



Generating Facility Interconnection Guide

ATC

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American Transmission Company (ATC) is a member of the Midcontinent Independent System Operator (MISO)¹. ATC owns, plans, constructs, operates, maintains and will expand its transmission facilities to provide adequate and reliable transmission of power. ATC provides nondiscriminatory service to all customers, supporting effective competition in energy markets without favoring any market participant. ATC owns more than 10,000 miles of transmission lines and 582 substations in portions of Wisconsin, Michigan, Minnesota, and Illinois and is interconnected with more than 60 Generating Facilities owned by municipalities, cooperatives, independent power producers and investor-owned utilities. In general, ATC accommodates additions or modifications for generation customers according to the requirements of Attachment X of MISO's Open Access Transmission, Energy and Operating Reserve Markets Tariff. ATC will collaborate with MISO and the Customer in development and implementation of the appropriate interconnection solution in response to the Customer's requested need. The Customer is directed to MISO for formal submittal of an Interconnection Request for a Generating Facility for each of the following types of projects:

1. Interconnection of new generating capacity to the Transmission System.
2. Modifications² to existing interconnected Generating Facilities, as defined by MISO.

This Generating Facility Interconnection Guide is intended to supplement MISO requirements and address ATC's role within that process.

Any questions or requests for additional information concerning Generating Facility interconnection to the Transmission System should be directed to:

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 ATC Interconnection
 Solutions
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¹ Capitalized terms are defined in the Glossary in Appendix A of this Guide or in Attachment X of MISO's Open Access Transmission and Energy Markets Tariff.

² It is possible that the Customer may have a proposed modification that MISO would not consider a "Material Modification" or "substantive modification to the operating characteristics of an existing Generating Facility" according to Section 2.1 of Attachment X of the MISO Tariff but may otherwise have an impact on the Transmission System or generation-transmission interconnection. Consult Section 7.0 and Appendix B of this Guide for ATC's requirements pertinent to such proposed modifications.

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1 Introduction

1.1 Purpose

As a transmission-only utility, ATC partners with its interconnected and interconnecting Customers for long-term, successful Generating Facility Interconnections. This Generating Facility Interconnection Guide describes the general requirements for the connection of generation to the Transmission System. Additional specific interconnection facility requirements may be identified during studies conducted in connection with the particular Customer-proposed project. The Federal Energy Regulatory Commission (FERC) set forth the process for interconnection of generation to the Transmission System in its Order No. 2003 and, for non-synchronous generation, in its Orders No. 661, 661-A, and 827.³ This process is administered by the Midcontinent Independent System Operator (MISO) according to the Attachment X Generator Interconnection Procedures (GIP) of its Open Access Transmission, Energy and Operating Reserve Markets Tariff (Tariff). The GIP governs the interconnection of new or increased generating capacity to the transmission facilities subject to MISO Tariff, including ATC's Transmission System. The general facility requirements described herein are consistent with the Facility Interconnection Requirements promulgated in Mandatory Reliability Standard FAC-001 Requirement R1 (as modified from time-to-time).

New Generation

The primary application of this Guide is for the interconnection of new generator interconnection projects submitted through the MISO Generator Interconnection Queue, interconnecting to the ATC Transmission System. General requirements for new generating facilities, at new proposed ATC substations, non-ATC substations, or existing ATC substations are further described in Sections 3.1.1, 3.1.2. & 3.1.3.

Existing Generation

It is essential that the Customer and ATC maintain updated details on the characteristics of Generating Facilities interconnected to the Transmission System. Modification of an existing Generating Facility may impact the Transmission System, the interconnection service provided to the Customer or other Customers at other locations. Therefore, the Customer is to notify ATC of planned or proposed modification according to Section 7.7 of this Guide and ATC will provide guidance on how to proceed.

Distributed Energy Resources

This Guide does not apply to generation connected to distribution systems that are themselves interconnected to the Transmission System (generally those operating at voltages below 50 kV). For information concerning such distribution-connected generation typically referred to a Distributed Energy Resources, reference the *ATC Load Interconnection Guide* on the ATC Web site at <https://www.atcllc.com/customer-engagement/connecting-to-the-grid/>.

³ *Standardization of Generation Interconnection Agreements and Procedures*, Order No. 2003 *et seq.*, Fed. Reg. Vol. 68, No. 160 (August 19, 2003), Order 661, 111 FERC ¶ 61,353 (June 2, 2005), Order 661-A, 113 ¶ 61,254 (December 12, 2005), and Order 827, 155 ¶ 61,277 (June 16, 2016).

1.2 ATC's Role

The ATC Interconnection Solutions group coordinates ATC's collaboration with the Customer and MISO throughout the following processes:

New Generation

As coordinated with MISO, ATC performs the Interconnection System Impact Study and Facilities Study within the GIP Definitive Planning Phase. ATC also performs verification analysis prior to commercial operation of the Generating Facility using the Customer's final as-built information to ensure that the Generating Facility characteristics, as were provided by the Customer for the interconnection studies, are consistent with the Facility, as installed. Additionally, ATC will review the role of any proposed Generating Facility in ATC's Black Start System Restoration Plan.

Existing Generation

For Customer planned or proposed modifications to existing Generating Facilities that may potentially impact the Transmission System or interconnection, ATC will perform analysis as described in Section 7 of this Guide to determine impacts and the time and costs of associated upgrades.

1.3 Legal and Regulatory Requirements FERC

1.3.1 Throughout the interconnection process, ATC adheres to the FERC Standards of Conduct⁴ as well as the rules relating to critical energy infrastructure information. A Generator Interconnection Agreement among MISO, the Customer, and ATC will be filed with FERC before the facility is energized. A Standards of Conduct Agreement (SOCA) will also be needed between ATC and the Interconnection Customer.

1.3.2 State

The states in which ATC operates have their own requirements for generator siting and construction. This Guide is not intended to describe those requirements. The Customer will be responsible for compliance with the specific state requirements and processes. Further information regarding these requirements and processes is available from the pertinent state regulatory agency:

- Public Service Commission of Wisconsin - <http://www.psc.wi.gov/>
- Michigan Public Service Commission - <http://www.michigan.gov/mpsc/>
- Minnesota Public Utilities Commission - <https://mn.gov/puc/>
- Illinois Commerce Commission - <http://www.icc.illinois.gov/>

1.3.3 NERC

ATC is registered as a Transmission Owner, Transmission Operator and Transmission

⁴ Order No. 888, 61 FR 21540 (May 10, 1996)

Planner, with both the Midcontinent Reliability Organization (MRO) and ReliabilityFirst Corporation (RFC) under the requirements of the electric reliability organization, the North American Electric Reliability Corporation (NERC).

ATC and the Customer will plan, design, construct, own, operate, and maintain their respective facilities within the Transmission System, Interconnection Facilities, and Generating Facility consistent with applicable Reliability Standards.

2 New or Modified Generating Facility Interconnection Process

The specific steps and requirements of the process for interconnecting new generating capacity to ATC's Transmission System are set forth in detail in MISO's Business Practices Manual (BPM) – Generator Interconnection. This guideline is intended to provide further information concerning how ATC can assist the Customer throughout this process.

2.1 Initiation and Development

A Customer request for interconnection to MISO begins with the MISO Pre-Queue and Application Review process. The specific requirements of the interconnection request are available on the MISO website Generator Interconnection page at: <https://www.misoenergy.org/planning/generator-interconnection/>

In addition to the formal mechanisms, ATC encourages communication throughout the process and offers meeting with prospective generator Customers prior to and during the development of the interconnection request.

2.2 Interconnection Studies

2.2.1 MISO Related Interconnection Studies

ATC will work with the Customer throughout the study process, including participating in Ad-Hoc meetings the Customer may request beyond the standard queue process discussions. The MISO queue process involves a series of interconnection studies including preliminary system impact, final system impact, interconnection facilities, and network upgrades facilities studies, as shown on this webpage: https://www.misoenergy.org/planning/generator-interconnection/GI_Queue/ and is further detailed the Attachment X of the MISO Tariff.

The Customer may consult the MISO Business Practice Manual for Generator Interconnection for further details on milestones and the scope, timeframe and deposits required for each of the Interconnection Studies.

2.2.2 Other ATC Interconnection Studies and Considerations

The power generation and transmission landscape is rapidly evolving due to the growing use of new and emerging technologies. While the use of these technologies provides unique benefits, if not properly applied, their interactions with the system can outage or damage equipment or result in degraded system performance. To ensure that this does not occur, special studies are often required

that have not traditionally been part of the planning process. This section is intended to provide an introduction to these studies, the phenomena they analyze, and when they might be required. It is not meant to be an exhaustive list of all possible new concerns or types of studies but rather a high-level overview to illustrate the possible and probable areas of concern.

The implementation of new generation or transmission devices utilizing power electronic inverter-based equipment is one example of a situation which may require additional special studies. Alternatively, the siting of new traditional generation or transmission devices near existing devices with power electronic conversion equipment may also require additional studies.

The special studies are typically electro-magnetic transient (EMT) studies which ATC prefers to perform using the PSCAD/EMTDC software. As such, appropriate detailed PSCAD models will be required to be delivered for all projects which utilize power electronic inverter-based technologies. The use of a generic PSCAD model will typically not produce simulation results of acceptable accuracy. Models using binary/DLLs of the actual control and protection code from the inverters and control and protection systems are usually required to accurately model complete device control details. Acceptability of specific models will be determined when they are delivered. ATC can be contacted to provide more detailed information on PSCAD model preferences and supported simulation features.

The specific types of studies of concern may include, but are not limited to, the following:

- a. Studies required in “weak grid” conditions:
 - Control interactions between multiple nearby power electronic or inverter-based devices (type 3 or 4 wind machines, solar PV, HVDC, STATCOM, SVC, etc.)
 - Sub-synchronous studies (near inverter-based generation, HVDC, SVCs, STATCOMs, etc.). For example, Sub-Synchronous Torsional Interaction (SSTI), Sub-Synchronous Resonance (SSR), Sub-Synchronous Oscillations (SSO), Sub-Synchronous Control Interaction (SSCI), etc.
 - Fault ride through performance verification (e.g., to support FERC Order 828, PRC-024-2, etc.). This could be especially applicable to inverter-based generation which may have unusual responses during and after fault conditions.
 - Other “weak grid” related studies for devices connecting to an area with low short circuit strength (voltage regulation, other control or protection system tuning, etc.)
- b. Control interaction studies required for non-weak grid conditions (e.g., power electronic/inverter devices in close proximity to each other, etc.)
- c. A delayed current zero study is required if the generator is a cylindrical or wound rotor type of machine.
- d. Power quality around generators or other devices utilizing power electronic inverters; especially those with IGBTs. This includes harmonics, interharmonics, and other applicable power quality topics. This may apply to power electronic or inverter-based devices (type 3 or 4 wind machines, solar PV, HVDC, STATCOM, SVC, etc.)

Screening level studies and engineering judgment will be used, as appropriate, to determine the depth and breadth of detailed analysis required for the concerns and topics outlined above.

2.2.3 Generator Material Modification Study Review Prior to Commercial Operation

To standardize and streamline the Generator Material Modification Study review process in ATC area (MISO's Tariff Attachment X Section 4.4), ATC requires that, when submitting a Generator Material Modification Study to MISO prior to Commercial Operation Date (COD), Interconnection Customers are to follow the instructions described in the ATC Area Generator Material Modification Study Review Template posted on <https://www.atcllc.com/customer-engagement/connecting-to-the-grid/> under the Generator Interconnection section.

2.3 Data Requirements

Information is required from the Customer during the interconnection study process under the GIP and throughout the life of the interconnected operation of the Generating Facility. Generally, the information required during the GIP is noted in the MISO BPM. Additional details are included in Appendix B of this Guide. Section 7 of this Guide addresses ATC's process for working with Customers to manage and maintain accurate data once new generating capacity achieves Commercial Operation.

2.4 Interconnection Agreement

After the Interconnection Studies are completed and prior to final design and construction of any required Network Upgrades, the Customer, ATC and MISO will execute a Generator Interconnection Agreement (GIA). The GIA sets forth a schedule of milestones for the construction of the Interconnection Facilities and Network Upgrades necessary to interconnect the proposed new generating capacity, as determined by the Interconnection Studies. The schedule reflects the expected time to obtain all necessary governmental and regulatory approvals and permits required for the construction and operation of the Generating Facility, Interconnection Facilities, and Network Upgrades.

The GIA includes an accurate description of the Customer's facility being interconnected along with a one-line drawing of the facility. The expectation is that the GIA facility description and drawings are an accurate reflection of the generation facility being installed and not just an indicative generic description of the interconnection facility.

The GIA also establishes the terms and conditions for the interconnected operation of the Generating Facility including, among other things, operational coordination, outage scheduling, coordination of planned and emergent maintenance, future modifications, billings and payments and other communications and coordination procedures. Some additional detail in this regard is provided in Section 7 of this Guide.

