requirements for under-frequency relaying.

LCRA TSC shall periodically review its system to determine if under-voltage load shedding is necessary and shall coordinate with affected Parties as necessary.

System operating conditions may dictate limits outside of normal and contingency ratings.

2.1.12 Inspection Requirements for Existing or New Facilities

To maintain the reliability of the LCRA TSC transmission system, LCRA TSC reserves the right, upon request, to review the interconnecting party’s design schemes, equipment placement and ratings.

To maintain the reliability of the LCRA TSC transmission system, LCRA TSC reserves the right to conduct facility inspections of Generation and Transmission Facilities. The inspection of interconnection facilities is to observe and not to be construed as a formal engineering review of the interconnecting party’s compliance with, among other things, ERCOT Nodal Operating Guides, section 6.2.6, Requirements and Recommendations for ERCOT System Facilities.

Facility inspections shall be coordinated between the respective Project Managers and shall consist of, but not limited to, the following substation design categories:

- Substation/Switchyard
- Fence
- Steel Structures
- Concrete Foundations
- Grounding
- Bus & Fitting
- Control House
- Substation Equipment
• Telecommunications Equipment

Additionally, Section 6.2.5 (3) of the ERCOT Nodal Operating Guides states “The Facility Owner shall periodically test and inspect all components of the protective relay system to assure continued reliability. Identified deficiencies shall be corrected. Documentation demonstrating compliance with the Facility Owner’s maintenance and testing programs shall be supplied to ERCOT or NERC upon their request within 30 days.”

2.1.13 Communications and procedures during normal and emergency operating conditions

Normal Operations
The Transmission System Operator shall assist neighboring utilities and generation interconnects in implementing all transmission switching functions as necessary, according to associated interconnect agreements, good utility practice, regulator and statutory requirements, and to safely and efficiently operate the transmission bulk system.

The Transmission System Operator shall notify ERCOT and appropriate neighboring utility of any abnormal relaying configuration that may affect reliability.

The interconnecting party’s operation center is expected to fully cooperate with the LCRA TSC Transmission System Operators.

Emergency Operations
The Transmission System Operator shall render available emergency assistance to neighboring utilities and generation interconnects provided the neighboring utility or generation interconnect has completed implementation of its own emergency procedures. These actions by Transmission System Operator shall not, however, violate safety, equipment or regulatory or statutory requirements.

The Transmission System Operator shall not remove any facilities from service that would burden a neighboring utility or generation interconnect. If removal is necessary, the Transmission System Operator shall contact ERCOT and the affected neighboring utility or generation interconnect at the earliest possible time and explain the impact of removing such facilities.

The Transmission System Operator shall notify ERCOT and appropriate neighboring utility of any abnormal relaying configuration at LCRA TSC owned or operated facilities that may affect reliability.

The interconnecting party’s operation center is expected to fully cooperate with the LCRA TSC Transmission System Operators.
All load customers connected to the LCRA TSC system participates in the ERCOT Energy Emergency Alert (EEA). When ERCOT declares an EEA 3, LCRA TSC’s share of the load shed will be allocated to the customers proportionately based on their summer peak load ratio share. Customers shall communicate their ability and willingness to shed their own load. During an ERCOT declared EEA3 event, LCRA TSC SOCC Operators will shed load for Customers who cannot shed their own load.

2.2 Generation Interconnection Specific Requirements

The following requirements apply to generation resources requesting interconnection for transmission service at nominal voltage levels of 345-kV, 138-kV, and 69-kV. LCRA TSC requires the execution of an ERCOT Standard Generation Interconnection Agreement (SGIA), notice to proceed (NTP), and posting of financial security prior to commencing the design, procurement, and construction of the interconnection facilities for the POI and provision of transmission service to the Generator.

2.2.1 Planning for the Generation Interconnection

LCRA TSC follows the Generation Interconnection and Change Request process outline in section 5 of the ERCOT Planning Guide to evaluate requests to interconnect new generation facilities or to materially modify an existing interconnection by increasing the capability of existing generation facilities by 10 megawatts (MW) or greater. Interconnections less than 10 MW, LCRA TSC follows the NERC FAC-002-2 standard. LCRA TSC evaluates existing generation interconnections through annual transmission assessments.

