TRANSMISSION FACILITIES INTERCONNECTION REQUIREMENTS

AMP Transmission

INDEX

AMP Transmission (AMPT) Transmission Facilities Interconnection Requirements

APPENDICES and ATTACHMENTS

Objective

This document contains the interconnection requirements to facilitate the safe, efficient, and reliable integration of any electrical transmission, generation, and end-user facility into the transmission system (System) of AMP Transmission, LLC (AMPT).

Purpose

The criteria set forth in this document ensure compliance with the Facilities Design, Connections, and Maintenance standards of the North American Electric Reliability Corporation (NERC), ReliabilityFirst (RF), and PJM Interconnection, L.L.C. (PJM). AMPT is a Transmission Owner (TO) member of the PJM Regional Transmission Organization (RTO). AMPT subscribes to and designs its Bulk Electric System (BES) and all networked non-BES transmission facilities to comply with the reliability principles and responsibilities and, in all cases, the AMPT standards are consistent with the requirements for Facility Interconnections as specified by the applicable NERC Reliability Standards, RF reliability principles and standards, guides, procedures, and reference documents, PJM documents and manuals and applicable RTO tariffs and governing documents. The requirements included in this document apply to all AMPT facilities included in the applicable PJM Open Access Transmission Tariff. Any Interconnecting Party seeking to modify or establish a new Interconnection to the AMPT System shall comply with the requirements set forth herein, which may not address all applicable requirements. The requirements set forth herein provide a reference for typical situations, and, as such, should be considered as the minimum requirements.

Definitions

For the application of this document, the following definitions apply. Capitalized terms that are not defined herein shall have the meaning ascribed to them in NERC Glossary of Terms (see references).

End-User Interconnection (Load Customer): An electrical connection between the AMPT System and a wholesale load customer such as a municipally owned electric system, a cooperative electric system, or an investor-owned distribution utility.

Generation Interconnection: An electrical connection between the AMPT System and a generation facility that is a PJM Capacity and/or Energy Resource. This does not include behind-the-meter generation.

Interconnecting Party: A person or entity seeking to establish a new or modify an existing Transmission, Generation and/or End-User Interconnection to the AMPT System.

Transmission Interconnection: An electrical connection between the AMPT System and another networked transmission system, such as the Transmission Facilities of an adjacent Transmission Owner (TO), whereby components are operated in synchronism such that the failure of one or more of such components may adversely affect the ability of the operators of other components within the system to maintain reliable operation of the Transmission Facilities within their control.

Behind-The-Meter Generation: Generation facility which is directly connected to end user load and is not separately metered from the load for billing purposes.

1. AMPT Transmission Interconnection Requirements

1.1 General

The planning and implementation of new or modified Transmission, Generation, and End-user Interconnections to the AMPT System are coordinated through the PJM Regional Transmission Expansion Plan (RTEP), and the updated Multi-Regional Modeling Working Group Process (MMWG) base cases. The RTEP processes are documented on the PJM web site at (www.pjm.com).

For End-User and Transmission Interconnections, AMPT will perform Preliminary Interconnection Studies and Final Interconnection Studies for any proposed new or modified Interconnections to evaluate the impact on the AMPT System. AMPT will notify adjacent Transmission Owners, transmission customers, RTOs or others that may be impacted by the proposed new or modified Interconnection as required by applicable requirements as soon as feasible. AMPT will share and coordinate its study results with the impacted parties as appropriate and in compliance with AMPT's Standards of Conduct Policy. Any impacted party, at its discretion, may perform an independent evaluation of the impact of the proposed project. As a prerequisite to construction, the End-User or Transmission Owner proposing the new or modified Interconnection to the AMPT System must resolve all disputed issues with any intervening party.

For End-User Interconnection requests, please fill out the form that is shown in Attachment D.

An Interconnection Study is an assessment by AMPT of the capability of the existing system to accommodate the request for the new or modified Interconnection. It typically includes but is not limited to the following:

- Power flow analysis
- Short circuit level at point of interconnection
- Dynamic Study as needed for generation interconnection
- Consideration of special circumstances if deemed necessary (for example power quality issues such as a large welding shop or an arc furnace

customer)
- Identification of direct connection requirements
- Identification of network upgrades needed
- Consideration of multiple connection alternatives
- Operational limitations
- Written report of results
- Estimates of costs associated with direct connect and system upgrades
- Preliminary protection requirements

Any costs provided in the Interconnection Study are preliminary, Order of Magnitude (OOM) level estimates. Such estimates are often generated with AMPT Engineering input and typically should assume a +/- 30% variance.

Generation Interconnections that participate in the PJM market must follow the PJM Interconnection Process. AMPT will coordinate the study with PJM for those Generation Interconnections.

For generation considered "Behind-The-Meter" but impactful to the AMPT System, AMPT will study proposed new or modified interconnections to evaluate the impact on the AMPT System. AMPT will notify those impacted by the proposed BTM generation. AMPT will coordinate the study results with impacted parties (such as other TO's) as appropriate and in compliance with applicable confidentiality requirements. Any impacted party, at its own discretion, may perform an independent evaluation of the impact of the proposed project. As a prerequisite to construction, the generator owner proposing the new or modified interconnection must resolve all disputed issues with any intervening party.

For Behind-The-Meter Generation requests, please fill out the form that is shown in Attachment C.

The applicability of each main section of this document to Transmission, Generation, and End-User Connection facilities is identified in the title of each of the following sections.

2. Interconnection Applications (Transmission, Generation, and End-User Interconnections)

2.1 General

When the location and size of any new or modified End-User or Transmission Interconnection proposal has been determined, the End-User or Transmission Owner must complete the appropriate application and submit it with any required deposit to the specified AMPT agent. The appropriate application can be found on the AMPT website or the PJM website (for Generator Interconnections that wish to participate in the PJM market). Refer to AMPT FERC Form 715 for all Transmission Planning criteria.

AMPT will coordinate any resulting system upgrades required by the proposed Interconnection with PJM as applicable.

3. End-User Interconnection Requirements

3.1 General

All connections to the AMPT System must be designed such that, under normal operating conditions, faults at the Interconnecting Party's facility will be cleared and isolated by a dedicated interrupting device(s) and will not result in an outage of any transmission line, bus, transformer, AMPT facility, or AMP Member facility, other than the faulted facility itself.

3.2 Tap Connection Definition and Requirements

A radial connection directly to an AMPT transmission line is generally prohibited. Interconnecting to an AMPT transmission line will require construction of, at minimum, a 3-breaker ring bus substation. Alternative (lesser) configurations may be considered on a case-by-case basis, for very small End-User Interconnections. See Figure 1 and Figure 2 for allowable Interconnections to an AMPT transmission line.