2.5 Coordination with Local Utilities

Generating Facility interconnection projects require significant coordination with other local utilities. As a transmission-only company, ATC does not provide local distribution utility services, but as a business partner, ATC supports the integration of new generation into its territory. The Customer is responsible for compliance with the requirements of the local distribution utilities (existing interconnected entities) and while this Guide is not intended to describe those requirements in detail, there are a number of typical issues that warrant consideration early in the interconnection process.

- a. Facilities locations and potential conflicts
 - Overhead distribution facilities
 - Underground distribution facilities
 - Delivery route for large equipment, including “crane-walk” plans for equipment installation
- b. Metering
 - Balancing authority metering (BA metering)⁵
 - Revenue metering
- c. Coordination of Substation Site Preparation at substation not owned by ATC
 - Expansion of substation site
 - Acquiring “Danger Tree” or other real estate easement rights adjacent to the substation expansion (if required).
- d. Temporary (construction) and permanent service
 - Auxiliary power

⁵ Consult ATC’s Coordination of Balancing Authority Business Practice for guidance on the coordination of Balancing Authority Area (BAA) facilities associated with generator interconnections. BA metering shall be located in the Customer’s collector substation and not located in either an ATC or other interconnected entity-owned substation. See Section 5.2 for additional information.

3 Design Requirements

3.1 Interconnection Configuration

An Interconnection Customer may interconnect at:

- a new substation interconnected to one of more ATC transmission lines, or
- an existing ATC substation under MISO functional control, or
- a substation owned by another interconnected entity of ATC.

The configuration of the interconnection substation will depend on several factors including, but not limited to the number and size of generating units connected, the nominal voltage of the transmission facilities to which the generation is being interconnected, the number of transmission outlets either existing or required and whether or not any of the transmission lines are part of a black start system restoration path. The configuration of the Interconnection Facilities will be determined through the study process. However, the exact transmission line and substation locations may be modified during the detailed design and regulatory processes.

3.1.1 Generator Interconnection at A New ATC Substation

For interconnection of generator(s) to an ATC transmission line or new substation site at voltages of 100 kV and above, the minimum configuration for the new ATC interconnection substation will be a three-position ring bus as shown in Figure 3.1.

Straight bus configurations may be considered for interconnection at voltages below 100 kV, subject to the provisions of Section 7 of this Guide.

As shown in Figure 3.2, an ATC-owned circuit breaker and disconnect switch in series with the Customer's transformer circuit breaker as part of the ATC Interconnection Facilities will be required for any straight bus configuration. As shown in both Figures 3.1 and 3.2, for all interconnections, the Customer will, at minimum, procure, install, own and maintain a circuit breaker and disconnect switch between the Point of Change of Ownership (PCO) and the Customer's transformer (step-up or auxiliary) to transmission voltage to be located in the Customer's substation.

3.1.2 Generator Interconnection at An Existing ATC Substation

For interconnection of generator(s) to an existing ATC substation under MISO functional control, the interconnection must integrate into the substation ultimate bus design while considering the need for a new ultimate configuration. Factors that may influence the specific bus configuration may include:

- physical limitations at the site,
- environmental concerns,
- cost,
- substation site space reserved for future planned facilities in the original ultimate design of the substation or future facilities identified in the ATC Ten Year Assessment,
- known system constraints,
- substation criticality to the network (including potential involvement in a blackstart plan),
- operational flexibility, and
- ease of maintenance and outage restoration time.

As shown in Figure 3.2, an ATC-owned circuit breaker and disconnect switch in series with the Customer's transformer circuit breaker as part of the ATC Interconnection Facilities will be required

for any straight bus configuration

3.1.3 Generator Interconnection at A Non-ATC Substation

For an interconnection at a substation owned by an LDC (Interconnected Entity) interconnected to ATC, but where ATC does not have any facilities in the substation and the substation is not under MISO Functional Control; ATC and the Interconnection Customer will need to work with the LDC (Interconnected Entity) to determine the viability of a generator interconnection at that substation. The Interconnected Entity will be, at a minimum, an Affected System as defined by the MISO Tariff at this proposed interconnection location.

Figure 3.1 The minimum configuration for interconnection at 100 kV and above at a new ATC substation

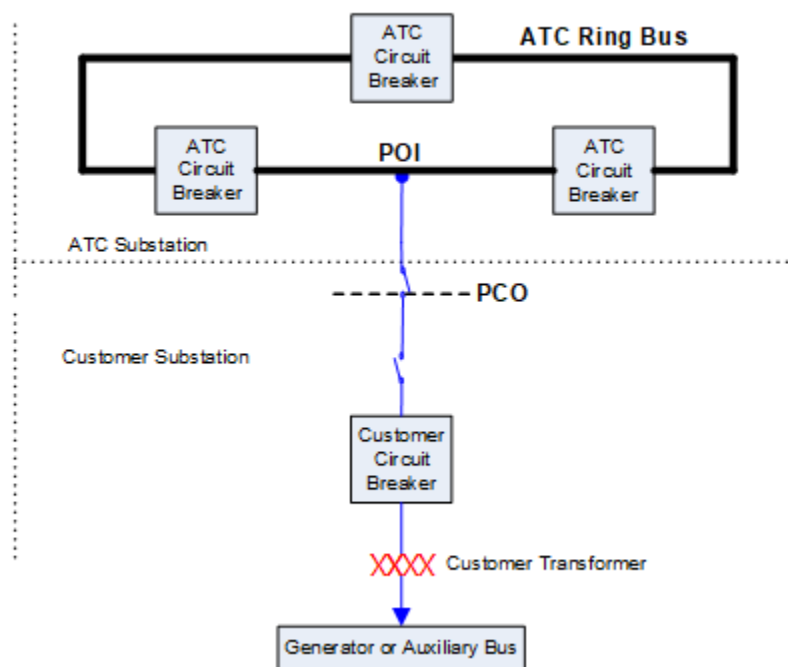
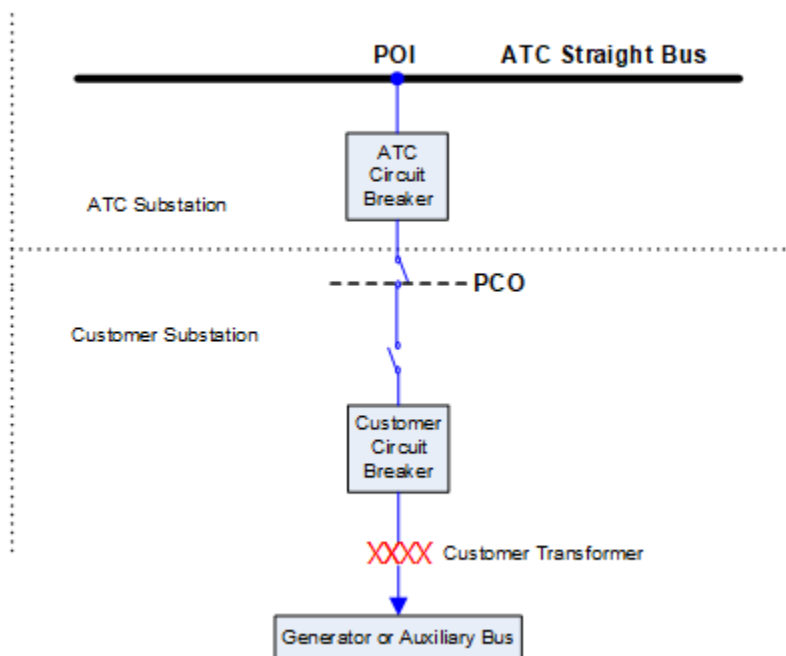


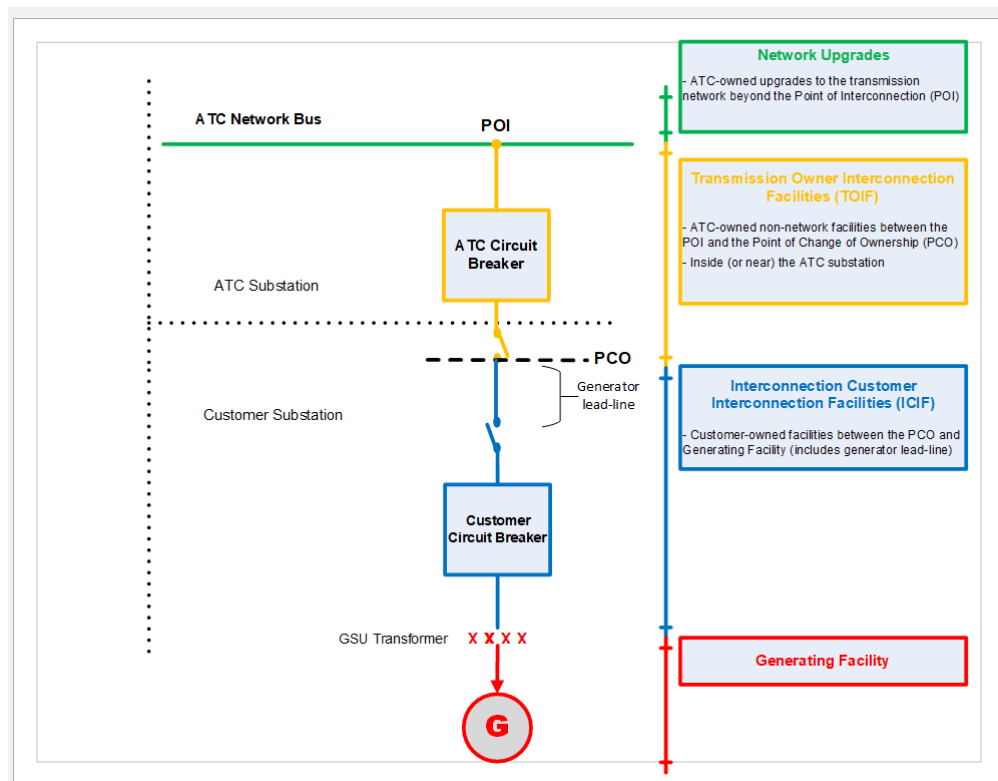
Figure 3.2 Straight bus configuration for a new ATC substation below 100 kV
(Example configuration)



3.1.4 Functional Breakdown of a Typical Generator Interconnection Substation for MISO Ownership and Financial Obligation purposes

For generator interconnections within the MISO system, functional responsibilities of Network Upgrades, Transmission Owner Interconnection Facilities, and Interconnection Customer Facilities are specified in the MISO Tariff. Figure 3.3 below shows the general arrangement of those facilities at a typical generator interconnection substation. The relationship between the various functional areas in an interconnection substation are color coded in Figure 3.3. For example, the green ATC Network Bus shown in Figure 3.3 can be any type of bus configuration (Figure 3.3 shows a portion of an ATC bus configuration and is shown for convenience only), the ownership responsibility remains the same. Cost responsibility for constructing or modifying these facilities are described further in the MISO Tariff. Please note, Figure 3.3 depicts the typical arrangement for these facilities, there may be exceptions to these arrangements and will be dealt with on a case-by-case basis in the planning and design phases of these generator interconnection projects.

Figure 3.3 Generator Interconnection Facility Ownership and Financial Obligation Responsibilities as described in the MISO Tariff and MISO Attachment X



3.1.5 Proximity of ATC and Customer Substations

For an ATC interconnection substation built adjacent to the Customer's substation (i.e., shared or abutting fences), the connection between the ATC network bus and the Customer's substation will be considered by ATC as a bus extension and a bus protection scheme will be required. Additionally, this configuration will require interconnected ground grids between the Interconnection Customer and ATC substations. It is for this reason that a bus protection scheme will be required.

If the substations are not located adjacent to one another and the ground grids are not interconnected, the connection will be considered a line, not a bus extension and a line protection scheme will be employed by ATC.

For both of the substation examples discussed above, the Customer is expected to install a circuit breaker on Customer end of the generator tie line where it interconnects to the high side of their GSU transformer. This expectation is the same for one or many Customer GSU transformers.

3.2 Demarcation and Ownership

The Point of Interconnection (POI) will be the point at which the ATC Interconnection Facilities connect to the ATC interconnection substation bus. The PCO will be at the point at which the strain bus from the Customer's substation connects to the dead-end structure of the ATC Interconnection Facilities located in or near the ATC interconnection substation. In the event that the interconnection is via rigid bus conductor, the PCO will be the terminal connection of ATC's switch in the ATC interconnection substation. Note: Jumpers between the generator tie-line (overhead conductor or rigid bus conductor) and the ATC disconnect switch will be owned by the ATC in both situations described above.