2.2.2 Voltage Level and MW and MVAR Capacity or Demand at Point of Interconnection (POI)

Generation facilities connecting to the ERCOT Transmission Grid with output generator unit rating of greater than 20 MVA or connected to a POI that have gross generating unit ratings aggregating to greater than 20 MVA must provide ERCOT Voltage Support Services (VSS) as required under ERCOT Nodal Protocol 3.15, Voltage Support.

2.2.3 Voltage, Reactive Power, and Power Factor Control

Power Factor (ERCOT requirement)

- Generator 95% leading and lagging

Generators shall be able to remain online and delivering power during voltage disturbances up to the time periods and associated voltage levels set forth in
NERC Reliability Standards and ERCOT Requirements for voltage ride-through capability.

ERCOT and/or LCRA TSC will establish a voltage profile at the POI for new and existing generators. The voltage profile is reviewed two times each year by ERCOT and LCRA TSC for interconnected generation and updated based on changing system needs. LCRA TSC in coordination with ERCOT may work with Generators to change the voltage set point in real time based on system conditions. The voltage set point at the POI for generating facilities shall be established per guidelines outlined in ERCOT Nodal Protocol 3.15 – Voltage Support and ERCOT Operating Guide 3.15.2 – Generation Resource Requirements Related to Voltage Support. Generator Operators shall maintain the voltage at the POI within the bandwidth of the voltage set point in conformance with ERCOT Nodal Protocols and Operating Guides.

2.2.4 System Protection and Coordination

The Generator will provide a line protection panel for Generator’s interconnecting line at the Generator’s facilities, which will coordinate with the LCRA TSC line panel(s) at the LCRA TSC Substation.

The Plant and the Generator Interconnection Facilities shall be designed to isolate any fault, or to disconnect from or isolate any abnormality that would negatively affect the ERCOT system. The Generator shall be responsible for protection of its facilities. In particular, Generator shall provide relays, circuit breakers, and all other devices necessary to promptly remove any fault contribution of the generation equipment to any short circuit occurring on the LCRA TSC system. Such protective equipment shall include, without limitation, a disconnect device or switch with the appropriate interrupting capability to be located within the Generator Interconnection Facilities. In addition to faults within the Plant and the Generator Interconnection Facilities, Generator shall be responsible for protection of such facilities from such conditions as negative sequence currents, over or under frequency, sudden load rejection, over or under voltage, generator loss of field, inadvertent energization (reverse power), uncleared transmission system faults and other special requirements as specified by ERCOT (SSO, SSCI, etc.).

The Plant and the Generator Interconnection Facilities shall have protective relaying that is consistent with the protective relaying criteria described in the ERCOT Requirements and NERC standards. If reasonably requested by LCRA TSC, Generator shall, at its expense, provide corrections, upgrades, or additions to existing control and protective equipment required to protect the ERCOT system or to comply with government, industry regulations, or standard changes.

The Generator’s protective relay design shall incorporate the necessary test switches to enable complete functional testing. The required test switches will be placed such that they allow operation of lockout relays while preventing breaker
failure schemes from operating and causing unnecessary breaker operations and tripping generator units.

Generator shall install sufficient disturbance and fault monitoring equipment to thoroughly analyze all system disturbances of the generation system. This equipment shall monitor the voltages at major nodes of the system, current at major branches, breaker and switch positions, and provide sequence of event reporting and relay event reporting to analyze a system disturbance. LCRA TSC shall provide for disturbance and fault monitoring equipment in the LCRA TSC Substation. The disturbance and fault monitoring for both Generator and LCRA TSC shall be consistent with the disturbance monitoring requirements described in the ERCOT Requirements and NERC standard.