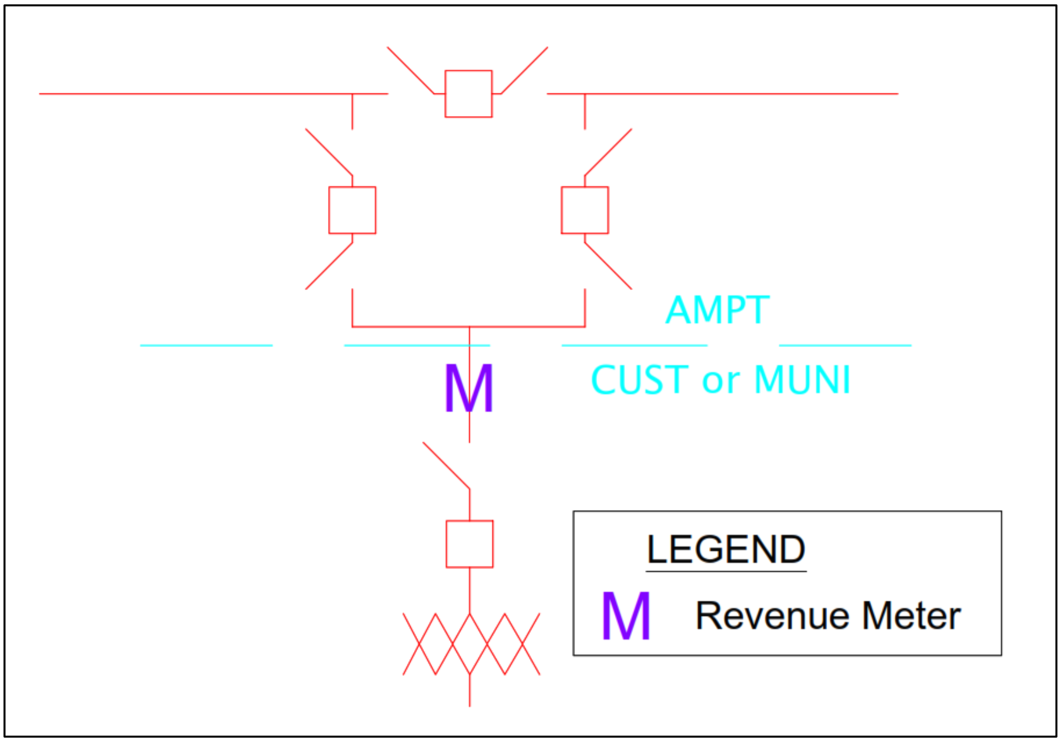


Figure 1: Radial Tapped Load Supply 138 kV and Below

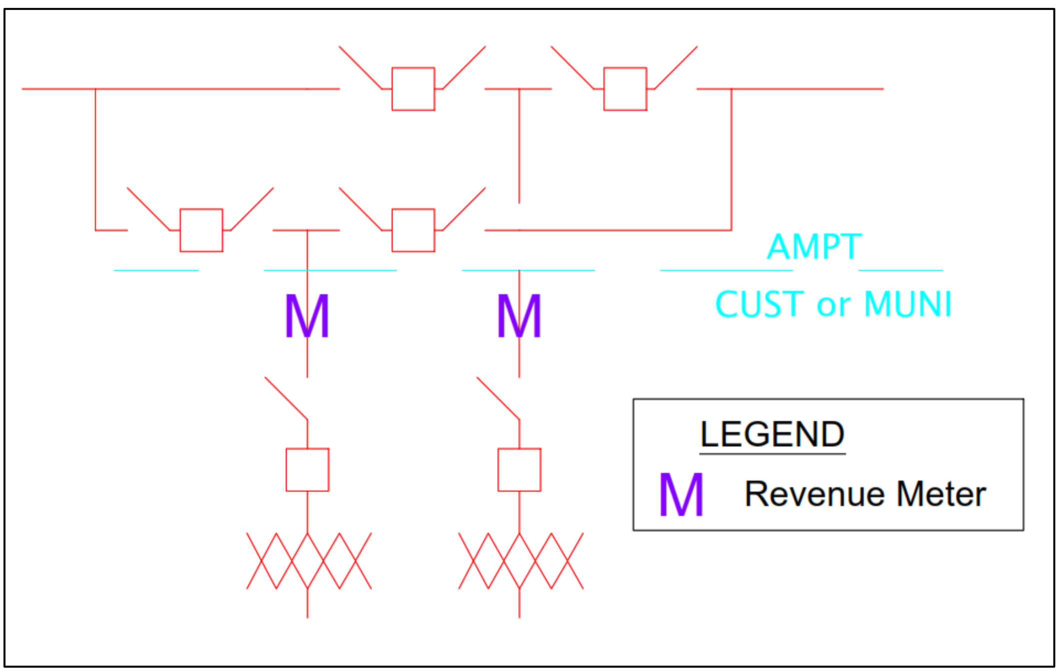


Figure 2: Radial Tapped Load Supply 138 kV and Below

4. Voltage Levels, System Capacity, and Operational Issues (Transmission, Generation, and End-User Interconnections)

The Interconnecting Party's facility will be supplied from AMPT's transmission system, which is designed to operate between the following voltage ranges under normal and single transmission element outage conditions.

95.0% - 105%: System Normal Conditions
92.0% - 105%: System Emergency (Outage) Conditions

These values are specified in the AMPT FERC 715 document, which is the controlling document.

Under certain emergency conditions involving multiple system contingencies, the transmission system may operate for a period outside of this range but must be able to return to stated operational limits within an acceptable period. The Interconnecting Party is responsible for providing any voltage sensing relaying required to protect its facility during abnormal voltage operation.

The real and reactive (MW and MVAR) capacity or demand at the point of connection is limited by the capabilities of the AMPT System. Analysis and documentation of these capabilities are provided through the Interconnection processes referenced in Section 1 (General) of this document. Operational issues associated with the proposed facilities will be analyzed and documented through the Interconnection processes referenced in Section 1 (General) of this document.

All AMPT analysis will include detailed modeling of associated interconnection facilities to ensure the Interconnecting Party's and AMPT's systems operate within acceptable limits as described in AMPT FERC Form 715 Transmission Planning criteria.

5. Load Power Factor Requirements (End-Users Only)

End-Users interconnected directly to the AMPT System should plan and design their systems to operate at approximately unity power factor under peak loading conditions to minimize the reactive power burden on the transmission systems. AMPT recommends that End-Users achieve between 0.98 Lagging PF and unity power factor at the point of interconnection (e.g., high side of distribution transformer) during peak load conditions. Operating at lagging power factor during light load is generally preferrable to prevent high voltage concerns during light load. Ultimately, the power factor requirements shall default to those of the zonal transmission owner (i.e., ATSI, AES, AEP, etc.).

Shunt capacitors are frequently used to control the power factor of an Interconnecting Party's facilities. However, there are several operating conditions that the Interconnecting Party should address in applying capacitors to avoid potential problems. These problems can include, but are not limited to, transient voltages due to capacitor switching and voltage amplification due to resonance conditions. Interconnecting Parties are responsible for engaging the services of a qualified consultant to review the specific application and provide recommendations regarding control of these phenomena. Procurement and cost of qualified consultant is the responsibility of the Interconnecting Party. However, AMPT reserves the right for approving any proposed recommendations to control the power factor.

6. Frequency Range (Transmission, Generation, and End-User Interconnections)

The PJM and MISO Transmission Systems typically operate at a nominal 60 Hz with a variation of ± 0.05 Hz. Under certain emergency conditions, the transmission system may operate for a period of time outside of this range. The Interconnecting Party is responsible for providing any frequency sensing relaying required to protect its facilities during abnormal frequency operation.

7. Power Quality (Transmission, Generation, and End-User Interconnections)

7.1 Voltage Flicker and Harmonics

Certain electrical equipment located at an Interconnecting Party's facilities (large motors, arc furnaces, cycloconverters, inverters, etc.) may generate voltage flicker and harmonics that can adversely impact the transmission system. Harmonics in particular can have far-reaching impacts remote from the location where the harmonics are generated.

The Interconnecting Party's facility shall comply with harmonic voltage and current limits specified in the most recent revision of IEEE Standard 519, "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

AMPT will evaluate voltage flicker for infrequent events such as a large motor starting in cooperation with the AMP Member. The Interconnecting Party shall notify AMPT well in advance of any planned addition of large load (i.e., load additions greater than 1 MW) which may cause flicker or harmonics, and AMPT will calculate the anticipated flicker prior to the load being connected. In addition, AMPT may study or measure voltage flicker on an as-needed basis for existing loads, when voltage flicker complaints are received. AMPT will follow Annex A of IEEE Std. 1453-2004 or the most recent revision.

AMPT will measure voltage flicker on AMPT-owned facilities as described in the most recent version of IEEE Std 1453, "IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems". P_{st} is a measure of short-term perception of flicker obtained for a ten-minute interval. P_{lt} is a measure of long-term perception of flicker obtained for a two-hour period calculated from 12 consecutive P_{st} values. The Interconnecting Party shall design and operate the interconnected facility such that P_{st} does not exceed 0.8 and P_{lt} does not exceed 0.6 for 1% of the time (99% probability level) using a minimum assessment period of one week.