3.3 Substation Site

3.3.1 New Interconnection Substation

ATC's interconnection substation will be designed as an entirely separate substation from the Customer's substation. The Customer is responsible for providing a suitable site for the ATC interconnection substation. The Customer will be required to convey to ATC all necessary easements, in a form acceptable to ATC, over all property owned, leased or otherwise controlled by the Customer, including easements for ingress and egress to permit ATC access to all of the ATC Interconnection Facilities and Network Upgrades, which are on the property of the Customer. Additionally, the site that the Customer provides to ATC must be sufficiently large enough to accommodate the present and future uses of ATC and meet the rough grading requirements of ATC for the substation pad. ATC design expectations and review of rough grading will be detailed in the GIA Milestone tables in Exhibit B. The specific real estate requirements will be determined during the detailed design. If the Customer's substation is adjacent to the ATC interconnection substation, a fence separating them will be required. ATC will design, own and maintain this common fence according to its standards.

The Customer will be responsible for obtaining all necessary zoning, building, and environmental, permits or approvals required for ATC's interconnection substation. This includes permits for impacts to waterways, wetlands, floodplains, or endangered resources and any compensatory mitigation associated with such permits. The specific permits required will depend on the characteristics of the site and the local jurisdiction. Copies of all environmental permits obtained shall be provided to ATC in order to ensure that ATC's construction of the substation meets all permit requirements.

The Customer is responsible to design, obtain permits and install all storm water management facilities for ATC's interconnection substation and the overall Customer property. The Customer will be responsible for establishing final grade, revegetation, and any necessary landscaping of the portion of their property outside of the footprint of ATC's interconnection substation. The Customer's storm water management permit shall allow for ATC's construction activities to build the substation and bring it to final grade. Long-term maintenance and inspections of all storm water management facilities are the responsibility of the Customer. If ATC's construction activities disturb areas where the Customer has completed final grading and re-vegetation, ATC will repair the disturbance in a timely manner.

ATC will obtain all applicable environmental permits or approvals required for its facilities at remote end substations and transmission line assets. Please see Section 3.1.1 through 3.1.3 for additional information on the various substation types found on the ATC transmission system.

3.3.2 Interconnection at an Existing Substation

If the Customer selects a POI at an existing substation that results in an expansion or need for environmental permits/approvals, ATC and the Customer (and landowner if other than ATC or Customer) will coordinate to determine which entities will be responsible for obtaining the necessary permits/approvals. This may include ATC and the Customer being co-permittees to ensure that the entity driving the need and selecting the location are represented in permit applications and supporting alternatives analysis. Please see Section 3.1.1 through 3.1.3 for additional information on the various substation types found on the ATC transmission system.

3.3.3 Coordination with Local Utilities – Common Facility Upgrades

In certain instances, a substation with ATC transmission facilities under MISO functional control, may be owned by another local distribution company (Interconnected Entity). These substations are legacy situations that evolved during the creation of ATC. In these cases, the LDC (Interconnected Entity) is the owner of substation common facilities such as ground grid, fences, lighting, etc. A complete discussion of this situation can be found in the ATC Business Practice entitled *“Joint-Use Substations Cost Responsibility for Common Facilities”* and found on the ATC website <https://www.atcllc.com/customer-engagement/connecting-to-the-grid/>.

When the work to support a generator interconnection project is not considered a Network Upgrade, the Generator interconnection(s) at these substations will require additional coordination and involvement with the substation owner (the LDC / Interconnected Entity) and changes or modifications to the substation or substation site may result in the substation owner (the LDC / Interconnection Entity) being determined to be an “Affected System” as defined by the MISO Tariff.

3.3.4 Construction Coordination

The Customer is responsible for identifying the main point of contact for all construction related activities, system integration work plans, outage planning activities, accessing or working around ATC assets and for data sharing. The Customer is responsible for following all ATC expectations for accessing ATC substations and when working around or within close proximity to ATC assets. The Customer shall produce and share with ATC a Safe Work Plan in advance of working on, around or accessing ATC assets, and maintain and communicate

ATC

its updated Safe Work Plan as conditions require. A Safe Work Plan to include:

- minimum approach distance for the voltage present in the work zone
- hazards present in the work zone
- mitigation steps for the hazards present
- PPE standards required per the hazards present
- other safety measures that will be deployed by the Customer

The Customer is responsible for coordinating with the ATC Responsible Person (the single point or field contact for ATC Operations) for outage planning, Lock Out/Tag Out needs, switching, phasing, and coordination of energization. Installation of the final jumper connections at the POI shall be performed by ATC unless the Customer and ATC project teams agree on an alternative method. Outage planning with the ATC Responsible Person shall occur a minimum of 90 days prior to the start of an ATC requested outage. The Customer will work with the ATC Responsible Person for obtaining clearance points they require to perform their work and will be the POC for clearance requirements on the Customer's equipment. The Customer will coordinate all interconnection testing and commissioning activities with the ATC commissioning representative prior to energization.

3.4 Power Factor

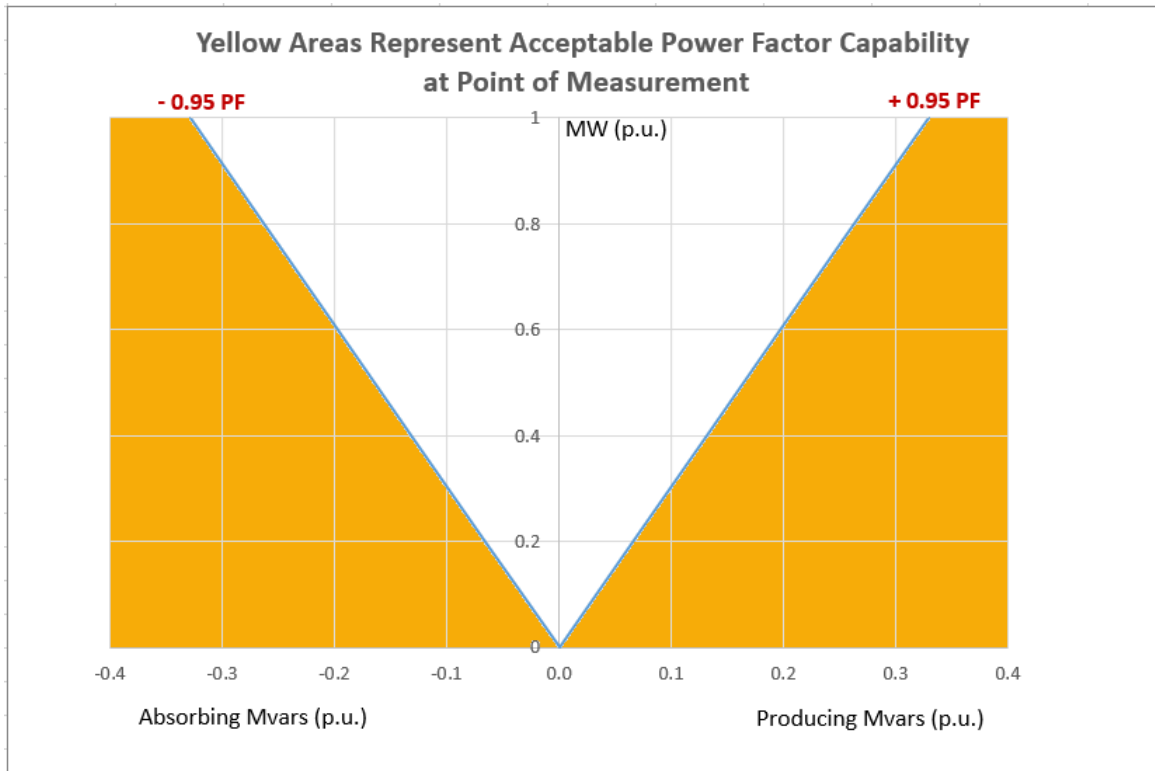
Power factor requirements for interconnecting generating units are as follows. ATC's standard power factor range for synchronous and non-synchronous (e.g., wind turbines, solar) generation is 0.95 leading (when a Generating Facility is consuming reactive power from the transmission system) to 0.95 lagging (when a Generating Facility is supplying reactive power to the transmission system).

As illustrated in a generic example graph below, the Generating Facility must be capable of maintaining ATC's standard power factor range at all power output levels by providing continuous dynamic reactive power at the following locations (i.e., point of measurement):

- a) The Point Of Interconnection (POI) for all synchronous generators
- b) The high-side of the generator substation for all non-synchronous generators¹

¹FERC Order No. 827, para 34.

Figure 3.4 – A Generic Example Graph of Acceptable Power Factor Capability



This power factor requirement applies at all power output levels unless the Generating Facility is physically disconnected from the ATC transmission system. Physically disconnected means an open

- generator step-up transformer high or low-side breaker(s) for a synchronous Generation Facility, or
- generator substation step-up transformer high-side breaker(s) for a non-synchronous Generation Facility.

For synchronous generators, the interconnection studies will account for the net effect of all energy production devices and losses on the Customer's side of the POI.

- Dynamic reactive power provided by a synchronous Generating Facility may meet the dynamic reactive power requirement by utilizing a combination of the inherent dynamic reactive power capability of the synchronous generator, dynamic reactive power devices (e.g., Static VAR Compensators), and static reactive power devices (e.g., capacitors) to make up for losses.
- Dynamic leading reactive power provided by a synchronous Generating Facility cannot use inductive losses from generator step-up transformer(s) and generator tie line(s) to meet the leading power factor calculation at POI. A synchronous Generating Facility must be able to meet a 0.95 leading power factor, as measured at the generator terminal (i.e., the low-side of the generator step-up transformer).

For non-synchronous generators, the interconnection studies will account for the net effect of all energy production devices and losses on the Customer's side of generator substation step-up transformer.

- Dynamic reactive power provided by a non-synchronous Generating Facility must meet the following requirement from FERC order 827 paragraph 35:

- “Non-synchronous generators may meet the dynamic reactive power requirement by utilizing a combination of the inherent dynamic reactive power capability of the inverter, dynamic reactive power devices (e.g., Static VAR Compensators), and static reactive power devices (e.g., capacitors) to make up for losses.”
- Dynamic leading reactive power provided by a non-synchronous Generating Facility cannot use inductive losses from pad-mount and station step-up transformers and collector system to meet the leading power factor calculation at the high-side of the generator substation. A non-synchronous Generating Facility must be able to meet a leading 0.95 power factor, as measured at the generator terminal (i.e., the low-side of the pad-mount transformer).
- Dynamic lagging reactive power provided by a non-synchronous Generating Facility cannot use collector system charging to meet the lagging power factor calculation at the high-side of the generator substation. A non-synchronous Generating Facility must be able to meet a lagging 0.95 power factor, as measured at the generator terminal (i.e., the low-side of the pad-mount transformer).
- When the Generating Facility is not generating active power (i.e., zero MW output):
 - a. The reactive power injection to the transmission system at the high-side of the generator substation should be zero Mvar. Exceptions for a short transition period during the switching of inverter control modes may be granted on a case-by-case basis if there is no reliability concern. For example, solar PV facilities may have a transition period during sunrise and sunset periods. The transition period should be minimized by the non-synchronous Generating Facilities as much as possible.
 - b. When the Generating Facility is physically connected but operating at zero MW and zero Mvar as measured at the high-side of the generator substation, the Generating Facility is not required to control system voltage as specified in Section 3.5 below.

The requirements in bullet a and b above are minimum requirements. If a non-synchronous Generating Facility has the capability to provide dynamic voltage control and maintain ATC's voltage schedule as specified in Section 3.5 below when it is at zero MW output, that is acceptable and preferred by ATC.

Static Reactive Power Devices (e.g., capacitors and inductors) can only be used to make up for

- Inductive losses between the generator terminal and the POI for synchronous generators, or
- Inductive losses or collector system charging between the generator terminal and the high side of generator substation for non-synchronous generators.

All other reactive power needed to meet the power factor requirement must be provided by continuous and sustainable dynamic sources (i.e., Dynamic Reactive Power Devices). Operation across the entire power factor range must be fully dynamic, variable, and capable of sustained indefinite operation.

3.5 POI Voltage

The interconnecting generator must be capable of automatically and dynamically maintaining a POI voltage schedule that is specified by the Transmission Operator. Any generator interconnected within the ATC system is expected to maintain a voltage schedule (voltage setpoint) of 1.02 per unit at its POI, within limits of its reactive capabilities, to facilitate transmission operations reliability under normal system conditions (system intact) and contingency conditions, unless another voltage level is communicated to the generator by the ATC Transmission Operator (cf.

3.6 IBR Momentary Cessation

IBRs shall be designed and configured to continue current injection (active, reactive, or a combination of current) inside the “No Trip Zone” of the frequency and voltage ride-through curves of the currently enforceable version of PRC-024 when the reliability study is performed unless that reliability study identifies a system need to cease injecting current.

IBRs shall be designed and configured to use momentary cessation only outside the “No Trip Zone” if this helps mitigate potential tripping conditions based on interconnection studies.

Any use of momentary cessation shall be based on equipment limitations or based on reliability studies identifying a system need. Return from momentary cessation upon voltage recovery to within the continuous operation range shall occur as quickly as possible with no intentional time delay while maintaining stability.

3.7 IBR Power Priority Mode

IBRs shall be designed and configured to use a Q (reactive power) priority for the Power Plant Controller (PPC) and inverter in steady-state and transient operation.