Prior to modifying any relay protection system design or relay setting involving the connecting facilities between the two Parties, Generator shall submit the proposed changes to LCRA TSC for review and approval. LCRA TSC’s review and approval shall be for the limited purpose of determining whether such proposed changes are compatible with the ERCOT transmission system.

In accordance with Good Utility Practice and ERCOT and NERC standards, LCRA TSC shall determine requirements for protection of the POI and the zone of protection around the POI and shall specify and implement protection and control schemes as necessary to meet such requirements. Generator shall have the right to review and comment on the necessary protection requirements, and such comments shall not be unreasonably refused by LCRA TSC when determining such requirements. LCRA TSC shall coordinate the relay system protection between Generator and the ERCOT system.

The Generator shall provide in Aspen One-Liner format the short circuit model for the Generator Interconnection Facilities, the generators and collector facilities prior to the protective relays settings being calculated and in no case later than 60 days prior to the initial actual in-service date.

2.2.5 Metering and Telecommunications

Metering and telemetry of data shall be accomplished in accordance with ERCOT Requirements. The specific ERCOT-polled settlement ("EPS") Meters, telemetry and communications equipment to be installed, and the data to be telemetered, are described in Exhibit “C” of the SGIA.

At the Point of Interconnection, the EPS Metering Facilities shall be owned by LCRA TSC. However, the metering values may be accessed, at request, by the Generator or its Qualified Scheduling Entity via LCRA TSC’s Third Party Metering Agreement. The telemetry values can be obtained by the Generator via an ICCP link with ERCOT.
LCRA TSC shall notify the Generator at least five (5) working days in advance of any planned maintenance, inspection, testing or calibration of the EPS Metering Facilities, unless otherwise agreed to in writing. The Generator, or its designated representative, shall have the right to be present for these activities and to receive copies of any documents related to the procedures and results.

Prior to the connection of the GIF to the TIF, acceptance tests shall be performed by the owning Party to ensure the proper functioning of the EPS Metering Facilities, telemetry and communications equipment associated with the POI and both Parties’ interconnection facilities, and to verify the accuracy of data being received by LCRA TSC, ERCOT and the Generator. All acceptance tests shall be performed consistent with ERCOT Requirements.

LCRA TSC shall, in accordance with Good Utility Practice and ERCOT Requirements, specify communications facilities necessary for the effective operation of the Plant and the GIF with the LCRA TSC System. Such communication facilities shall be included in Exhibit “C.” The Generator shall make arrangements to procure and bear the cost of such facilities.

Each Party shall promptly advise the other Party if it detects or otherwise learns of any metering, telemetry or communications equipment errors or malfunctions that require the attention and/or correction by the other Party. The Party owning such equipment shall correct such error or malfunction as soon as reasonably feasible in accordance with ERCOT Requirements.

**ERCOT Polled Settlement (EPS) Meters**

In accordance with ERCOT requirements, EPS Meters shall be installed at substations where generation over 10 MW is interconnected to the substation bus. The EPS metering point shall have primary and backup meters that can provide power and energy values for billing purposes. If the metering point is bidirectional, extended range Current Transformers (CT) shall be installed to measure the large amount of generation into the substation under normal conditions and the small amount of back-feed (station service) to the Generator when the generation facilities are not online. All EPS Metering Facilities shall comply with, and be certified with, ERCOT protocols and metering guidelines.

### 2.2.6 Maintenance Coordination

The Parties agree to operate and maintain their systems in accordance with Good Utility Practice, National Electric Safety Code, ERCOT Requirements, PUCT Rules and all applicable laws and regulations. Subject to any necessary ERCOT approval, each Party shall provide necessary equipment outages to allow the other Party to perform periodic maintenance, repair or replacement of the Transmission Interconnection Facilities (TIF) or Generation Interconnection Facilities (GIF) as the case may be. Such outages shall be scheduled at mutually agreeable times, unless conditions exist which a Party believes, in accordance with Good Utility
Practice, may endanger persons or property. No changes shall be made in the normal operation of the POI without the mutual agreement of the Parties except as otherwise provided herein. All testing of the Plant that affects the operation of the POI shall be coordinated between LCRA TSC, ERCOT, and the Generator, and shall be conducted in accordance with regulatory and statutory requirements, including NERC and ERCOT Requirements.