AMPT may initially, or in the future, require the Interconnecting Party to install reduced voltage starting, harmonic filters, or other mitigating equipment to reduce or eliminate adverse power quality impacts to other customers on the system.

7.2 Sensitive Electrical Equipment

Certain electrical equipment may be sensitive to normally occurring electric interference from nearby connected loads in the Interconnecting Party's facility or from other customers connected to the power system. If such equipment is to be supplied from the electric power system, it is recommended that the equipment grounding requirements and power supply requirements be examined by the Interconnecting Party or its consultant prior to installation. Attention should be given to equipment tolerance to various forms of electric interference, including voltage sags and surges, momentary outages, transients, harmonics, or other electrical noise.

When AMPT or other customers cannot tolerate electrical disturbances to sensitive electrical equipment, the Interconnecting Party shall furnish additional equipment as may be necessary to mitigate this issue.

8. Interconnecting Party Substation Equipment Requirements (Transmission, Generation, and End User Interconnections)

8.1 Size and Pull-Off Tension of Line Conductors and Overhead Ground Wire

The sizes and approximate pull-off or dead-end tension for each phase conductor and ground wire will be provided by AMPT for design of the takeoff structure. AMPT will determine the exact pull-off tensions after the substation plans are finalized.

The line terminal connectors furnished by the Interconnecting Party to bolt to the air switch terminal pad shall be compression type. The ground wire shall be bonded to the steel structure and the station ground grid by the Interconnecting Party.

The point of attachment of the line entrance conductors shall be of sufficient height to provide the basic vertical clearance requirements for lines crossing over public streets, alleys, or roads in urban or rural districts, as outlined in the National Electrical Safety Code's latest revision.

8.2 Short Circuit Data and Interrupting Device Ratings

AMPT will provide the following anticipated short circuit data for a specific point of connection:

- 3 Phase Fault in Amperes (AMPS)
- Phase to ground fault (AMPS)
- Single Line-Ground Fault (AMPS*)
- System Impedance on 100 MVA Base as Z1%, Z0%

*Note: AMPT System phase to ground fault values are calculated assuming transformers with either a wye-ungrounded or delta-connected high side. For wye-grounded transformers, the transformer contribution to the total fault current will have to be taken into account.

The Interconnecting Party will be responsible for providing short circuit data related to their modeled facility in a format coinciding with ASPEN One-Liner modeling software outputs.

Substation equipment shall have interrupting and momentary ratings adequate for the short circuit conditions of the existing facilities. As described in Table 1, this includes a minimum 40 kA momentary withstand limit or greater if location specific studies require it. Fault interrupting devices shall have the open-close duty cycle ratings necessary to accommodate their required open-close sequences.

While AMPT will endeavor, where possible, to anticipate future system changes which may affect the provided values, it does not assume responsibility or liability with respect to such protective devices, nor guarantee their continuing adequacy against increased interrupting capacity requirements resulting from system changes.

Interconnected Parties are responsible for periodic review of existing and future fault conditions and for any future equipment upgrades, modifications or replacements that are required. PJM and AMPT would also analyze these situations if there is appropriate data to do so and work with the Interconnecting Party to update their systems.

All gas and vacuum insulated interrupting devices within the Interconnecting Party's facility having a direct connection to an AMPT transmission line shall be equipped with a low gas pressure or low vacuum alarming/tripping/lockout scheme (as appropriate for the particular device) in order to minimize the possibility of a transmission fault resulting from a of loss of insulating gas or loss of vacuum.

8.3 Other Design Criteria

8.3.1 Equipment Basic Insulation Levels

The minimum required Basic Insulation Levels (BIL) are listed in Table 1. Substations in areas with significant airborne pollution may require a higher insulation level.

8.3.2 Transformer Surge Protection (Lightning Arresters)

Metal oxide arresters are preferred for transformer protection. Minimum arrester gradings/classifications are listed in Table 1.

Arresters protecting transformers are generally mounted on the transformer. When the arresters will not be mounted next to the terminals of the equipment to be protected, the voltage at the protected insulation will usually be higher than at the arrester terminals. Interconnecting Parties should consult the MOV arrester application guide, IEEE Std C62.22, to determine the maximum acceptable separation distance between the arresters and the protected equipment.

Interconnecting Parties should consult manufacturer's catalog for details concerning arrester protective characteristics, ratings, and application.

8.3.3 Transformer Type & Windings

AMPT requires that the End-User transformers be two-winding. Transformers with a low side voltage that is considered distribution levels (e.g., 4.16 kV, 12.47 kV, 13.2 kV, 13.8 kV, etc.) shall be delta-wye connections. This is to reduce harmonics and separate protection schemes.

8.3.4 Ratings of Current Carrying Equipment

For looped or networked configurations, the Interconnecting Party's high voltage bus and associated equipment, such as switches, connectors, and other conductors, shall have a minimum continuous current carrying rating and a momentary asymmetrical current rating as listed in Table 1. The ampacity of all substation equipment in the network through-path shall meet or exceed the ampacity of the transmission line. Minimum current ratings will be provided by AMPT for looped or network supply configurations.

8.3.5 Electrical Clearances (Outdoor)

Electrical substation design clearances are listed in the attached Table 1. These design clearances shall be used for electrical facilities up to and including any interrupting device connected directly to an AMPT transmission line and for all facilities that are part of the AMPT transmission current path.

The safety clearances from live parts to all permanent support surfaces for workers shall be no less than the minimum listed in Table 1 and shall be applied throughout the entire substation.

The minimum vertical clearance of the conductors above ground and the vertical and horizontal clearance of conductors passing by but not attached to a building or wall shall be in accordance with the National Electrical Safety Code or applicable state and local codes.

8.3.6 Insulators for Substation

The required station post insulator types are listed in Table 1. Substations in areas with significant airborne pollution may require a higher insulation level. Higher strength insulators are available and Interconnecting Parties use such high strength insulators as needed to meet bus momentary short circuit withstand values.

8.3.7 Switch(es) With Arcing Horns and Disconnect Switch(es)

Interconnecting Party shall install a gang operated air break switch with arcing horns on each transmission line supply entrance to the Interconnecting Party's facility at a location that is accessible by AMPT personnel 24 hours a day. The switch shall be lockable in the open position with an AMPT padlock to provide for a visible electric isolation of the Interconnecting Party's facility and shall be identified with an AMPT-designated equipment number/name. Interconnecting Party shall provide a ground mat of 4' x 6' dimension beneath the air switch operating handle and located so that the switchman will remain on the mat while operating the switch. The mat shall be connected electrically directly to the grounding point of the switch handle and from there to the station ground grid.

These switches with arcing horns shall be three pole, single throw, gang operated. Disconnect switches may be single pole, single throw, hook-stick operated or three pole, single throw, gang operated. Characteristics for all switches with arcing horns and disconnect switches including voltage and BIL ratings, clearances and pole spacing shall be as given in Table 1. Substations in areas with significant airborne pollution may require a higher BIL level. There shall be no braids in the current carrying parts of the switch. Gang operated switches shall be complete with a horizontal, rotating-type operating handle. Interconnecting Parties shall furnish a grounding device for the operating shaft that shall consist of a tin coated, flexible copper braid, located as close as possible to the operating handle. The braid shall have a cross sectional area equivalent to 4/0 copper cable, or greater. The braid shall be secured to the shaft by means of a galvanized steel U-bolt clamp and associated cradle-type galvanized steel hardware. The opposite end of the braid shall have two (2) 9/16 inch holes at 1-3/4 inch spacing. Both ends of the braid shall be stiffened and protected by a ferrule or additional tinning.

All switches are to be manufactured and tested in accordance with the latest revision of IEEE Std C37.30, ANSI C37.32, and IEEE Std C37.34.

8.3.8 Substation Fence Safety Clearances

The fence safety clearances in the Interconnecting Party substation shall comply with Section 11 of IEEE Std C2, National Electrical Safety Code (NESC).