3.8 IBR Return to Service

IBRs shall expeditiously return to service following an event that trips any portion of the IBR plant, assuming the IBR plant remains physically connected to the transmission grid and IBR plant equipment can be safely returned to service unless doing so would interfere with blackstart procedures or if system is not within sustainable limits for the IBR to resynchronize (e.g., below 0.9 per unit or above 1.1 per unit voltage). The plant must reassert their previously assigned voltage schedule within 5 minutes of tripping.

3.9 IBR Phase Jump Immunity

ATC typically applies a maximum reclosing angle of 40 degrees for all transmission lines. Therefore, all IBRs must ride through positive-sequence phase angle changes within a sub-cycle-to-cycle time frame of the applicable voltage of less than or equal to 40 electrical degrees.

3.10 IBR ROCOF Trip Settings

IBR plants shall not trip for frequency excursions having an absolute rate of change of frequency (ROCOF) magnitude that is less than or equal to 5.0 Hz/s.

3.11 Energy Storage State of Charge (SOC)

Because an energy storage device's state of charge (SOC) impacts its ability to provide reliability services, for energy storage devices (including as part of hybrid configurations) connecting to the system, ATC requires the following real-time information to be provided via ICCP²:

- SOC (expected MWh and as % of Max limit SOC)
- Max limit SOC (MWh and as %)
- Min limit SOC (MWh and as %)
- Max discharge rate (MW)

² Inter-Control Center Communications Protocol

- Max charge rate (MW)

Any SOC limitations and their impacts to storage operation should be provided to ATC. This may include informing ATC of the type of service the device is providing to the BPS and when the storage would ramp down when nearing SOC limits. SOC limits should not impact reactive power capability. Additionally, the manner in which the storage device will charge must be communicated by the GO (e.g., charging from a collocated plant or from the grid).

3.12 Low Voltage Ride-Through Capability

All generators connected to the Transmission System must be capable of “riding through” disturbances that depress system voltages, as required by FERC Orders 661-A and 693. All generators must communicate the low voltage as-built ride-through capability of the Generating Facility following the Commercial Operation Date (COD).

3.13 Generation Voltage, Reactive Power and/or Power Factor Control

The Customer must design the Generating Facility such that controls are included on each generating unit to be interconnected to control voltage, reactive power, and/or power factor consistent with the requirements of the GIA and Section 7.2 of this Guide. Additionally, the Customer must design the Generating Facility to include provisions for power system stabilizers, except where exempted by the FERC. Depending on the size and location of the generator, a power system stabilizer may be required for interconnection.

3.14 Inverter-Based Resources - Reactive Power Capability

All new inverter-based resources (IBRs) interconnecting to the ATC transmission system shall have the capability to support voltage by providing dynamic leading and lagging reactive power at all levels of real power output including zero MW. The maximum reactive power capability in MVAR shall be at least 32.87% of the IBR nameplate capacity in MVA, with this capability available at all levels of real power output. The duration the IBR can operate in a voltage support mode will not be limited by any other IBR facility component.

3.15 Inverter-Based Resources - Negative Sequence Current

All new IBRs connecting to ATC shall inject short circuit current as described in IEEE 2800, clause 7.2.2.3 and associated subclauses. Positive and negative sequence short circuit measured at IBR unit terminals shall be injected dependent on IBR unit terminal voltage.

ATC requires data to model short circuit capability of IBRs. Short circuit data shall be provided in per unit based on the IBR unit terminal voltage and MVA ratings and assume pre-fault nominal active power output. Short circuit information shall be provided in the following format:

Table 3.15-1 Positive Sequence Short Circuit Data

Positive Sequence Voltage V1	Time since initiation of fault (cycles)					
	1 cycle		3 cycles		Steady state (≥ 5 cycles)	
	Pos. Seq. Current I1 (per unit)	\angle between V1 and I1 ($^{\circ}$)	Pos. Seq. Current I1 (per unit)	\angle between V1 and I1 ($^{\circ}$)	Pos. Seq. Current I1 (per unit)	\angle between V1 and I1 ($^{\circ}$)
0.9 pu						
0.8 pu						
0.7 pu						
0.6 pu						
0.5 pu						
0.4 pu						
0.3 pu						
0.2 pu						
0.1 pu						
0.0 pu						

Table 3.15-2 Negative Sequence Short Circuit Data

Negative Sequence Voltage V2	Time since initiation of fault (cycles)					
	1 cycle		3 cycles		Steady state (≥ 5 cycles)	
	Neg. Seq. Current I2 (per unit)	\angle between V2 and I2 ($^{\circ}$)	Neg. Seq. Current I2 (per unit)	\angle between V2 and I2 ($^{\circ}$)	Neg. Seq. Current I2 (per unit)	\angle between V2 and I2 ($^{\circ}$)
0.5 pu						
0.4 pu						
0.3 pu						
0.2 pu						
0.1 pu						
0.0 pu						

3.16 Power Quality, Voltage Flicker and Harmonics

The design, energization and operation of any Generating Facilities must be consistent with ATC's Tariff-required Planning Criteria and Planning Guidelines PLG-GDE-0019 and 0020 regarding power quality including harmonics; permissible voltage deviations, flicker and distortion; and distortion of current waveforms as measured at the POI. ATC's Planning Criteria and Operating Instructions are available upon request.

3.17 Frequency

The interconnected Transmission System has a nominal operating frequency of 60 Hz. The Customer will install both generation controls and protective relaying equipment necessary to maintain proper Transmission System frequency (see Section 4.2).

3.18 Fault Current

Customer facilities connected to ATC's Transmission System can be subjected to fault levels that are largely the product of system characteristics and interconnection impedance. The Customer's facilities must possess sufficient fault interrupting and momentary withstand ratings to meet the maximum expected fault current, with appropriate margin for future system growth. ATC will provide the transmission contribution to the fault current levels at the Point of Interconnection in the System Impact Study report and otherwise at the request of the Customer.

3.19 Auxiliary Power

The Customer shall procure its own primary and secondary sources of auxiliary power for its substation. ATC shall procure its own primary source of auxiliary power for the ATC interconnection substation. ATC may require the Customer to provide, at Customer's expense, a secondary source of auxiliary power to the ATC interconnection substation off of the Customer's substation equipment.

3.20 Voltage Level

New interconnections must effectively address the voltage requirements of both this section and Section 7.2. ATC operates transmission facilities predominantly at nominal system voltages of 69, 138, 345 kV. For the purposes of this guide, any reference to 138 kV voltage levels shall also encompass interconnections to ATC's 115 kV system as well. ATC will discuss with the Customer, on a case-by-case basis, requirements associated with interconnections to the relatively small amount of 161 and 230 kV facilities owned and operated by ATC.

3.21 Basic Impulse Insulation Level

ATC and the Customer must ensure that all equipment is adequately protected from excessive system over-voltages. This includes selection of equipment Basic Impulse Insulation Level (BIL) and protective devices (e.g., surge arresters) to achieve proper insulation coordination across the interconnection.

ATC designs its transmission facilities for the BILs shown in Table 3.1 below. Interconnections at 230kV or 161kV will be reviewed on an exception basis. New substations energized at 115 kV will be built to 138 kV system BIL. Additions to existing substations energized at 115 kV or 138 kV; with 550 kV BIL construction will be continued similar to their original design. In all other cases consideration will be given to the existing substation design.

Table 3.1: Basic Impulse Insulation Levels (BIL)

Nominal Operating Voltage (phase-to-phase)	345 kV	138 kV	69 kV
Basic Insulation Level (BIL)	1300 kV ¹	650 kV ²	350 kV
1. In some remote locations and transformers, a 1050 kV BIL may be acceptable. 2. In some remote locations and transformers, a 550 kV BIL may be acceptable.			

3.22 Required Customer Step-Up Transformer Configuration

ATC prefers that the Customer install a generator step-up or substation transformer with a high-side, nominal center tap, with two taps above and two taps below, each set at 2.5% of the nominal voltage. ATC requires that this transformer have a high-side wye winding that is grounded and a delta-connected secondary or tertiary winding; examples of acceptable connections include wye-ground/delta two winding transformer, wye-ground/delta/wye-ground three winding transformer, and autotransformer with a delta tertiary winding.

4 Protection

4.1 General

All Generating Facility interconnections to the Transmission System shall be designed to avoid safety hazards or to avoid adversely affecting the quality of electric transmission service to ATC customers. Protective equipment may need to be added to standard ATC facilities to provide adequate protection of the Transmission System. Requirements for additional protective equipment will vary depending upon the amount of generating capacity being added and on the nature of ATC's local system.

4.1.1 Protective Relaying

As part of the protection facilities, ATC will design and construct a protective relaying scheme to protect the Transmission System from faults occurring on the Customer's Interconnection Facilities, the Generating Facility, ATC Interconnection Facilities, or the Transmission System. The Customer will be responsible for protecting the Generating Facility and all Customer Interconnection Facilities from faults occurring on its facilities or the Transmission System.

4.1.2 Protective Devices

The Customer will design, install, set, and maintain all protective devices necessary to protect the Generating Facility in accordance with ANSI/IEEE standards, Good Utility Practice(s), Applicable Reliability Standards, the Interconnection System Impact and Facilities Studies and applicable standards and guides. Protective devices, including those performing the protective functions required by ATC in accordance with this Guide, will be installed by the Customer to disconnect the Generating Facility from the Transmission System whenever a fault, abnormal operating condition or equipment failure occurs on or within the Generating Facility. The Customer will ensure that such protective devices and related equipment properly coordinate with ATC protective equipment, both locally and remotely and provide a comparable level of protection to the Generating Facility and the Customer Interconnection Facilities as is provided by ATC for the ATC Interconnection Facilities and Transmission System. The specific requirements and specific protective devices to be installed will be determined in the Interconnection Studies. Customer owned 345 kV and above breakers should be rated for the application; including generator synchronization.

4.1.3 ATC Protection Relay

The Customer will allow ATC to review the Generating Facility protection, control design and settings and their coordination, where applicable, with the ATC protective devices prior to and after the In-Service Date (ISD) as specified in the Generator Interconnection Agreement. ATC reserves the right to refuse to allow the Customer to initiate the tender of energy to the Transmission System if, in the judgment of ATC, the Generating Facility protection devices, controls or overall protection methods do not adequately prevent the Generating Facility from introducing or causing an adverse impact on the Transmission System.

4.1.4 Protective Relay Requirements

Protective relays utilized by the Customer shall:

- a. Meet or exceed ANSI/IEEE standards for protective relays (i.e., C37.90-1989, C37.90.1, C37.90.2, and C37.90.3).
- b. Have the appropriate documentation covering application, testing, maintenance, and service.
- c. Give positive indication of what has caused a trip (targets).
- d. Have a means of testing that does not require disturbance to wiring (e.g., a draw-out case, test-blocks, test switches, etc.).

The Customer shall use microprocessor-based protective relays that include self-diagnostic abilities, sequence of events, event-recording capabilities, and operating flexibility.

4.2 Frequency Protection (IEEE 81)

The design of the Generating Facility relating to over-frequency protection of the Generating Facility is discretionary with the Customer. However, the over-frequency protection used by the Customer will be provided to ATC. Under-frequency protection will be in accordance with the Applicable Reliability Standards.

4.3 Customer Breaker Failure Protection (IEEE 50BF)

The Customer shall install a local dedicated 50BF breaker failure protective relay and 86BF breaker failure lockout relay on its breaker on the high-side of the generator step-up transformer. The 50BF/86BF relay will be coordinated with ATC in order to trip adjacent substation breakers, in the event the generator breaker fails to successfully open for any reason.

For interconnections with a bus protection scheme, the Customer shall provide two normally open 86BF contacts and one normally closed 86BF contact for each ATC breaker to be tripped. Additionally, the Customer shall provide one normally open 86BF contact for lockout status indication to ATC.

For interconnections with a line protection scheme, the Customer shall provide breaker failure transfer trip signals to ATC incorporated into each line protection communication channel.

4.4 Synchronism Check Relay (IEEE 25)

The Customer will synchronize the Generating Facility to the Transmission System across the Customer-owned breaker installed on the high-side of the generator step-up transformer. The Customer shall provide a synchronism-check relay to supervise the automatic or manual synchronization of the Generating Facility to the Transmission System. Automatic synchronism-check relays will contain the manufacturer's optional voltage monitoring functions and supervise the closing of the circuit breaker. ATC will be entitled to review the settings and operation of the Generating Facility's synchronism check relay.

4.5 Bus Differential Protection (IEEE 87)

The Customer shall provide a dedicated current transformer input to the ATC bus differential protection scheme to provide coordinated bus differential protection of ATC's bus. This current transformer shall be placed in a manner to ensure that the bus differential protection overlaps the generator bus or step-up transformer protection.

4.6 Reverse Power (IEEE 32)

The protection system for all combustion turbine generators connected to the Transmission System and the reverse power relay pickup shall be set no more than -7% of the machine rated MVA to protect the Transmission System from a possible voltage collapse due to the gas turbine high power consumption during motoring.