Any outages needed at the Substation POI for the Resource Entity shall be coordinated with the SOCC Outage Coordinator as soon as possible for outage studies and submission to ERCOT.

2.2.7 Synchronizing of Facilities

The Generator will be responsible for the proper synchronization of its facilities with the LCRA TSC transmission system, in accordance with the ERCOT Resource Integration Handbook and associated ERCOT Requirements. LCRA TSC is not responsible for the design of the Facilities’ synchronization relaying. It is highly recommended that the Generator consult with the equipment manufacturers when setting relays associated with the protection of their equipment.

2.2.8 Provision of Facilities for the Interconnection by LCRA TSC

LCRA TSC will provide the following interconnection facilities:

- LCRA TSC will own the necessary interconnection facilities inside the LCRA TSC Substation.
- LCRA TSC will own the interconnection facilities to, and including, a POI dead-end structure (POI Structure) located outside of the LCRA TSC Substation, no less than 30 feet from the substation fence.
- LCRA TSC will own an OPGW splice box on the LCRA TSC-owned POI Structure and make splices at the splice box with the Generator’s OPGW.
- LCRA TSC will review and approve the Generator’s conductor and static wire tensions connecting to the LCRA TSC-owned POI Structure to ensure tensions meet the structure requirements.
- LCRA TSC will own conductor (including jumpers) and OPGW between the LCRA TSC-owned POI structure and the LCRA TSC-owned A-frame at the LCRA TSC Substation.
- Subject to LCRA TSC review, acceptance, and approval, LCRA TSC will acquire the necessary real property rights and/or easement(s) from the Generator for construction of the LCRA TSC interconnection facilities.
- LCRA TSC will provide vehicle access to the third party fence and to the TL Easement either on LCRA TSC substation property or via an off-property access easement.
- The substation control house will be set back a minimum of 50 feet from substation fence.
- Telecommunications equipment bay(s) shall be as close to the telecom tower as possible within the control house to minimize cable distances.

- Telecommunications towers will be located on the LCRA TSC substation property such that:
  - Provides third party access; where third party access is required, a separate telecom shelter will be constructed and telecom shelter and control house will be connected via fiber.
  - Does not compromise substation physical security requirements.
  - Has no more than 20 feet distance between the telecom shelter and the telecom tower, and no more than 20 feet distance between the customer shelter and the telecom tower.
  - Cable routing will be above ground (via ice bridge or other structure).
  - Has an ice bridge for distances greater than 5 feet.
  - If the customer cannot be accommodated in telecommunications shelter; the customer shelter will be constructed by the customer.
  - Third party fence will be same type of security fence as remainder of substation fence.
  - Substation site design will provide drivable access outside of the LCRA TSC substation fence to “third party fence” area.

The general configuration for the LCRA TSC interconnection facilities for generation interconnection requests at existing LCRA TSC Substations (Brownfield) and new LCRA TSC Substations (Greenfield) are depicted below:
2.2.9 Provision of Facilities for the Interconnection by Generator

The Generator will provide the following for the generation interconnection facilities:

- One radial circuit with necessary material to dead-end and connect to the LCRA TSC-owned POI dead-end structure (POI Structure) outside the LCRA TSC Substation;
- A full tension, dead-end, structure located near the LCRA TSC-owned POI Structure (Generator shall coordinate the height of this structure, the arrangement of the phases, and the exact location of the structure with LCRA TSC);
- Fiber optic cable (Corning SMF-28e or equivalent 72 fiber, single-mode, fiber optic OPGW) from Generator's interconnection substation control building to the LCRA TSC OPGW cable splice box on the LCRA TSC POI Structure at the Point of Interconnection;
- The Generator will terminate conductor and OPGW at the LCRA TSC-owned POI structure.
- Generator’s interconnection substation(s) including control building(s), step-up transformer(s), transformer protection package(s), circuit breaker(s),
disconnect switch(es), and protective relaying panels for the Generator’s line protection that will coordinate with the LCRA TSC line panels at the LCRA TSC Substation;
  o The Generator will configure the transmission voltage side winding of the Plant’s Generation Step-Up Unit (GSU) to have a grounded wye configuration.
- Multi-ported RTU(s) and panels to provide breaker status, telemetry and energy data from the Generator’s interconnection substation(s) to the Plant, Generator and ERCOT;
- Associated structures, bus-work, conductor, connectors, grounding, conduit, control cable, foundation work, perimeter fencing, grading/dirt work and any appurtenances necessary for construction and operation of the generation interconnection facilities;

The Generator will provide LCRA TSC:
- For interconnection requests at existing LCRA TSC Substations (Brownfield):
  o The Generator will acquire and convey easement(s) for the LCRA TSC interconnection facilities located outside the LCRA TSC Substation property, including the POI structure. If direct access from the existing LCRA TSC Substation property is not feasible, the Generator will acquire and convey an access easement to the LCRA TSC interconnection facilities. The acquisition by LCRA TSC of the above easement(s) are subject to LCRA TSC review, acceptance, and approval.
- For interconnection requests at new LCRA TSC Substations (Greenfield):
  o The Generator will acquire and convey to LCRA TSC the suitable real property rights for the new LCRA TSC Substation and related interconnection facilities. If required, the Generator will construct the access road to the LCRA TSC Substation and convey an access easement to LCRA TSC. The Generator will acquire and convey any easements required for the for the LCRA TSC interconnection facilities, subject to LCRA TSC review and approval. The acquisition by LCRA TSC of the above real property rights and easements are subject to LCRA TSC review, acceptance and approval.

2.3 Transmission Interconnection Specific Requirements

The following requirements apply to Transmission Service Provider (TSP) or Distribution Service Provider (DSP) interconnection requests for transmission service at nominal voltage levels of 345-kV, 138-kV, and 69-kV.

2.3.1 Planning for the Load Interconnection

LCRA TSC evaluates load interconnections through annual transmission assessments and individual load interconnection requests. LCRA TSC performs the annual transmission assessments by processing and applying load forecasts
provided annually by load-serving entities through the ERCOT Annual Load Data Request (ALDR) process to the SSWG and DWG cases. Through annual assessments, LCRA TSC is able to evaluate transmission system performance when the load interconnection request is provided through the ERCOT ALDR process for requests with energization dates more than 36 months after the ERCOT ALDR submittal is completed. For load interconnection requests received outside of the ERCOT ALDR process or with an energization date sooner than 36 months following the ERCOT ALDR submittal, LCRA TSC applies load data obtained from the entity requesting the interconnection to the SSWG and DWG cases used to evaluate the impact of the interconnection.

When transmission system improvements are needed to integrate the load interconnection into the transmission system, LCRA TSC coordinates with the owners of impacted facilities to develop the project scope and cost. LCRA TSC follows the requirements provided in ERCOT Protocol Section 3.11.4 for seeking ERCOT review of the project. Smaller transmission improvements (generally those less than $25 million, not requiring modifications to the 345-kV system, and not requiring an amendment to LCRA TSC’s Certificate of Convenience and Necessity) do not require ERCOT review. Larger transmission improvements may require an ERCOT endorsement. Upon completing the ERCOT review process, including obtaining ERCOT endorsement when required, LCRA TSC presents the project to its Board of Directors for approval and funding.

LCRA TSC communicates the plan for new or modified facilities to ERCOT through the SSWG and DWG case-building process upon approval of the project by the LCRA TSC Board of Directors.

2.3.2 Voltage Level and MW and MVAR Capacity or Demand at Point of Interconnection (POI)

Anticipated MW and MVAR demand is determined by the interconnecting party at a POI and must be communicated to LCRA TSC for planning purposes. Annual updates are accepted through the ERCOT ALDR process. ERCOT power factor requirements must be followed for all connected loads.