8.3.9 Grounding System Design and Test

The Interconnecting Party shall design the grounding system in accordance with IEEE Std 80 – latest revision, "IEEE Guide for Safety in AC Substation Grounding." The Interconnecting Party shall ensure the grounding system design and construction is verified by tests in accordance with IEEE Std 81, "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Surface Potentials of a Ground System." The Interconnecting Party shall provide a copy of the test results to AMPT.

Ground fault currents from AMPT sources are referenced in Section 8.2, Short Circuit Data & Interrupting Device Ratings.

Interconnecting Party assets can contribute significant fault current independent of the ground fault values in Section 8.2. The Interconnecting Party shall consider these ground sources in the design of the grounding system.

If the substation structure is to be wood-pole type construction, the transmission line overhead ground wire, all switch bases, fuse bases, and other non-current carrying metal parts shall be grounded.

9. System Protection (Transmission, Generation, and End-User Interconnections)

9.1 AMPT System Protection

AMPT will provide functional specifications and relay settings for protective relays, including the protection and control equipment required for synchronizing of power systems at the Interconnecting Party's facility that have a potential impact on the reliability of the AMPT System. The criteria for these functional specifications and settings will be based upon requirements set forth by AMPT. AMPT also reserves the right to specify the type and manufacturer for these protective relays. The specific recommendations and requirements for protection will be made by AMPT based on the individual substation location, voltage, and configuration.

Those protective relays required by AMPT and any auxiliary-tripping relay associated with those relays shall be utility-grade devices. Utility grade relays are defined as follows:

1. Meet IEEE Std C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus."
2. Have relay test facilities to allow testing without unwiring or disassembling the relay.
3. Have appropriate test plugs/switches for testing the operation of the relay.
4. Have targets to indicate relay operation.
   The relaying system shall have a reliable and separate source of power independent from the ac system or immune to ac system disturbances or loss (e.g., dc battery and charger) to assure proper operation of the

protection scheme.

AMPT will provide short circuit data for the specific point of connection for additional AMPT transmission facility outage contingencies as requested by the Interconnecting Party for use during the completion of power system studies.

AMPT will review settings for the Interconnecting Party's internal relays to establish coordination between the facility protective equipment and the AMPT System relays.

9.2 Interconnecting Party Protection

It is the Interconnecting Party's responsibility to assure protection, coordination and equipment adequacy within their facility for conditions including but not limited to:

1. Single phasing of supply
2. System faults
3. Equipment failures
4. Deviations from nominal voltage or frequency
5. Lightning and switching surges
6. Harmonic voltages
7. Negative sequence voltages
8. Separation from AMPT supply
9. Synchronizing generation
10. Synchronizing facilities between independent transmission system and AMPT Transmission System

It is the Interconnecting Party's responsibility to determine that their internal protective equipment coordinates with the required AMPT protective equipment and is adequate to meet all applicable standards to which the party may be subject.

AMPT further reserves the right to modify relay settings when deemed necessary to avoid safety hazards to utility personnel or the public and to prevent any disturbance, impairment, or interference with AMPT's ability to serve other customers. AMPT will ensure they coordinate any relay changes with the Interconnecting Party as appropriate.

10. Remote Relay Access (Transmission, Generation, and End-User Interconnections)

10.1 Loop or Network Connected Substations

AMPT reserves the right to request event data from any digital devices which have the capability of recording system disturbance information and that are used to protect AMPT transmission facilities. Interconnecting Party shall provide such devices to AMPT with the equipment necessary to allow AMPT to retrieve data after an operational event.

10.2 Tap Connected Substations

Although not normally required at tap connected facilities, AMPT may at its option require remote relay access at a specific facility.

11. SCADA Requirements (Transmission, Generation, and End-User Interconnections)

11.1 Loop and Network Connected Substations

Loop and network connected facilities shall be equipped with a Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU) and shall be connected via an appropriate, Interconnecting Party-supplied, dedicated communications channel to the AMPT's Transmission System Control Center. The RTU shall provide AMPT with at least the information and control capabilities listed within PJM Manual 1. Facilities with unusual or non-conforming load characteristics may be required to provide additional information and control capabilities beyond those listed.

11.1.1 Control

The RTU shall provide AMPT with control of all circuit interrupting devices that are directly in the AMPT transmission path.

11.1.2 Position Indication

The RTU shall provide AMPT position indication of all transmission voltage circuit interrupting devices and motor operated disconnect devices.

11.1.3 Alarms

The RTU shall provide AMPT equipment alarm information for each circuit interrupting device and associated protective relaying in the transmission path. Indication of protective relay operation alarms for relaying other than the transmission line relaying that operates a circuit interrupting device in the transmission path will also be provided. (These might include breaker failure or bus differential relaying).

11.1.4 Operational Metering

The RTU shall provide AMPT instantaneous bi-directional real and reactive power metering (MW and MVAR) and voltage (kV) for all AMPT transmission lines connected to the facility, as well as current (A) metering of each circuit breaker in the transmission path. These quantities may be measured using relay accuracy class instrument transformers and meters/transducers.

11.1.5 Revenue Metering

The RTU shall provide AMPT access to the revenue metering quantities specified in Section 12 using DNP 3.0 or other approved industry standard communications protocol. Revenue metering is to be provided by and owned by the Interconnecting Party unless the zone-owning Transmission Owner has a policy that affects the project, which is dependent on the proposed project location and tie-in point.

11.2 Radial Connected Substations

AMPT may require radial-connected facilities with unusual or non-conforming load characteristics to install a SCADA RTU. If an RTU is required, AMPT will specify the information and control capabilities to be provided.

12. Revenue Metering Requirements (Transmission, Generation, and End-User Interconnections)

12.1 Requirements For All Interconnecting Parties

Revenue metering requirements will be specified by the PJM settling entity in accordance with its specifications as applicable. Metering requirements can be found within PJM Manual 1.

All Metering Equipment shall be tested prior to any operation of the Interconnecting facilities. Power flows to and from transmission customers shall be measured at the Point of Interconnection, or, upon the mutual agreement of the Interconnected Transmission Owner, at another location with appropriate loss compensation incorporated into the meter readings. Metering equipment shall be installed to meter the aggregated load of the connect facility consisting of instantaneous bi-directional real and reactive power (MW and MVAR) as well as integrated hourly real and reactive energy (MWH and MVARH).

The meters, test switches and any other secondary devices that could have any impact on the performance of the metering facilities shall be sealed at all times and the seals shall be broken only when tests, adjustments, and/or repairs are required and after both parties have been informed. Communication equipment shall be provided to allow AMPT to remotely retrieve revenue metering data via Interconnecting Party supplied access to available fiber communications system. AMPT shall set the password and any other security requirements for remotely accessing the revenue meters to ensure the security of the meters and the meter data.

The instrument transformers for the revenue metering system shall follow the latest IEEE Std C57.13. It is the Interconnecting Party's responsibility to source and provide adequate equipment that can perform the required functions as described in this document. The Interconnecting Party, or the Transmission Owner in whose zone the Interconnecting Party is located if applicable, will maintain ownership of metering equipment.

12.2 Revenue Metering Requirements Specific for Transmission

Any Interconnecting Party that anticipates interconnection via tie-line between AMPT and a zone-owning Transmission Owner, will be required to provide revenue metering if the site location is cross-zonal. If the proposed facility location is not cross-zonal, then the need for revenue metering will be assessed on a case-by-case basis by AMPT and the zone-owning Transmission Owner. Additional requirements on revenue metering may need to be met depending on the neighboring Transmission Owner's policies.

The zone-owning Transmission Owner shall determine the location where the Metering Equipment will be installed, after consulting with Interconnection Customer and the Interconnected Transmission Owner.

12.3 Revenue Metering Requirements Specific for Generation

The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only back-feeding station service from the Transmission Owner. This may require the use of high accuracy extended range current transformers. AMPT shall determine the location where the Metering Equipment shall be installed after consulting with Interconnecting Party and the zone-owning Transmission Owner.

12.4 Revenue Metering Requirements Specific for End-User

The instrument transformers and revenue meter equipment shall be installed on the transmission voltage side of the Interconnecting Party's step-down transformer, on the load side of the fault-interrupting device, and within the local zone of fault protection of the interconnecting load facility.