4.7 Power Transformer Ground Time Overcurrent Protection (IEEE 51N)

The Customer shall install ground time overcurrent protection for all generator step-up and auxiliary power transformers to protect them from internal ground faults. Such protection will be coordinated with the backup ground time overcurrent protection.

4.8 Protection Redundancy

In accordance with Good Utility Practice, the Customer shall design protection schemes such that no single component failure will prevent the isolation of faults and/or failed equipment. This may require providing redundant or backup protective schemes with separate sensing sources, separate trip paths, dual trip coils on breakers, separate control power supplies, etc.

4.9 Generator Tripping

Each generating unit of the Generating Facility must be capable of disconnecting itself from ATC's Transmission System in the event of a system fault, abnormal operating condition or equipment or system failure. If the Generating Facility is an inverter-based resource, it must be disconnected at the collector bus to remove the ground source of the collector to eliminate its contribution to a system fault, abnormal operating condition or equipment or system failure.

4.10 Recommended Generator Protection Functions

ATC recommends the following protective functions, which may provide the Generating Facility with additional backup protection from transmission relaying malfunctions, mis-operations, equipment or system failure.

4.10.1 Phase Distance (Impedance) Protection (IEEE 21)

The Customer's distance relay zone that extends into the Transmission System should be time-coordinated with line protective relays to assure transmission protection operates first. The time delay will be set higher than a second zone clearing time for a line fault (typically 20 cycles). Impedance protection is provided for a generating unit when transmission line(s) that connect it to the Transmission System are protected with phase distance relays.

4.10.2 Time Overcurrent with Voltage Control/Restraint (IEEE 51V)

The Customer's overcurrent relays that are voltage-controlled or voltage-restrained should be set below load current for adequate sensitivity to Transmission System faults while restraining operation under emergency overload conditions. To prevent miscoordination with transmission relaying, overcurrent relays should be sufficiently time-delayed. The time-delay setting should be based on the worst-case coordination with ATC protective relays, which is usually a delayed trip with breaker failure clearing times. Backup time overcurrent protection is provided for a Generating Facility when transmission line(s) that connect it to the transmission grid are protected by overcurrent relays.

4.10.3 Backup Ground Time Overcurrent Protection (IEEE 51N)

It is recommended that any backup ground time overcurrent protection operate for ground faults at the end of all transmission lines coming out of the Generating Facility and be set to coordinate with the slowest ground fault protection on the Transmission System. This relay is typically installed in the high-side neutral of the generator step-up transformer.

4.10.4 Negative Sequence Current (Unbalanced Load) Protection (IEEE 46)

The Customer should apply a negative sequence time overcurrent relay to protect the Generating Facility from external unbalanced conditions such as system phase-to-phase faults and open conductors that can damage a generating unit(s).

4.10.5 Out-of-Step (Loss of Synchronism) Protection (IEEE 78)

The Customer shall ensure that each generating unit is capable of separating from the Transmission System before an "out-of-step condition" or loss of synchronism can occur.

4.10.6 Voltage Balance (IEEE 60)

The Customer should ensure the following voltage-dependent protective functions are blocked when a loss of fuse is detected to prevent relaying misoperation:

- a. Phase distance (impedance) protection (IEEE 21);
- b. Under-voltage protection (IEEE 27);
- c. Loss of field (under-excitation) protection (IEEE 40);
- d. Time overcurrent with voltage control/restraint (IEEE 51V);
- e. Under-frequency protection (IEEE 81).

f.

4.11 Transmission Line Automatic Reclosing Near Generating Facility

The automatic re-closing of breakers on ATC transmission lines can be potentially damaging to Customer equipment that is in close electrical proximity to the lines. As a general policy, ATC will not eliminate automatic reclosing of overhead transmission lines near a Generating Facility because that could significantly affect the reliability of service to transmission customers. Automatic reclosing is single-shot and is blocked should a fault be of a permanent nature.

In cases where the ATC interconnection substation has two transmission outlets, a line side single-phase voltage-sensing potential device will be installed at the remote terminal of each line. Additionally, the automatic reclosing scheme at the remote terminal of each line will support disabling automatic reclosing via supervisory control.

4.12 Generating Facility Single Points of Failure

Generating facilities connected to ATC must not have Single Points of Failure (SPF) if the generating facilities share a ground grid with or are connected to a BES substation by a short line that doesn't allow for coordination of tie line and system backup elements. Single Points of Failure are defined as the non-redundant components of a Protection System in Footnote 13 of NERC Reliability Standard TPL-001-5. SPFs in scope include those that result in delayed clearing of a fault between the POI and the high voltage side of the GSU or MPT. SPFs that result in delayed clearing of a fault on the low voltage side of the GSU or MPT are out-of-scope due to the minimal effect on the transmission system. The Footnote 13 exceptions for non-redundant components that are monitored and reported at a Control Center are allowed (i.e., they are not valid SPFs).

4.13 Reserved

4.14 Equipment Ratings

ATC shall determine the individual equipment ratings for the ATC Interconnection Facilities and Network Upgrades during the detailed design of the facilities in accordance with its design standards and the Interconnection Studies. The Customer shall size its Interconnection Facilities to appropriately coordinate with the ATC Interconnection Facilities. ATC and the Customer shall exchange information before the COD or implementation of any future modifications, including identification of the most limiting piece of equipment, to achieve common understanding of each party's respective Interconnection Facilities' normal and emergency ratings.

5 Telemetry and Metering Requirements

5.1 Telemetry

The Customer shall provide ATC with real-time analog and digital Generating Facility data. The method in which the signals shall be transmitted to the ATC location will be specified during the detail design of the Interconnection Facilities and Network Upgrades. The Customer shall provide the data in a format acceptable to ATC. If the Customer cannot supply the data in an acceptable format like ICCP, then ATC will install an RTU at the Generating Facility to collect this information. Additionally, the Customer will install and maintain interconnection metering and status data for the connection of each generating unit, except as noted below.

In general, ATC requires continuous telemetry of the items listed in Sections 5.1.1. through 5.1.3.

5.1.1 Status of Circuit Breakers

The status of circuit breakers owned by the Customer with the following functions will be communicated to ATC continuously:

- Breakers capable of disconnecting the Generating Facility from the Transmission System
- Breakers capable of disconnecting any auxiliary load from the Transmission System
- Breakers capable of disconnecting any device that is required to be in-service to meet the unit(s) requirements for reactive power compensation as part of the Interconnection Agreement.

5.1.2 Status of Relay Equipment

Status of relay equipment is required when the Customer's relay equipment is protecting, as primary or backup, any of ATC's Transmission System equipment.

5.1.3 Instantaneous Real and Reactive Power Data

Instantaneous real and reactive power data are required for each generating unit at the generator terminal or compensated to the generator terminal. For wind farms, aggregated real and reactive power data at the collection substation are required. Load values, MW and MVAR, for the following locations will need to be continuously communicated to ATC:

- All Generating Facility auxiliary loads connected between the generator terminal and the POI with the Transmission System
- All Generating Facility auxiliary loads connected directly to the Transmission System
- All third-party loads supplied from the Generating Facility of Customer Interconnection Facilities

5.1.4 Instantaneous Voltage Data

Instantaneous voltage data needs to be continuously communicated at the terminal of each generator for all generator types with the exception of wind farms. For wind farms, instantaneous voltage data will be collected at the substation bus.

Instantaneous voltage data will also be collected and communicated at the terminal of any device installed to provide static or dynamic reactive power compensation within the Customer's substation.

5.1.5 Status and Readiness

Continuous communication is required as to the status of whether the following is in-service and "ready":

- Any power system stabilizer installed
- Automatic voltage regulator (AVR)
- Any special protection system (SPS)
- Any reactive power compensation, whether static or dynamic.

5.2 Local Balancing Authority Metering

The Customer is responsible for working with an appropriate Local Balancing Authority to install necessary metering facilities, including instrument transformers within the Customer's interconnection substation. Prior to energizing the interconnection via the Transmission System, the Customer must provide evidence of a Balancing Authority Agreement to ATC. See ATC's Coordination of Local Balancing Authority Metering Boundary Modifications Business Practice for additional information:

<https://www.atcllc.com/customer-engagement/connecting-to-the-grid/>

5.3 Inverter – Based Resource Measurement Data

Consistent with the IEEE 2800 Standard and NERC reliability guidelines, the following measurement data shall be collected by the Inverter-Based Resource (with a signed GIA with ATC) and the data will be shared with ATC on request in order to support the reliable operations of the Bulk Power System and post-event analysis.

IBR Measurement data—type, points, sampling rate, retention and duration (from IEEE 2800)

Provision data type	Measurement/data points (as applicable)	Recording rate	Retention	Duration	Measurement (as applicable)
Plant SCADA data (CSV file)	<p>The plant SCADA system is often a lower resolution repository of information that, at minimum, shall include the following data points:</p> <p>Measurements</p> <ul style="list-style-type: none"> • <i>Point of measurement</i> voltage and medium-voltage collector system voltages • <i>Point of measurement</i> frequency • <i>IBR plant</i> active and reactive power output • <i>IBR units</i> active and reactive power output of individual • Shunt dynamic device reactive power output <p>Signals</p> <ul style="list-style-type: none"> • External control signals from the <i>TS operator</i> (BA, RTO, RC, etc.) • External automatic generation control signals • Active and reactive power commands sent to <i>IBR units</i> 	One record per s	1 year	One year	Subclause 4.4, Table 1

ATC

Provision data type	Measurement/data points (as applicable)	Recording rate	Retention	Duration	Measurement (as applicable)
Plant equipment status (tabular log file)	<ul style="list-style-type: none"> All breaker statuses, including change of status log Shunt (dynamic or static) reactive compensation device statuses Substation transformer status (main step-up and <i>collector system</i>) Status of on load tap changer Medium-voltage <i>collector system</i> statuses Status of individual <i>IBR units</i> Time stamp Time synchronization (e.g., GPS status word) or status of the GPS clock signal 	Static, as changed	1 year	N/A	N/A
Unit functional settings	<ul style="list-style-type: none"> <i>IBR unit</i> autonomous functions parameter settings 	Static, as changed	1 year	N/A	N/A
Sequence of events recording (SER) data (tabular log file, time tag shall have an accuracy of one millisecond or less)	<p>SER devices should be sized to capture and store hundreds or thousands of event records and logs. SER event records can be triggered for many different reasons but at minimum, shall include the following:</p> <ul style="list-style-type: none"> Event date/time stamp (synchronized to common reference, e.g., Coordinated Universal Time [UTC]) Event type (status changes, synchronization status, configuration change, etc.) Sequence number (for potential overwriting) 	Static, as changed	90 days	N/A	N/A

ATC

Provision data type	Measurement/data points (as applicable)	Recording rate	Retention	Duration	Measurement (as applicable)
Digital fault recording (DFR) data (COMTRADE format and tabular log file)	<p>This data shall be captured for at least the plant-level (e.g., at the <i>point of measurement</i>) response to BPS events. It is typically high resolution (kHz) point-on-wave data (transient) and triggered based on configured settings. Data points shall include:</p> <ul style="list-style-type: none"> • Time stamp • Phase-to-ground voltage for each phase • Bus frequency (as measured/calculated by the recording device) • Each phase current and residual or neutral current • Calculated active and reactive power output • If applicable, dynamic reactive device voltage, frequency, current, and power output • Applicable binary status 	≥ 128 samples per cycle, triggered	90 days	5 s COMTRADE data, (split between pre-fault and post-fault data needs to be mutually agreed upon with the <i>TS owner/TS operator</i>)	Subclause 4.4, Table 2
Dynamic disturbance recorder (DDR) data (COMTRADE format and tabular log file)	<p>A DDR shall capture the specified plant-level data continuously at the <i>point of measurement</i>. This data can be used for multiple purposes including event analysis and disturbance-based model verification. Data points shall include:</p> <ul style="list-style-type: none"> • Time stamp • Bus voltage phasor (phase quantities and positive-sequence) • Bus frequency • Current phasor (phase quantities and positive-sequence) • Calculated active and reactive power output 	<p>Input: ≥ 960 samples per s</p> <p>Output: ≥ 60 times (records) per s, continuous.</p> <p>If based on triggers, then triggered records shall be at least 3 min.</p>	1 year	N/A	Subclause 4.4, Table 2