2.3.3 Voltage, Reactive Power, and Power Factor Control

Power Factor (ERCOT requirement)

- Load 97%

LCRA TSC reviews voltage performance at substations with interconnected loads during the initial interconnection study and through subsequent annual assessments.
2.3.4 System Protection and Coordination

For interconnections of power transformers with capacity of 10 megavolt ampere (MVA) and below, fuse protection is allowed if the utilization of the fuse protections does not compromise reliability. However, for interconnection of power transformers above 10 MVA, a fully-relayed circuit switcher or circuit breaker installation is required.

Distribution protection schemes shall be coordinated with the transformer owner.

2.3.5 Maintenance Coordination

The Parties shall, consistent with maintaining good operating practices, coordinate their operations to maintain continuity of services to their respective customers to the extent practicable. Planned facility maintenance by either Party that will cause a deviation from the normal power and energy flow at a POI shall be scheduled at a mutually agreeable time. No changes shall be made in the normal operation of a POI without the mutual agreement of the Parties. The Parties shall, to the extent necessary to support continuity of operations, coordinate the operation of protective devices on the facilities they operate in the proximity of the Points of Interconnection which might reasonably be expected to affect the operation of facilities on the other Party’s system. All testing of the facilities that affects the operation of the POI shall be coordinated between LCRA TSC, the TSP and ERCOT and shall be conducted in accordance with regulatory and statutory requirements, including NERC and ERCOT Requirements.

2.3.6 Synchronizing of Facilities

Synchronizing at transmission tie points shall be determined on a site-specific basis as consideration for ERCOT-approved Black Start plans. If applicable, synchronizing requirements shall be stated in the appropriate Interconnection Agreement.

2.3.7 Provision of Facilities for the Interconnection by LCRA TSC

The provision of facilities by LCRA TSC described below is limited to typical requests for interconnection. Requests that result in other interconnection options shall be evaluated on a case-by-case basis.

Transmission Facilities
- For interconnecting a substation (load-serving and/or autotransformer) or a transmission line to an existing LCRA TSC transmission line, at minimum, LCRA TSC shall provide all series elements on the existing LCRA TSC transmission line and the termination equipment for the interconnecting transmission element(s).
• For interconnecting a transmission element to an existing LCRA TSC substation, at minimum, LCRA TSC shall provide the termination equipment for the new transmission element.

**Metering Facilities**

• If requested by the interconnecting entity, LCRA TSC shall provide the metering facilities where LCRA TSC does not provide transformation facilities and it is cost-effective to LCRA TSC. If metering CT is internal, the transformer owner owns the CT.

• A Wholesale Metering Service Agreement (WMSA) shall be developed and executed.

**Load-interconnecting substations:**

• Where a main-and-transfer bus configuration is installed, the installation may include a back-up protection device (e.g. fuse) during periods when the transfer bus is providing the service.

• Where a by-pass is used for the interrupting device (e.g. circuit switcher), a back-up relaying scheme shall be provided.

### 2.4 Transformation Interconnection Specific Requirements

The following requirements apply to Distribution Service Provider (DSP) interconnection requests for transformation service at nominal voltage levels of 24.9-kV or 12.5-kV.

#### 2.4.1 Voltage Level and MW and MVAR Capacity or Demand at Point of Interconnection (POI)

LCRA TSC provides Transformation Service at nominal voltage levels of 24.9-kV or 12.5-kV and it is limited to a load-serving function.

#### 2.4.2 System Protection and Coordination

For transformation and distribution (i.e., load-serving) interconnecting facilities, the Interconnection Agreement (Article 6) includes, in part, protection requirements.