13. Communications (Transmission, Generation, and End-User Interconnections)

13.1 Normal Voice Communications

When required by AMPT, the Interconnecting Party shall provide a dedicated voice communication circuit to the AMPT Transmission System Control Center. Such a dedicated voice communication circuit would originate from the Interconnecting Party's 24-hour manned operations office and would be typically required for:

- Generation Facilities – Synchronization and operation of generation in excess of 2.5 MW supplying to the AMPT System,
- Transmission Substations – Connected transmission facilities only supplying customer load.

All other normal voice communication concerning facility operations shall be conducted through the public telephone network to the AMPT Transmission System Control Center phone number(s) issued by AMPT.

13.2 Emergency Voice Communications

Voice communications in the event of a transmission facility emergency shall use the dedicated voice circuits, if available, or public telephone network and phone number(s) designated for emergency use.

It is the Interconnecting Party's responsibility to take prudent steps when an area or system wide capacity emergency is declared.

The Interconnecting Party is responsible for providing the assigned AMPT Transmission System Control Center a "Customer Contact List." This generally is a listing of two or more people, their titles, and their business and home phone numbers. Any special information such as Police and Fire phone numbers as well as Substation phone numbers should be attached. Interconnecting Parties are provided an unlisted phone number to be used for emergency or routine operations. Operational emergencies (equipment) warrant a direct call either way. The AMPT Transmission System Control Center Dispatcher will advise the designated AMPT customer representative of problems that need to be handled directly with the customer.

System capacity emergencies are communicated through the local media except for contractual customers. Contractual customers are notified electronically in the event of an "Emergency Interruption."

14. Generation Connection Requirements (Generation and End-User Interconnections)

Generation facilities directly or indirectly connected to and operated in synchronism with the AMPT System will have additional requirements beyond those specified up to this point. Those requirements are described in this section.

14.1 Connection Configurations

New generation connected at transmission voltage levels, 69 kV and above, will require detailed system studies to determine the feasibility of the proposed connection point and the specific connection requirements. At a minimum, an interrupting device and associated controls are required, as described in the Interrupting Device section below.

14.2 Design Requirements

The generation owner is responsible for specifying appropriate equipment and facilities such that the parallel generation is compatible with the AMPT System. The generation owner is also responsible for meeting any applicable federal, state, and local codes. The minimum AMPT System connection design requirements for parallel generation are as follows.

14.2.1 Reactive Power

The Facility's minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery for the Facility at the Interconnection Point at a power factor that meets PJM requirements as stated in PJM Manual 14G. AMPT will coordinate with the Interconnecting Party to identify the optimal generator step-up transformer tap to make such a capability available when demanded.

Induction generators and other generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide supplementary reactive support equivalent to that provided by a similar-sized synchronous generator. All generation, both synchronous and non-synchronous, must be capable of providing reactive output anywhere within the power factor range set forth within PJM Manual 14G.

14.2.2 Generator Frequency

Connected generation shall be designed to produce balanced, three-phase, 60.0 Hz voltages and currents.

14.2.3 Interrupting Device

All generation owners shall provide a three-phase interrupting device to isolate the parallel generation from the AMPT supply for all faults, loss of AMPT supply or abnormal operating conditions. This device shall be capable of interrupting the maximum available fault current at its location (refer to Section 8.2 herein). The device shall interrupt all three phases simultaneously. The tripping control of the interrupting device shall be powered independently of the AMPT System AC source in order to permit operation upon loss of the AMPT supply.

14.2.4 System Grounding

For all interconnections of generation, the transformer high side winding configuration and grounding will be considered on a case-by-case basis. Where momentary isolation of the generation on a portion of the AMPT System does not result in an effectively grounded system (X0/X1 positive and less than 3, and R0/X1 positive and less than 1 for an effectively grounded system), then the AMPT System will be subject to overvoltages on unfaulted phases during system faults involving ground. Prior to the synchronization of the generation to the AMPT System the generation owner will be responsible for the replacement of any silicon carbide gapped arresters on the affected AMPT circuit(s) that would experience overvoltages exceeding the arrester duty cycle rating due to the generation source during the clearing of ground faults. Metal oxide (MOV) arresters on the affected AMPT circuit(s) will be evaluated against their temporary overvoltage (TOV) capability characteristic.

The generation owner will be responsible for the replacement of any MOV arresters should their TOV capability be exceeded due to the generation source during the clearing of ground faults.

14.2.5 Disconnecting Devices

As previously specified in Section 8.3.6 herein, an AMPT approved, gang operated switch shall be installed on each transmission line supply entrance to the generation owner's facility in order to provide for the visibly assured electrical isolation of the generation owner's facility. Generating facilities with looped line connections shall also be equipped with an AMPT approved disconnecting device installed to provide for the visibly assured electrical isolation of the generation. The disconnecting means shall be located in the high side leads of the generator step-up transformer or at a mutually agreed upon location. The disconnecting device(s) shall be accessible by AMPT personnel 24 hours a day. The disconnecting device(s) shall be designed such that the switch is lockable in the open position with an AMPT padlock and shall be identified with an AMPT designated equipment number(s).

14.2.6 Transient Stability Performance

All generation must comply with all NERC, RF, PJM and AMPT transient stability performance standards. AMPT or the applicable RTO will, during the system studies, perform a transient stability analysis to verify compliance with these standards. All generation owners must perform verification testing to confirm as-built data upon completion of new facilities. This as-built data must be provided to AMPT for information record purposed and to PJM for analysis.

14.2.7 Step-Up Transformer Requirements

All three-phase generators must be connected to the AMPT transmission system by a power transformer. AMPT may specify whether this power transformer must be delta-connected, wye- connected, solidly grounded, grounded through an impedance, or ungrounded at the interconnection line voltage. Delta connection on the generator side is generally preferrable, to prevent ground faults through the transformer.

14.3 Generation Controls

In addition to the normal excitation system and automatic voltage regulation equipment, the following controls are also required for each synchronous generator.

14.3.1 Reactive Compensation

The Interconnecting Party shall provide a circuit in the automatic voltage regulator (AVR) to permit the control of voltage beyond the generator terminals. This is known as reactive line drop compensation. The point of control is to be adjustable over a range covering 0 to 15% reactance (on the generator base) beyond the generator terminals.

14.3.2 Overcurrent Limiter

The Interconnecting Party shall provide the excitation system with a current limiting device and field protection function, which will supersede or act in conjunction with the AVR to automatically reduce excitation so that generator field current is maintained at the allowable limit in the event of sustained under- voltages on the transmission system. This device must maximize the field forcing time and protect the generator field.

14.3.3 Under excitation Limiter

The Interconnecting Party shall provide a limiter to prevent instability resulting from generator under excitation.

14.3.4 Power System Stabilizer

The Interconnecting Party shall install power system stabilizers on all generating units of 70 MW or larger.

14.3.5 Speed Governing

All synchronous generators shall be equipped with speed governing capability. This governing capability shall be unhindered in its operation consistent with overall economic operation of the generation facility. Overspeed protection in the event of load rejection is the responsibility of the generation owner.

14.3.6 Automatic Generation Control (AGC)

Depending upon various control area factors applicable to tie line and frequency regulation, provision for dispatch control of the generation facility by the AMPT Transmission System Control Center AGC system may be required. This determination will be made on a case-by-case basis.

14.4 Operating Requirements

The Interconnecting Party is responsible for operating their parallel generation with full regard for the safe practices of, and with full cooperation under the supervision of, the AMPT Transmission System Control Centers. Parallel generation shall not supply power into the AMPT System unless a specific written agreement has been made to do so. The written agreement shall comply with the PJM RTEP process. Under no circumstances shall an Interconnecting Party energize AMP Transmission System facilities that have been de-energized without authorization from the AMPT Transmission System Control

Center. to avoid a potential safety hazard for both AMPT personnel and the general public. Also, the energizing of such circuits at abnormal voltage or frequency could cause damage to connected electrical equipment of both AMPT and other parties.