ATC

Provision data type	Measurement/data points (as applicable)	Recording rate	Retention	Duration	Measurement (as applicable)
Inverter fault codes and dynamic recordings (CSV file and tabular log file)	For grid BPS faults/events which trigger ride-through operation of an <i>IBR unit</i> or cause it to trip, the following information shall be recorded at <i>IBR units</i> for analysis: <ul style="list-style-type: none"> • All major and minor fault codes • All fault and alarm status words • Change of operating mode • High- and low-voltage ride-through • High- and low-frequency ride-through • PLL loss of synchronism • DC current and voltage • AC phase currents and voltage • Pulse width modulation index (if applicable) • Control system command values, reference values, and feedback signals 	Many kHz, triggered	90 days	5-s data, (split between pre-fault and post-fault data needs to be mutually agreed upon with the <i>TS owner/TS operator</i>)	Stated by <i>IBR owner</i>
Power quality—flicker (PQDIF format)	Plant-level <i>Pst</i> and <i>Plt</i> using a flicker meter that is compliant with IEC 61000-4-15 and IEC 61000-4-30	10 min	90 days	N/A	IEC 61000-4-30 Electromagnetic compatibility (EMC) - Part 4-30: Testing and measurement techniques - Power quality measurement methods
Power quality—RVC (PQDIF format)	Plant-level RVC (DeltaV/V) using a PQ meter that is compliant with IEC 61000-4-30 (IEC RMS value measured by one cycle, updated every half cycle)	N/A	90 days	N/A	IEC 61000-4-30

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Provision data type	Measurement/data points (as applicable)	Recording rate	Retention	Duration	Measurement (as applicable)
Power quality— Very short-term harmonics (COMTRADE or PQDIF format)	Plant level, both voltage and current harmonics as applicable (total distortion and individual harmonics up to order 50). Unless required by the <i>TS owner</i> , very short-term harmonics measurements are optional.	3 s	10 days	N/A	IEC 61000-4-7 and IEC 61000-4-30 Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
Power quality— short-term harmonics (COMTRADE or PQDIF format)	Plant level, both voltage and current harmonics as applicable (total distortion and individual harmonics up to order 50).	10 min	90 days	N/A	IEC 61000-4-7 and IEC 61000-4-30
Power quality— long-term harmonics (COMTRADE or PQDIF format)	Plant level, both voltage and current harmonics as applicable (total distortion and individual harmonics up to order 50).	95 weekly percentile (per IEEE Std 519)	1 year	N/A	IEC 61000-4-7 and IEC 61000-4-30

6 Testing, Inspection and Commissioning

6.1 Testing and Inspection

Before ATC provides final approval for energization of the interconnection, the Customer must demonstrate to ATC, through witnessed tests and/or certified test documentation, that the Generating Facility and each generating unit will not have adverse impact on the operation of the Transmission System. Such tests and inspections will include pre-energization testing of equipment connected to the transmission bus, protection and control systems and pre-commercial testing of the governor, excitation and/or power system stabilizer controls. Protection and control systems include, but are not limited to, AC auxiliary, DC systems, relaying systems, potential and current circuits, and communication systems. Synchronous Generating Facilities must test at minimum and maximum real power capabilities and all Generating Facilities (synchronous and non-synchronous) must test at minimum and maximum reactive power capabilities as system conditions allow. A final report must be submitted to ATC for review no less than ten (10) business days prior to the Customer's planned date for initial energization.

6.2 Generator Owner and Original Equipment Manufacturer (OEM) Attestations

For all inverters, plant level controllers, and other supplemental dynamic devices in the facility, the EMT model provided by the GO must be an accurate representation of the inverter-based resource, representing all pertinent controls, and protections (both software and hardware) that could affect the electrical output of the facility for the types of studies in which it is intended to be used.³

The GO must obtain equipment manufacturer attestation that confirms that the user-defined model(s) provided by them are site-specific, accurately represent the equipment installed (or planned), and include settings as configured and left on-site (or planned). As part of the verification process, the equipment manufacturer quality attestation must:

- Attest to meeting ATC EMT model requirements.
- Describe exactly how the model is configured: operating mode, settings (including control gains, limits, threshold), and all pertinent forms of protection and controls (enabled and disabled).
- Include the facility name for which the model was provided. This is to ensure that project specific models and parameters have been used.
- Include a revision history.

The GO must confirm that the EMT model of the entire facility accurately represents the equipment installed in the field. GOs must work with the equipment manufacturers to ensure that any user-settable parameters are updated to match the equipment in the field. The plant model quality attestation from the GO should be provided to ATC thirty (30) business days prior to commercial operation and attest that:

- The EMT model meets all ATC model requirements.
- Each piece of equipment installed in the field is appropriately represented in the EMT model either explicitly or in aggregate.
- The model control modes and settings match the equipment installed in the field. This includes appropriate EMT model parameterization of operating modes, settings, and all forms of protection (enabled and disabled, including protective relays) represented in the model.
- GO has received equipment manufacturer attestation on all parameters from above (and provide ATC a copy thirty (30) business days prior to commercial operation).
- Include a revision history.

³ See NERC Reliability Guideline here: https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Reliability_Guideline-EMT_Modeling_and_Simulations.pdf

6.3 Initial Transformer Energization

Installation and commissioning of a new Customer transformer will require the initial energization to occur from the Transmission System. Prior to initial energization of a new Customer transformer at a new or existing Generating Facility and if determined necessary by ATC, the Customer must permanently install mitigation equipment (e.g., pre-insertion resistors on the high-side transformer circuit breaker, or another option is to install a Point-On-Wave switched circuit breaker) or commission a technical study of the initial energization event to ensure that the initial energization of the transformer will not result in any unacceptable impact to the Transmission System or any other interconnected customers. If the Customer commissions a technical study for this purpose, a final report must be submitted to ATC for review no less than ten (10) business days prior to the Customer's planned date for initial energization.

6.4 Reduction of DC Residual Flux

The Customer will perform an excitation current test to determine if the core of any new Customer transformer is magnetized. If the test establishes that the core is magnetized, the Customer will perform the transformer manufacturer's recommended procedures to reduce the residual DC flux on the core. The Customer will then re-perform the excitation current test to verify that the core has been de-magnetized. The Customer will provide documented results of these procedures to ATC prior to energization of the Customer transformer.

6.5 Generating Facility Synchronization

Unless otherwise permitted by ATC, the Generating Facility shall be synchronized to the Transmission System at the Customer's step-up transformer's high-side circuit breaker installed at the POI. ATC shall furnish Transmission System bus potentials that may be used by the Customer for synchronizing the Generating Facility to the Transmission System.

7 Requirements after Commercial Operation

The GIA (per Section 2.4) establishes the terms and conditions for the interconnected operation of the Generating Facility after achieving Commercial Operation, especially procedures for communication and coordination among the Customer, ATC, and MISO. ATC sees such effective communication and coordination as essential to planning, operating, and maintaining a safe and reliable Transmission System and Generating Facility Interconnection. This section provides summary guidance on certain Interconnection Agreement provisions that may impact the Customer's decision-making in the design of new or modified Generating Facilities for interconnection to the Transmission System. The Customer should consult the Interconnection Agreement for additional detail on requirements pertinent to ongoing interconnected operations.

7.1 Operating Guidelines

The specific requirements of each interconnection will dictate the establishment of mutually agreeable interconnection and/or operating guidelines applicable to each Generating Facility, if necessary.

7.2 Generating Facility Voltage Schedule

NERC Mandatory Reliability Standards VAR-001 and VAR-002 set forth the requirements Transmission Operators and Generator Operators/Owners must follow to maintain network voltage schedules. VAR-001 requires that the Transmission Operator specify a voltage schedule at the POI “and direct the Generator Operator to comply with the schedule in automatic voltage control mode (AVR in-service and controlling voltage).” VAR-002 requires that the Generator Operator maintain the voltage schedule set by ATC and operate each generator in automatic voltage control mode, among other requirements.

VAR-001 provides that “[t]he voltage schedule is a voltage target that must be maintained within a tolerance band during a specified period.” ATC's standard voltage schedule is a target voltage of 102% of the nominal voltage at the Point of Interconnection within a maximum permissible range of 95% to 105% until ATC specifies a new voltage schedule. The Generating Facility must be designed and operated for this voltage schedule unless directed otherwise. In addition, operation within a desired tolerance band of 100% to 105% is recommended to ensure efficient and reliable operation of the bulk electric system due to real time system conditions that may not have been specifically modeled in the planning horizon.

7.3 Unit Stability

The Customer shall operate the Generating Facility in accordance with the operating requirements of ATC, MISO, NERC, and any applicable regional entity in addition to the stability requirements identified in the Interconnection System Impact Study report, or its equivalent, prepared for the interconnection and which have been posted on the Transmission Provider's OASIS at:

<http://www.oatiaoasis.com/MISO/index.html>

7.4 System Restoration (Black Start)

The Customer is not required to operate as a Black Start Resource unless designated by a separate Black Start Service agreement. However, in accordance with Good Utility Practice, Customer will participate, when called upon by MISO or ATC, in ATC's Black Start System Restoration Plan for the Generating Facility and ATC's Transmission System, as well as any verification testing. The Customer is required to supply to ATC its facility black out plans. These plans shall include the equalized impedance of the systems within the Generating Facility auxiliary system to large motors expected to be started during emergency conditions along with the appropriate time-domain modeling assumptions for each large motor to be used by ATC to confirm ATC's Black Start Plan. ATC will use this information to study the ability of a degraded system to start large motors, such as fans, pumps, and other equipment during system black outs and restoration. The Customer will also be expected to participate in any Black Start System Restoration Plan verification testing.

7.5 Maintenance Testing

After commissioning of the Generating Facility, periodic maintenance, testing, modification or troubleshooting of Customer equipment shall be done with consideration of the impact to the Transmission System. Protective relay testing that can trip any element of the Transmission System shall be discussed and approved by the ATC system operator 10 business days prior to testing of equipment.

7.6 Detection of and Tripping for an Electrical Island Condition

In circumstances where the Generating Facility has no governor controls and the transmission system design could result in an islanding condition for the outage of two transmission elements, ATC requires the Customer to implement additional protection systems as mutually agreed by the Customer and ATC to prevent generation from being isolated or islanded with interconnected load. Alternatively, ATC will require the Customer to curtail their generation for circumstances that could result in an island condition with the next contingency. An islanding condition for an outage of a single transmission element is not allowed (i.e., connecting generation to a radial transmission line with distribution load).

7.7 Generating Facility Modifications

It is of critical importance for reliable interconnection service and operation of the Transmission System that the Generator Owner communicate to ATC proposed and planned changes to the Generating Facility, Interconnection Facilities and related equipment. Communication of changes should occur as early as possible using the ATC Generating Facilities Modification Notification (GFMN) form found at:

http://www.atcllc.com/wp-content/uploads/2013/12/GFMN-Template_121613.docx

The GFMN form may be sent to ATC via email at:

gfoanotices@atcllc.com

The GFMN is to be used to communicate events including, but not limited to, the following:

- Plant/Unit modifications due to emergency changes
- Planned/Proposed plant/unit modifications
- Plant/unit retirements – note that the GFMN does not replace other notification requirements; it is in addition to those requirements
- Plant/unit development
- The submittal of unit verification data created as a result of periodic testing

For the submittal of generator data/information, as required for reporting data related to NERC and/or Regional Entity Standards and/or as required reporting due to MISO transmission needs, please submit this data to giaoanotices@atcllc.com. An example of this type of information includes:

- The submittal of generator data/information, as required, for reporting data related to NERC and/or Regional Entity standards
- The submittal of generator data/information as required reporting due to MISO transmission and/or energy market needs

If proposed modifications are determined to have an impact on the Transmission System, ATC and the Customer will collaborate on the appropriate solution(s) to enable successful implementation of the proposed unit modification.

7.7.1 The Annual Review

ATC performs an Annual Generator Review to ensure the accuracy of its information for Generating Facilities connected to the Transmission System. Information obtained via the Annual Review also contributes to ATC filings made to RFC, MRO and NERC. The primary ATC functions using the Annual Review results are Planning, System Protection and Real Time Operations.

ATC will send an email communication to Generator Owners requesting the following information to initiate the Annual Review process:

- Any planned retirements of plants/units
- Any planned development of new plants/units
- Any modifications made in the prior year for which ATC is unaware
- Any modifications planned or proposed for the future
- Special data reviews such as capability curve confirmations

7.7.2 Generating Unit Testing

ATC desires to support and take part in the Generator Owner's generator reactive power capability verification testing. Coordination between the Generator Owner and ATC will provide a better test environment. ATC encourages the Generator Owner to use the NERC MOD 25 format to report the results, the same format Generator Owners use to report this data to NERC. Appendix C, Generating Unit Test Requirements, contains detailed information for coordinating testing.

7.8 Addressing Generator Performance Issues

If abnormal behavior is observed by ATC, the Generator Owner, or the Generator Operator at or near a Generating Facility during system normal periods or during faults events, the Generator Owner and Generator Operator shall expeditiously work with ATC in good faith to remedy the situation (both in the field and in modeling) before elevating the issue to a NERC standard's request or violation.

8 Requirements Assuring Reliable Operation at the Interconnection Point

ATC desires to ensure the operational reliability of interconnections to the ATC Transmission System. The Interconnection Customer will meet the following needs in order to receive approval to commence operation of a new plant or move to operation any modifications impacting an interconnection point.