#### 2.4.3 Maintenance Coordination

The Parties shall, consistent with maintaining good operating practices, coordinate their operations to maintain continuity of services to their respective customers to the extent practicable. Planned facility maintenance by either Party that will cause a deviation from the normal power and energy flow at a POI shall be scheduled at a mutually agreeable time. No changes shall be made in the normal operation of a POI without the mutual agreement of the Parties. The Parties shall, to the extent
necessary to support continuity of operations, coordinate the operation of protective devices on the facilities they operate in the proximity of the Points of Interconnection which might reasonably be expected to affect the operation of facilities on the other Party’s system. All testing of the facilities that affects the operation of the POI shall be coordinated between LCRA TSC, the DSP and ERCOT and shall be conducted in accordance with regulatory and statutory requirements, including NERC and ERCOT Requirements.

2.4.4 Provision of Facilities for the Interconnection by LCRA TSC

Transformation Facilities

- LCRA TSC shall provide the substation property (including fence, control house, ground grid, battery bank, HVAC system, yard lights and is responsible for vegetation management) at substations where LCRA TSC provides transformation service. The LCRA TSC transformation facilities include, but are not limited to, the transformer, transformer protection, voltage regulation, low-voltage bus and associated bus bays with switches, and high-side disconnecting device including switch in front of fuse or circuit switcher.
- If requested by the interconnecting entity, at substations where LCRA TSC does not own or will not own the property, LCRA TSC may provide the transformation facilities if it is cost-effective to LCRA TSC.
- LCRA TSC does not provide low voltage facilities (e.g., low voltage circuit breaker, foundation, jumpers, controls and distribution surge arresters).
- A Transformation Service Agreement (TSA) shall be developed and executed.

Metering Facilities

- LCRA TSC shall provide the metering facilities (including CTs, PTs and meter panel(s)) where LCRA TSC provides transformation facilities.
- A Wholesale Metering Service Agreement (WMSA) shall be developed and executed.

2.5 Distributed Generation

Distributed Generation (DG) is defined as an electrical generating facility located at an end-use customer’s point-of-delivery of 10 MW or less and connected to a voltage less than 60-kV, which may be connected in parallel operation to the utility system. DG includes but is not limited to, combustion turbine generators, batteries/fuel cells, or inverter based renewable generation resources (i.e. solar or wind).

LCRA TSC is not a DSP and does not own distribution voltage (below 60-kV) facilities other than those facilities that are associated with LCRA TSC transformation facilities.
LCRA TSC can provide transformation service to a DSP through its transformers for voltage step-up service through a substation transformer which is subject to LCRA TSC’s Wholesale Transformation Service tariff. The voltage step-up service is contingent upon review and approval by LCRA TSC of all related equipment associated with providing this service. The service will be specified in the Transformation Service Agreement between LCRA TSC and the requesting DSP.

DG interconnection requests for a POI to the low voltage side of LCRA TSC transformation facilities (regardless of the capacity level) will be directed to the local DSP.

In accordance with LCRA TSC’s tariff and through a WMSA with the interconnecting DSP, LCRA TSC may provide wholesale metering services to meter the DG installation.

**Notifications**
LCRA TSC shall be notified by the Transmission Service Customer of planned DG systems rated >50 kW intended for parallel operation that will be served off LCRA TSC transmission and transformation facilities.

DG facilities interconnected to Transmission Service Customer systems <60-kV shall be documented via the customer-submitted load forecast.

**Assessments**
A DG impact study may be performed for DG installations rated >50 kW intended for parallel operation.

**Metering Facilities**
Specialized revenue metering, instrument transformers, and communications may be required at the point of common coupling (PCC) to account for bi-directional energy flows and for revenue settlement purposes. Requirements may vary based on the DG size and application (e.g. Wholesale Storage Load (WSL) or Emergency Response Service (ERS)).

**Relaying and Control**
Depending on the results of a DG impact study, specialized protective relaying may be required to provide reverse-power, under-frequency, under-voltage, over-voltage, communication-assisted transfer tripping, or other protection requirements. Requirements vary based on the DG size and technology.

**Reference Documents**
PUC §25.211. Interconnection of On-Site Distributed Generation (DG)
PUC §25.212. Technical Requirements for Interconnection and Parallel Operation of On-Site Distributed Generation