AMPT reserves the right to disconnect service to any parallel generation facility if, for any reason, AMPT deems the continuation of the parallel generation is, or may be, a detriment to the safe operation of the AMPT System.

The minimum requirements for operation of parallel generation on the AMPT System are contained herein.

14.4.1 Synchronization

The Interconnecting Party assumes all responsibility for properly synchronizing their generation for parallel operation with the AMPT System. Upon loss of the AMPT supply, the Interconnecting Party shall immediately and positively cause the parallel generation to be separated from the AMPT System. Synchronizing of generation to the AMPT System may be required to be performed under the direction of the AMPT Transmission System Control Center.

14.4.2 Voltage Schedule/Power Factor

Specification of the generator voltage schedule will be determined under the direction of the AMPT Transmission System Control Center. A steady state deviation of ± 1.0% from this schedule of the nominal voltage will be permissible. Generator output voltage may be required to be under the control of the AMPT Transmission System Control Center.

In situations where use of a voltage schedule is determined by AMPT to be inappropriate, AMPT may substitute adherence to a specified power factor schedule. A steady state deviation from this power factor within ± 1% will be permissible.

Failure of the Interconnecting Party to maintain voltage or power factor within the scheduled range may result in penalties. Refer to the PJM Tariff Schedule 2.

14.4.3 Voltage Range

The generation facility must be capable of continuous non- interrupted operation within a steady-state voltage range during system normal and single facility outage conditions as specified in Section 4 herein. During emergency and/or transient system conditions, voltages may temporarily be outside of these ranges.

14.4.4 Frequency Range

The generation facility must be capable of continuous, non- interrupted operation in the frequency range of 59.5 to 60.5 Hz. For a limited time, non-interrupted operation is also expected outside of this frequency range in accordance with RF regional requirements or the turbine/generator manufacturer's recommendation, whichever is greater.

14.4.5 Voltage Balance

All three-phase generation connected to the AMP Transmission System shall produce 60.0 Hz balanced voltages. Voltage unbalance attributable to the generation owner's combined parallel generation and load shall not exceed 1.0% measured at the point-of-service. Voltage unbalance is defined as the maximum phase deviation from average as specified in ANSI C84.1, "American National Standard for Electric Power Systems and Equipment – Voltage Ratings, 60 Hertz."

14.4.6 Net Demonstrated Real and Reactive Capabilities

All generators will be required to comply with the appropriate NERC and RF regional requirements for both real and reactive capacity verification testing. Such tests must be performed in coordination with the AMPT Transmission System Control Centers, with sufficient notice provided for AMPT or its Transmission Agent approval, to assure that the system can be operated reliably during their completion.

For units located within the PJM RTO, the Net Demonstrated real capability as defined in PJM Capacity Testing Rules, must be documented and provided to AMPT annually for each generating unit connected to the AMPT System.

Individual generators in the generation facility must make available the full steady-state over- and under-excited reactive capability given by the manufacturer's generator capability curve at any MW dispatch level. Tests that demonstrate this capability must be conducted and documented at intervals that meet PJM guidelines and requirements. Such documentation shall be provided to AMPT. Note that a failure of the Interconnecting Party to show a compliance with the generator reactive power requirements as identified by test or from monitored operation will be subject to the terms of section 14.2.1 of this Document. The reactive testing procedures are listed in the PJM Manual 14D.

14.4.7 Other Applicable Operating Requirements

In order to assure the continued reliability of the AMP Transmission System, the generation owner may be required to adhere to other operating requirements and/or operating practices. These include the coordination of maintenance scheduling, observance of a specified forced outage rate, operations procedures during system emergencies, participation in control area operating reserves, provisions for backup fuel supply or storage, and provisions for emergency availability. Such requirements shall be addressed in the contractual agreement with the generation owner.

For plants in the PJM RTO, conformance with applicable requirements by PJM Documents are required. All data reportable to RF and/or NERC shall also be made available to AMPT upon request.

14.4.8 Operating Restrictions

Situations necessitating generation curtailments or forced outages as the result of unavailability of facilities owned and/or operated by AMPT are to be coordinated with PJM.

14.5 Generation Protection Requirements

The Interconnecting Party shall provide utility-grade relays for protection of the AMPT System. AMPT shall approve all relays specified for the protection of the AMPT System, including time delay and auxiliary relays. Relay operation shall initiate immediate separation of the parallel generation from the AMPT System. It is the responsibility of the Interconnecting Party to furnish and install adequate relay protection and settings per standard utility practices to protect their own equipment. AMPT is not responsible for the tripping of generation units.

In order to provide adequate protection to the AMPT System, AMPT may require the Interconnecting Party to furnish and install a transfer trip receiver(s) at their facility to receive tripping signals originating from an AMPT location(s). This additional protection would also necessitate, at the Interconnecting Party's expense, the purchase and installation of transfer trip equipment at the AMPT location(s) and a dedicated communication channel(s) between the AMPT location(s) and the Interconnecting Party's facility, including any lease fees for the communications channel.

15. Additional SCADA (Operational Metering) Requirements for Generation Facilities (Generation and End-User)

All generation facilities connected to the AMPT System shall be equipped with a SCADA RTU providing the information specified in Section 11.1 herein, SCADA Requirements – Loop and Network Connected Substations.

All requirements described in PJM Manual 1 must be met for all generation facilities connected directly to the AMPT System of any MW capacity. Furthermore, AMPT requires the SCADA equipment specified in Section 11.1 herein plus additional SCADA equipment needed to provide operational metering and status points for the following:

1. Net generator MW and MVAR and kilovolts on the high side of the generator step-up transformer.
2. Generator breaker position(s) sufficient to verify that the generators are synchronized to the AMPT System and that the AMPT transfer trip, when installed, has tripped.

For generation facilities that are indirectly connected to the AMPT System through the power system facilities of a wholesale or retail customer, AMPT requires the SCADA equipment specified in Section 11.1 herein plus additional SCADA equipment needed to provide operational metering and status points as described above if one of the following conditions exist:

1. If the generation facility has the potential for sustained generation backfeed at the delivery point(s) during certain operating conditions.
2. An individual generator rating is 20 MW or greater.
3. The total generating capacity of a group of generators is 20 MW or greater.
4. The generator breaker(s) are tripped by AMPT transfer trip.
   Aggregated operational metering and status point data may be used for a group of generators each less than 20 MW capacity and connected to a common generation bus or generator step-up transformer.

MW, MVAR, and Volts data, which is used for operational purposes, may be measured using operational metering equipment per Section 11 or obtained from revenue metering per Sections 12 herein. This information is to be provided directly to the AMPT assigned Transmission System Control Center (SCC) via SCADA or through the customer's control center that has electronic data communications links with the SCC using Inter Control Center Protocol (ICCP).

16. Inspection Requirements (Transmission, Generation, and End-User Interconnections)

Before an Interconnecting Party-owned substation can be energized, it must pass a final inspection by AMPT personnel. This inspection concentrates on all substation equipment up to and including the first protective fault interrupting device and the ground system. This may include circuit breakers, circuit switchers, power fuses, instrument transformers (e.g., CTs and PTs), switches, surge arresters, bushings, and relays and associated equipment (including battery and battery chargers). The inspection will consist of a visual inspection of all major equipment as well as a review of required test results.

The ground system must be checked by using the resistance measurement procedures in accordance with IEEE Std 81 "Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth."

The inspection will be performed by AMPT personnel who will document the inspection by completing a site-specific form supplied by AMPT. Refer to Attachments A and B for the required procedure and a typical inspection check-off list.

17. Maintenance Requirements (Transmission, Generation and End-User Interconnections)

All Interconnecting Party-owned substation equipment up to and including the first protective fault-interrupting device is to be maintained following industry accepted "good utility practice." This may include circuit breakers, circuit switchers, power fuses, instrument transformers (e.g., CT's and PT's), switches, surge arresters, bushings, data acquisition equipment, and relays and associated equipment (including battery and battery charger).