The following dates are used as end dates for receiving all required documentation and test results:

- 60 Calendar days prior to the first synchronization date for fossil or nuclear plants
- 60 Calendar days prior to the COD for all other plant types

For new plants, ATC approval will provide the Interconnection Customer with the ability to submit the COD letter identified in Appendix E of the GIA. For modifications to existing facilities impacting a generation to transmission interconnection point that do not require MISO intervention, ATC approval will allow the interconnection customer to move forward with operation.

Appendix B of this Guide identifies potential reporting requirements including:

- Description of the Generator Requirements Matrix which identifies the timing, rationale and uses of the data.
- Generator Requirements Milestone and Process Timeline which provides a picture of the milestones, showing where the milestones fall.

Effective Date: 10/1/2023		Revision: 14.0
TITLE: Trevor Stiles, Dir Customer Engagement and Associate General Counsel	Generating Facility Interconnection Guide Approved by:	Page 37 of 44

9 Revision History

Revision	Author	Date	Section	Description
1.0	Andrew Cotter	12-16-08	All	New / first publication
2.0	Andrew Cotter	10-12-09	2.5 3.1.1 3.3 4.12 App. B	- Added section “Coordination with Local Utilities” - 3-position ring bus as minimum configuration for most interconnections - Substation site must meet ATC rough-grade requirements - Synchronism checking devices required in certain instances - Added generator data requirement detail
2.1	Andrew Cotter	12-21-09	App. B	- Updated Black Start unit data requirements
3.0	Andrew Cotter	6-28-10	3.1.1 3.12 3.13 7.6 App. B App. B	- Updated Figure 3.2 - Added section “Voltage Level” - Added section “Basic Impulse Insulation Level” - Added section “Detection of and Tripping for an Electrical Island Condition” - Added corresponding NERC reliability standard reference to B.13
4.0	Andrew Cotter Randy Lange	12-07-12	3.13 7.7 App. B App. C	- Added section “Recommended Customer Step- Up Transformer Configuration” - Added section 7.7 “Generating Facility Modifications” - Modified Generator Data Inventory Matrix - Added Appendix C “Generating Unit Test Requirements”
5.0	Randy Lange and Heather Andrew	04/2014	Various Sections	-Cleaned up abbreviations and naming -Added Section 8 -Added summary of the Requirements Matrix in Appendix C
6.0	Heather Andrew	12/2015	Various Sections	Removed Planning Authority role and cleaned up links
7.0	Heather Andrew	12/2016	1.1 1.3.1 2.2 3.3 3.4 4.1.2 7.7	-FAC-001 reference -SOCA for new customers -Additional studies needed -Substation site expectations -Power Factor requirements -Protective Devices -GFM submission updates
8.0	Andrew Cotter	12/2017	1.1 2.2.1 2.3 3.4 3.5	- Included FERC Order 827 - Updated MISO Related Interconnection Studies - Updated Data Requirements - Clarified Power Factor requirements - Added POI Voltage section
9.0	Andrew Cotter	12/2018		- Version confirmed. No changes.
9.1	John Raisler	8/2019	3.4	- Modified Generator Power Factor Requirements
10.0	John Raisler	12/2019	3.14	- Updated GSU requirements
11.0	John Raisler	12/2020	3.3 3.14 Figure 5	- Clarified Permit Requirements - Updated GSU requirements - Updated Generator Reactive Test Process
12.0	John Raisler	7/2021	1.1 3.1	Updated paragraph Revised entire section for clarity

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			3.1.4 3.3 3.4 3.5	New sub-section Removed the word “Greenfield” Revised section consistent with ATC Power Factor Criteria Revised section consistent with ATC Planning Criteria
13.0	John Raisler	6/2022	1.1 1.2 2.4 2.5 3.1.2 3.1.3 3.1.5 3.2 3.3.1 3.3.2 3.3.3 3.4 3.8 3.9 4.12 4.3 5.3 Appendix 9	Changed DCG to DER Update Group Name Expanded facility description & one-line discussion Clarified BA Metering & easement rights discussion Added reference to Blackstart Plan Clarified Interconnected Entity Language Updated Paragraph – reinforced need for IC generator tie-line breaker Clarified tie-line jumper ownership Added reference to Sections 3.1.1 through 3.1.3 Added reference to Sections 3.1.1 through 3.1.3 Added discussion on common facility upgrades Added paragraph on zero MW output Added Reactive Power Capability paragraph Added discussion on Negative Sequence current Added Single Point of Failure paragraph Expanded breaker failure discussion Added table of measurements data requested per IEEE 2800 Added new terms to definitions list
14	John Raisler		1 2.2.3 3.12 Figure 3.1 Figure 3.2 Figure 3.3 3.4 3.5 – 3.11 6.1 6.2 7.6 7.8	Changed ATC logo Added new language Added new language New Drawing New Drawing New Drawing Updated language Added new sections Added new language Added new language Added new language Added new language

10 Appendix A: Glossary of Terms

Any capitalized terms not defined herein will have the meanings set forth in the MISO Tariff.

Applicable Regional Reliability Organization: the reliability organization of NERC applicable to the Balancing Authority of the Transmission System to which the Generating Facility is directly interconnected. ATC is a registered member of both the Midwest Reliability Organization (MRO) and ReliabilityFirst Corporation (RFC).

Applicable Reliability Standards: the requirements and guidelines of NERC, the Applicable Regional Reliability Organization, and the Balancing Authority of the Transmission System to which the Generating Facility is directly interconnected.

ATC Interconnection Facilities: all facilities and equipment owned by ATC from the Point of Change of Ownership to the Point of Interconnection as identified in the GIA. The ATC Interconnection Facilities are sole-use facilities and do not include Network Upgrades or the Customer's Interconnection Facilities.

Balancing Authority: an entity responsible for managing an electric system area (a Balancing Authority Area) bounded by interconnection metering and telemetry; and capable of controlling generation to maintain its interchange schedule with other Balancing Authority Areas and contributing to frequency regulation and which has received certification by NERC or a Regional Reliability Council of NERC.

Commercial Operation: the status of a Generating Facility that has commenced generating electricity for sale, excluding electricity generated during Trial Operation.

Customer: any entity that already has interconnected or proposes to interconnect a Generating Facility with the Transmission System also referred to as Interconnected Entity.

Customer's Interconnection Facilities: all facilities and equipment, as identified in the GIA, that are located between the Generating Facility and the Point of Change of Ownership, including any equipment necessary to physically and electrically interconnect the Generating Facility to the Transmission System.

Dynamic Reactive Power Devices: Static Var Compensators (SVCs), Static Synchronous Compensators (STATCOMs), Flexible AC Transmission Systems (FACTS), inverters, and synchronous condensers are all considered dynamic sources of reactive power. Dynamic sources can provide variable amounts of reactive power in a few milliseconds.

Electric Reliability Organization: the North American Electric Reliability Corporation authorized by the FERC to promulgate, seek approval for, and enforce Mandatory Reliability Standards.

Electrical Island: An isolated operating condition which couples a generator(s) to local load with no external connection to the Transmission System.

Emergency Condition: a condition or situation: (1) that in the reasonable judgment of the Party making the claim is imminently likely to endanger, or is contributing to the endangerment of, life, property, or public health and safety; or (2) that, in the case of either MISO or ATC, is imminently likely (as determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to the Transmission System, the ATC Interconnection Facilities or the electric systems of others to which the Transmission System is directly connected; or (3) that, in the case of the Customer, is imminently likely (as

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determined in a non-discriminatory manner) to cause a material adverse effect on the security of, or damage to, the Generating Facility or the Customer's Interconnection Facilities. System restoration and black-start will be considered Emergency Conditions; provided that the Customer is not obligated by this LGIA to possess black-start capability. Any condition or situation that results from lack of sufficient generating capacity to meet load requirements or that results solely from economic conditions will not constitute an Emergency Condition, unless one of the enumerated conditions or situations identified in this definition also exists.

Federal Power Act: the Federal Power Act, as amended, 16 U.S.C. §§ 791a *et seq.*

FERC: the Federal Energy Regulatory Commission or its successor.

Generating Facility: the Customer's device(s) for the production of electricity consisting of one or more generating units identified in the Interconnection Request, but not including the Customer's Interconnection Facilities.

Generating Facility Capacity: the aggregate net capacity of the Generating Facility where it includes multiple generating units at the Point of Interconnection.

Generator Interconnection Agreement (GIA): the interconnection agreement in the form of Appendix 6 of MISO's Generator Interconnection Procedures.

Generator Interconnection Procedures (GIP): the interconnection procedures that are included in the MISO Tariff and applicable to an Interconnection Request pertaining to a Generating Facility.

Generator Upgrades: the additions, modifications, and upgrades to the electric system of an existing generating facility or of a higher queued Generating Facility at or beyond the Point of Interconnection to facilitate interconnection of the Generating Facility and render the transmission service necessary to affect the Customer's wholesale sale of electricity in interstate commerce.

Good Utility Practice: any of the practices, methods and acts engaged in or approved by a significant portion of the electric industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region.

Governmental Authority: any federal, state, local or other governmental regulatory or administrative agency, court, commission, department, board, or other governmental subdivision, legislature, rulemaking board, tribunal, or other governmental authority having jurisdiction over the Parties, their respective facilities, or the respective services they provide, and exercising or entitled to exercise any administrative, executive, police, or taxing authority or power; provided, however, that such term does not include the Customer, MISO, ATC, or any Affiliate thereof.

Initial Synchronization Date: the date upon which the Generating Facility is initially synchronized and upon which Trial Operation may begin.

In-Service Date: the date upon which the Customer reasonably expects it will be ready to begin use of the ATC Interconnection Facilities to obtain backfeed power.

Interconnected Entity: Existing interconnection Customer. Often a Local Distribution Company (LDC) within the ATC system territory. (See “Customer” above)

Interconnection Agreement: the agreement executed or to be executed by ATC, the Customer, and MISO and filed at the FERC; representing mutually agreeable terms and conditions pertinent to the interconnection of the Generating Facility to the Transmission System. The form of this agreement not only acceptably includes MISO’s pro forma Generator Interconnection Agreement (GIA), but also agreements executed and filed for Generating Facilities whose interconnection preceded the existence of the GIA.

Interconnection Customer: For purposes of this Guide, an Interconnection Customer is the entity applying to MISO for a new generator interconnection or for a modification of an existing generator interconnection via the MISO Attachment X process resulting in a new or modified Generator Interconnection Agreement with ATC & MISO. This includes replacement and surplus generator interconnection applications.

Interconnection Facilities: all facilities and equipment between the Generating Facility and the Point of Interconnection, including any modification, additions or upgrades that are necessary to physically and electrically interconnect the Generating Facility to the Transmission System. Interconnection Facilities do not include Generator Upgrades or Network Upgrades.

Interconnection Facilities Study: a study conducted by MISO, or its agent, for the Customer to determine a list of facilities (including the ATC Interconnection Facilities, System Protection Facilities, and if such upgrades have been determined, Network Upgrades, Distribution Upgrades, Generator Upgrades, and upgrades on Affected Systems, as identified in the Interconnection System Impact Study), the cost of those facilities, and the time required to interconnect the Generating Facility with the Transmission System. The scope of the study is defined in Section 8 of MISO Generator Interconnection Procedures.

Interconnection Feasibility Study: a preliminary evaluation of the system impact of interconnecting the Generating Facility to the Transmission System, the scope of which is described in Section 6 of MISO Generator Interconnection Procedures.

Interconnection Request: a Customer’s request, in the form of Appendix 1 to the Generator Interconnection Procedures, to interconnect a new Generating Facility, or to increase the capacity of, or make a Material Modification to the operating characteristics of, an existing Generating Facility that is interconnected with the Transmission System.

Interconnection Study: any of the following studies: the Interconnection Feasibility Study, the Interconnection System Impact Study, and the Interconnection Facilities Study, or the Restudy of any of the above, described in the Generator Interconnection Procedures.

Interconnection System Impact Study: an engineering study that evaluates the impact of the proposed interconnection on the safety and reliability of Transmission System and, if applicable, an Affected System. The study will identify and detail the system impacts that would result if the Generating Facility were interconnected without project modifications or system modifications, focusing on the Adverse System Impacts identified in the Interconnection Feasibility Study, or to study potential impacts, including but not limited to those identified in the Scoping Meeting as described in the Generator Interconnection Procedures.

Mandatory Reliability Standards: those standards promulgated and approved by NERC as the ERO, or any Regional Entity authorized to do so, as ratified and approved by the FERC that are applicable to ATC and the Customer.

MISO: the Midcontinent Independent System Operator, Inc., the Regional Transmission Organization that administers the tariff and provides transmission and energy market services over the transmission facilities of its transmission-owning members in interstate commerce.

NERC: the North American Electric Reliability Corporation or its successor organization.

Network Upgrades: the additions, modifications, and upgrades to the Transmission System required at or beyond the point at which the Interconnection Facilities connect to the Transmission System to accommodate the interconnection of the Generating Facility to the Transmission System.

Point of Change of Ownership (PCO): the point, as set forth in Appendix A to the GIA or Exhibit 1 of an Interconnection Agreement, where the Customer's Interconnection Facilities connect to the ATC Interconnection Facilities.

Point of Interconnection (POI): the point at which the ATC Interconnection Facilities connect to the ATC interconnection substation bus.

Rate of Change of Frequency (ROCOF): ROCOF is the average rate of change of frequency over an averaging window of at least 0.1s.

Responsible Person: the single point or field contact for ATC Systems Operations for all outages, clearance needs and system impacts occurring during construction activities.

Regional Entity: the entity or entities that have entered into a delegation agreement with NERC and that have responsibility for the audit and investigation of the compliance with Mandatory Reliability Standards.

Safe Work Plan: the safe work plan includes a breakdown of the planned activities labeling hazards and mitigation steps required to be implemented for hazard elimination or control.

Static Reactive Power Devices: Mechanically switched capacitor banks and inductors are considered static sources of reactive power. Static reactive power sources can be switched on or off in the range of seconds and provide reactive power in large discrete blocks.

Tariff: MISO Tariff through which open access transmission service and Interconnection Service are offered, as filed with the FERC, and as amended or supplemented from time to time, or any successor tariff.

Transmission Operator: any entity responsible for the reliability of its "local" transmission system, and that operates or directs the operations of the transmission facilities.

Transmission System: the facilities owned by ATC and controlled or operated by MISO and ATC at voltages ≥ 69 kV and are used to provide transmission service or Wholesale Distribution Service under the Tariff.

Trial Operation: the period during which the Customer is engaged in on-site test operations and commissioning of the Generating Facility prior to Commercial Operation.

11 Appendix B: Generator Data Requirements

ATC requires the following information from the Customer to properly ensure proper system operation and to model any Generating Facility connected to the Transmission System. This information is required:

- For Commercial Operation of a new plant or unit
- For a modification impacting an existing interconnection
- If Generating Facility capability information has changed during implementation (*e.g.*, from typical/estimated to approved/final or due to a design modification)
- If Generating Facility capability information has changed due to plant/unit maturation
- The Generation Data Requirements Matrix can be requested at:

gioanotices@atcllc.com

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Interconnecti
on Solutions
262-506-6700

Modifications to Existing Plants/Units

The generator data requirements identified in Appendix B are applicable to new Generating Facility Interconnections and any modifications made to existing Generating Facilities (*e.g.*, exciters, governors, protection systems, main or auxiliary transformers, etc.). The Generator Owner shall communicate any planned generator modifications to the plant that would impact any of the parameters listed in Appendix B. Such modifications are communicated to ATC according to the terms of the Interconnection Agreement. Please communicate modifications using ATC's Generating Facilities Modification Notification (GFMN) form which is available online at:

[http://www.atcllc.com/wp-content/uploads/2013/12/GFMN-](http://www.atcllc.com/wp-content/uploads/2013/12/GFMN-Template_121613.docx)

[Template_121613.docx](#) Send the GFMN to ATC using the following e-mail

address:

gioanotices@atcllc.com

Upon receiving a GFMN, ATC will review the Customer's proposed/planned modification(s) and determine the impact of these on the transmission system. If

modifications are determined to impact the transmission system, ATC will establish a discussion to determine the appropriate solution(s) to enable successful implementation.

11.1 Data Requirements Matrix

Data requirements for the generator during construction and up to 180 days after the COD will be included in Appendix B of the Generator Interconnection Agreement.

12 Appendix C: Generating Unit Test Requirements

This Appendix summarizes the detailed guide Generator Owners use in scheduling generating unit testing with ATC as well as sets forth the communication requirements for the data derived from such testing. A sample of a generator capability curve can be seen in Figure 4. A flowchart documenting the process is included in Figure 5. The entire guide can be seen through the Generator Modeling Database extranet site. For further details on the extranet site contact ATC-Interconnection Solutions.

11.1 Generating Unit Test Data Requirements Timeline

Following are the ATC requirements of a Generator Owner when the Generator Owner is planning to perform a test of a generating unit. The requirement and benefits fall into two categories:

1. Test Plan and Execution
 - a. ATC real time Operations are aware of tests, are then aware of real time system anomalies and can react accordingly
 - b. ATC Operations can support the Generator Owner test with adjustments to the transmission system
 - c. ATC System Protection is aware of special conditions that may exist during the test and can react prior to the test
 - d. ATC Operations EMS function has awareness and can then record specific reactions during the test for the use in real time operations
2. ATC Receipt of Resulting Test Results
 - a. Provides/confirmes the most current generator capabilities allowing ATC Planning, System Protection and real time Operations to adjust data and system expectations
 - b. Results can directly impact the outcome of ATC 10-Year Plan
 - c. Satisfies the following Regulatory Requirements:
 - i. FAC-008 – Facilities Rating Methodology
 - ii. MOD-024 – Identifies the Test Data Required
 - iii. VAR-002 – Identifies the Requirement for the Communication
 - iv. TOP-003 – Defines Test Requirements

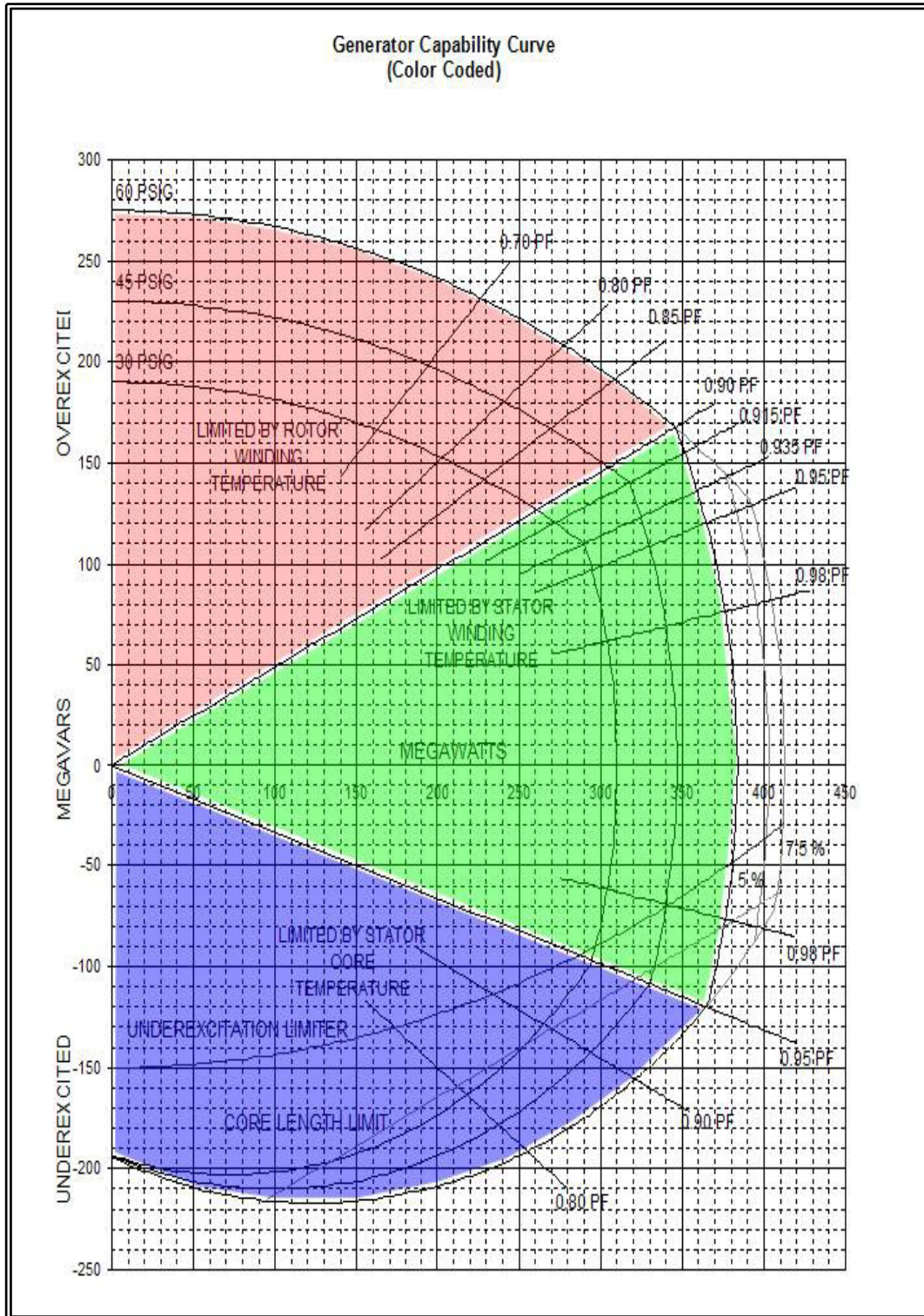


Figure 5 Generator Capability Curve

Last updated: 07/05/2022

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GO/ATC Generator Reactive Test Process

Communication and Coordination for Generator Owner and ATC

The period of time from point 3 To point 11 can be as short as 5 Business Days.

The time period can be longer, based on discussions with the customer for each specific test.

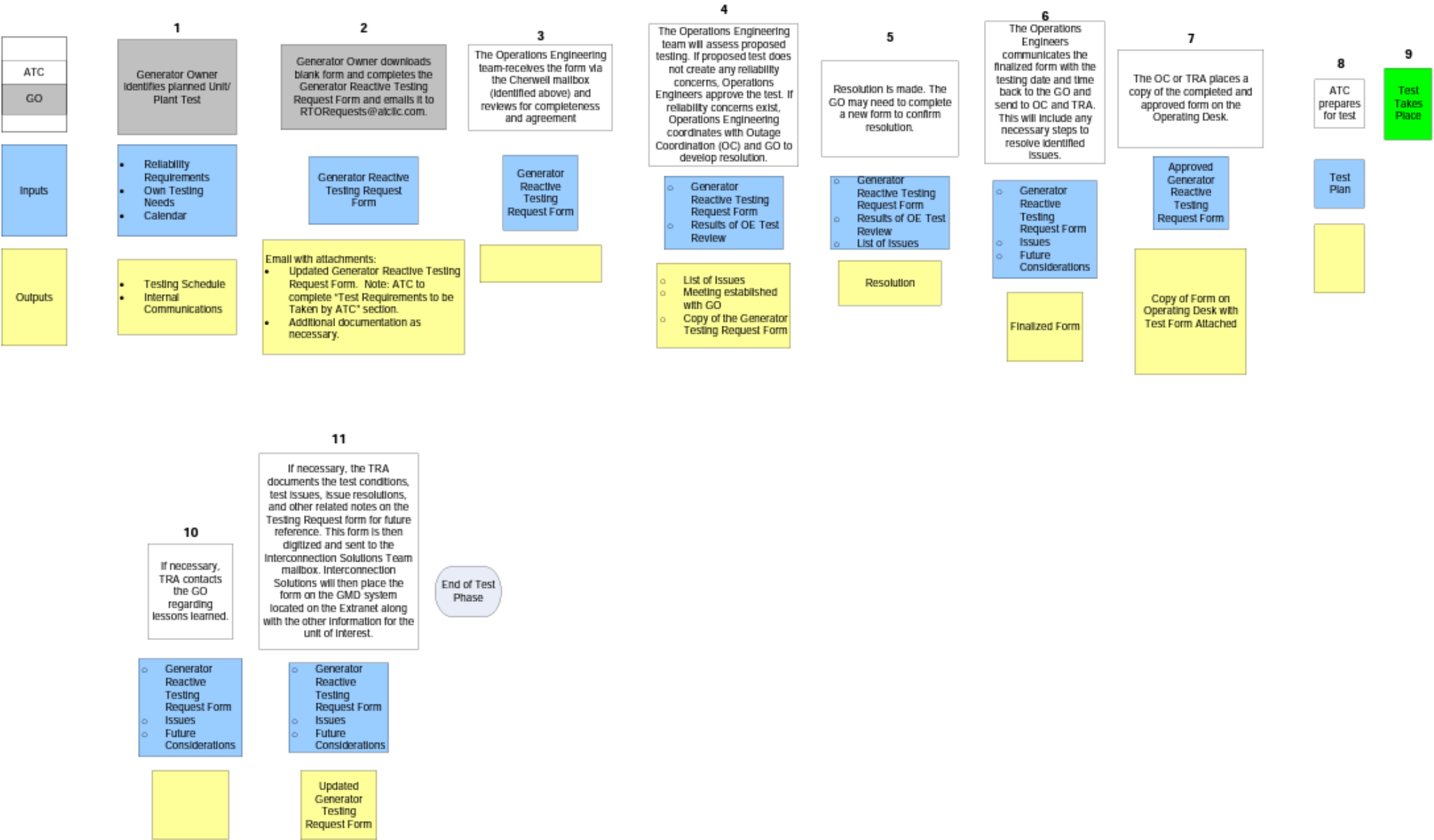


Figure 6 Generator Test Process Flowchart