The Interconnecting Party must have an AMPT approved organization test and maintain all devices and control schemes provided by the Interconnecting Party for the protection of the AMPT System. Included in the testing and maintenance will be any initial set up, calibration, and check out of the required protective devices, periodic routine testing and maintenance, and any testing and maintenance caused by an Interconnecting Party or AMPT change to the protective devices.

If the Interconnecting Party's testing and maintenance program is not performed to the satisfaction of AMPT or at the required maintenance interval, AMPT reserves the right to inspect, test, or maintain the protective devices required for the protection of the AMPT System.

All costs associated with the testing and maintenance of devices provided by the Interconnecting Party for the protection of the AMPT System, including costs incurred by AMPT in performing any necessary tests or inspections, shall be the responsibility of the Interconnecting Party. All testing and maintenance will meet ISA guidelines.

AMPT reserves the right to approve the testing and maintenance practices of an Interconnecting Party when the Interconnecting Party's system is operated as a network with the AMPT System.

18. Coordination with Other Codes, Standards, and Agencies (Transmission, Generation, and End-User Interconnections)

The information contained in this document is supplementary to and is not intended to conflict with or supersede the National Electrical Code (NEC), the National Electrical Safety Code (NESC), or such federal, state and municipal laws, ordinances, rules or regulations as may be in force within the cities or communities in which AMPT furnishes electric service. It is the responsibility of the Interconnecting Party to conform to all applicable national, state and local laws, ordinances, rules, regulations, codes, etc.

Notwithstanding anything to the contrary, the use and reliance upon the information contained in this document shall in no way relieve the Interconnecting Party from the responsibility to meet NEC, NESC, or any other applicable requirements governing their design, construction, operation, and materials.

19. Indemnification (Transmission, Generation, and End-User Interconnection)

.To the fullest extent permitted by law, the Interconnecting Party shall indemnify, defend, and hold harmless AMPT, American Municipal Power, Inc., and their respective members, affiliates, officers, consultants, agents, representatives, and employees in both individual and official capacities, and contractors (collectively, the "Indemnified Parties") from and against all claims, costs, damages, losses, fines, penalties, judgments, and expenses (including but not limited to all fees and charges of contractors, engineers, architects, attorneys, and other professionals and all court, arbitration, or other dispute-resolution costs) arising out of or in connection with the Interconnecting Party's establishment of or modification to an interconnection into AMPT's System as described herein, provided that any such claim, cost, damage, loss, fine, penalty, or expense is attributable to (i) bodily injury, sickness, disease, or death, or injury to or destruction of tangible property but only to the extent caused by the negligent acts, errors, or omissions of the Interconnecting Party or a person or entity for whom the Interconnecting Party may be liable; (ii) a hazardous environmental condition for which the Interconnecting Party, a subcontractor, or a person or entity for whom the Interconnecting Party or a subcontractor may be liable; or (iii) a violation of law but only to the extent attributable to the Interconnecting Party, a subcontractor, or a person or entity for whom the Interconnecting Party or a subcontractor may be liable.

The Interconnecting Party's indemnification obligation exists regardless of whether or not the claim, damage, loss, fine, penalty, or expense is caused in part by one or more of the Indemnified Parties. But this section does not obligate the Interconnecting Party to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

20. Modeling Requirements

All new and modified interconnecting facilities require the submission of modeling data to AMPT for verification at least 30 days before equipment energization. Any project files provided for modeling purposes should be compatible with PSSE v35 (or latest version approved by PJM). All line impedance and transformer impedance data shall be supplied in resistance and reactance (R + jX) in per unit on a 100 MVA base. It is the responsibility of the Interconnecting Party to verify the latest software version being utilized by AMPT prior to the submission of project files.

20.1 Steady State Modeling Data

The Interconnecting Party shall provide an equivalent power flow model for the newly interconnecting generation. The equivalent model shall include a single equivalent generator, equivalent pad-mounted transformer, equivalent collector system, and explicit representation of the plant-level shunt compensation, substation transformer(s) (i.e., plant transformer), and interconnecting transmission line. A single-line diagram of the interconnecting facility shall be provided for verification of the equivalent power flow model.

20.2 Short Circuit and Dynamic Modeling Data

The Interconnecting Party shall provide the positive sequence and zero sequence data for all the equipment (transmission line, transformer, inverter-based resource etc.) within the newly interconnecting project. Please fill out the form that is shown in Attachment C.

The Interconnecting Party shall provide the positive sequence dynamic models for the generating source using the latest generic models in the PSS/E standard library. Dynamic models representing the frequency and voltage ride-through characteristics of the inverter-based resource should be provided utilizing the applicable generic models. Based on the type of resource, the electrical control, plant-level control and generator control should be explicitly modeled using the generic models with accurate project specific parameters. The models shall not be populated with generic values. Additionally, any user-defined models will not be accepted. Refer to PJM MOD-32 Data Requirements.

21. Revisions

21.1 Revision Process

It is intended that all major revisions of this document will be reviewed and approved by AMPT Executive Management. Additional signoffs maybe be solicited as warranted. Clarifications and minor revisions may be made to the document without going through the review and approval process provided that:

1. The revisions/clarification are in fact minor as determined by the AMPT Executive Management.
2. The revised portion of the text must be clearly marked in the body of the document by underlining the revised section and footnoting with the revision date.
3. The date of change, the reason for the change, and revision author are recorded in the Revision History.
4. The revised section of the document must be duplicated in its entirety in the Revision History section of the document. In this duplicated section, deletions from the document are indicated with “strike through” text and additions that are made are shown in underlined and italics text.

21.2 Revision History

DOCUMENT APPROVAL

Prepared By:	Reviewed By	Approved By:	Approval Signature:	Date:
Alexandros Lousos Director of Transmission Planning	David Wood SVP of Transmission Planning & Development	Pamala M. Sullivan President	Pamala M. Sullivan	8/1/2024
Rayon Donaldson Director of Transmission Engineering	Scott Kiesewetter SVP of Transmission Operations			

DOCUMENT CHANGE/REVISION HISTORY

Revision:	Prepared By:	Summary of Changes:	Date:
1		• Updated sections 2, 9, 12, and 16 • Updated Table 1 • Updated Figures 1 and 2 • Clarified Generation, End User, and TO Interconnections throughout. • Updated 1-line diagrams for interconnecting to AMPT facilities • Updated responsibility for Power Quality issues mitigation • Removed requirements for substation configuration at generation facilities • Updated requirements for provision of generator modeling data	8/1/2024
0	Ryan Dolan Director of Transmission Planning	• Initial Document	9/12/2019

Attachment A

Procedure for Connecting New Substation or Lines to AMPT Facilities

1. Please note that the procedure defined below does not pertain to Generation Interconnection requests for generation facilities that plan to participate in the PJM capacity, energy markets and ancillary services. The processing of such requests is set forth in the PJM Open Access Transmission Tariff and Manuals which are available on the PJM web site (pjm.com).
2. A party desiring to connect to an AMPT facility will sign a Construction Service Agreement (CSA) and an Interconnection Service Agreement (ISA) (for a wholesale customer) after the Preliminary Interconnection Study and Final Interconnection Study and other required studies have been favorably completed. The CSA and ISA will define the project scope and facility ratings. These agreements will also specify details of all the protective relay or fuse requirements for the new facility for those portions of the new facility which will connect to the AMPT facility.
3. Following receipt of the signed CSA and an ISA for a (wholesale customer), the AMPT will appoint a project manager to oversee the connection details and act as AMPT's representative.
4. At the conclusion of the design process, the AMPT project engineer will supply a functional one-line showing devices, conductor sizes, equipment types and ratings, and specific relay types and styles for those items which will be connected to the AMPT facility. For network connections, the relay styles and types to be used will be either provided or approved by the AMPT project engineer. For projects which are not being engineered by AMPT, the Interconnecting Party is responsible for providing the functional one-line to the project engineer. "Connected to the AMPT facility" is defined as any device that is in the primary current path of the connection or any device that is tapped to the AMPT facility that if it were to fail, would cause a fault and outage to the AMPT facility. Where appropriate, AMPT equipment designations will be assigned to devices in the current path of the connection.
5. Following receipt of the functional one line, the AMPT project engineer will prepare a check-off list detailing those items which will need to be checked or tested prior to final release and energizing of the new facilities. The AMPT project engineer will supply this list to the Interconnecting Party and ensure that all items on the list are checked and tested to the satisfaction of the AMPT representative releasing the equipment. (This check-off and testing can be performed by the Interconnecting Party or their representative). The project engineer will also provide protective relay and/or fuse settings for those relays that are used in a network application or are necessary for proper protective coordination with the transmission grid.
6. For all Transmission Interconnections, AMPT will require that the connected equipment and check-off list be inspected and approved/released by the AMPT project engineer. For new connections involving circuit breakers or circuit switchers, the AMPT inspection representative will observe the functional trip testing of the protective device and its protective relays. The relays must have the AMPT recommended settings applied before testing begins. If phasing is required, the AMPT inspection representative will observe the phasing test. If deemed necessary, the AMPT

inspection representative has the authority to observe or conduct any test required by the check-off list.

7. After being satisfied that the connected facilities have been properly inspected and released, the AMPT inspection representative will notify the AMPT project engineer that it is permissible to energize the new facilities – provided all of the AMPT Transmission System Control Center's other clearance requirements are satisfied. This release of equipment may take the form of release for service or release for test. The AMPT Transmission System Control Center will not release its clearance on the new facilities until it receives notification from the AMP inspection representative. A completed copy of the check-off list and any supporting documentation including the results of any in-service testing will be provided to the project engineer.

Attachment B

CONNECTING SUBSTATION – EXAMPLE
Substation Checkout Guide

ITEM	ACTION/INFORMATION DATE	BY	
1. Substation Ground Resistance ______________________________	Review Test Results (remote earth)	______	
2. Safety and equipment grounding	Visual Inspection Review Test Results	______	________
3. Ground grid point-to-point checks	Visual Inspection	______	________
4. AMPT ID Nameplates for Breakers & Switches		______	________
5. Airbreak and Disconnect Switches			
a. A-26			
1. Alignment	Visual Inspection	______	________
2. Ductor Ground Mat (where applicable)	Review Test Results	______	________
b. D-4			
1. Alignment	Visual Inspection	______	________
2. Ductor Ground Mat (where applicable)	Review Test Results	______	________
6. Circuit Breakers			
a. B______________kV Breaker			
1. Gas filled	Visual Inspection	______	________
2. Timing Tests	Review Test Results	______	________
3. Ductor	Review Test Results	______	________
4. Doble Test	Review Test Results	______	________
5. CT Ratios & Polarities	Review Test Results	______	________
6. Breaker Alarms	Detailed Inspection	______	________
7. Circuit Switcher			
a. CS______________kV Transformer			
1. Hi-pot Test	Review Test Results	______	________
2. Timing Tests	Review Test Results	______	________
3. Ductor	Review Test Results	______	________
8. Fuses			
a. ________ kV Transformer			
1. Rating/Type (as specified)	Visual Inspection	______	
2. Air Flow Test Review Test Results			
9. Power Transformers			
a. TR#__ _ kV____MVA			
1. CT Ratio & Polarity ______________________________	Review Test Results	______	

CONNECTING SUBSTATION – EXAMPLE
Substation Checkout Guide

ITEM	ACTION/INFORMATION DATE	BY
10. CCVT/VT		
a. CCVT/VT_____kV Line		
1. Doble Test	Review Test Results	______ _
2. Potential Polarizing Test	Review Test Results	______ _
3. Ratio & Polarity Test	Review Test Results	______ _
b. CCVT/VT______Bus		
1. Doble Test	Review Test Results	______ _
2. Potential Polarizing Test	Review Test Results	______ _
3. Ratio & Polarity Test	Review Test Results	______ _
11. Phasing		
a.______ kV Main Bus	Detailed Inspection	______ _
12. Batteries and Charger		
a. DC Battery and Charger		
1. Battery Acceptance	Review Test Results	______ _
2. Intercell Resistance Test	Review Test Results	______ _
3. Charger Settings	Visual Inspection	______ _
4. Ground Detector	Detailed Inspection	______ _
13. SCADA		
a. Function Tested with SCC		
1. Control	Detailed Inspection	______ _
2. Indication	Detailed Inspection	______ _
3. Alarms	Detailed Inspection	______ _
14. Metering	Detailed Inspection	______ _
15. Relay and Control Schemes		
a. _________ kV Exit		
1. Correct CT/PT Ratios & Settings Applied	Review Test Results	______ _
2. Calibration Test	Review Test Results	______ _
3. Trip Test	Detailed Inspection	______ _

4. In-Service Load Angles	Detailed Inspection	______	_
5. Remote Relay Communications	Detailed Inspection	______	_
6. End-to-End Functional Test	Review Test Results	______	_

b. Annunciators and Alarms

1. Set Undervoltage & Time Delay Relays	Review Test Results	______	_
2. Function Tested	Review Test Results	______	_

c. Potential Transformer Selector Switch

1. Functional test (make before break)	Review Test Results	______	_

CONNECTING SUBSTATION – EXAMPLE
Substation Checkout Guide

ITEM	ACTION/INFORMATION DATE	BY
16. Miscellaneous		
a. Inspect Alignment on Rod Gaps	Visual Inspection	______ _
b. Line Arresters		
1. Sized as specified	Visual Inspection	______ _
2. Located as specified	Visual Inspection	______ _
c. Clearances		
1. _______ kV---Phase to Ground	Visual Inspection	______ _
2. _______ kV---Phase to Phase	Visual Inspection	______ _
d. Wave Traps		
1. Sized as specified	Visual Inspection	______ _
2. Located as specified	Visual Inspection	______ _
3. Frequency sweep response of trap to verify tuned frequency as specified	Visual Inspection	______ .
17. After the checkout is completed as needed for substation energization, ____ the project manager engineer must be notified before the equipment is released by the field engineer for energization.		______ .

Attachment C

BEHIND-THE-METER GENERATION INTERCONNECTION REQUEST FORM

Contact Information

1. Primary
Company/Customer Name: ________________________________
Phone No: (___) ___ - _____
Email: ________________________

2. Secondary
Company/Customer Name: ________________________________
Phone No: (___) ___ - _____
Email: ________________________

General Project Information

Project Address: ________________________________

Location of POI: ________________________________

Commercial Operation Date: ______________________

Requested Capacity (MW): ________________________

Synchronous Generator

Unit Ratings

kVA: __________ Rated ˚F: _______ Voltage (kV): _________
Power Factor: ______________ Speed (RPM): ___________
Frequency (Hz): _________
Field Volts: ________________
Max Unit Rating (MW): _________ @ ______ ˚F
Number of Units: _________
Stator Amperes at Rated kVA: __________

Reactance Data (Per Unit-Rated kVA) Direct Axis Quadrature Axis

	Direct Axis		Quadrature Axis	
Synchronous – saturated	X_{dv}	________	X_{qv}	________
Synchronous – unsaturated	X_{di}	________	X_{qi}	________
Transient – saturated	X'_{dv}	________	X'_{qv}	________
Transient – unsaturated	X'_{di}	________	X'_{qi}	________
Subtransient – saturated	X''_{dv}	________	X''_{qv}	________
Subtransient – unsaturated	X''_{di}	________	X''_{qi}	________
Negative Sequence – saturated	$X2_{v}$	________		
Negative Sequence – unsaturated	$X2_{i}$	________		
Zero Sequence – saturated	$X0_{v}$	________		
Zero Sequence – unsaturated	$X0_{i}$	________		
Leakage Reactance	Xl_{m}	________		

Field Time Constant Data (Sec)

Open Circuit	T'_{do}	________	T'_{qo}	________
Three-Phase Short Circuit Transient	T'_{d3}	________	T'_{q}	________
Line–Line Short Circuit Transient	T'_{d2}	________		
Line–Neutral Short Circuit Transient	T'_{d1}	________		
Short Circuit Subtransient	T''_{d}	________	T''_{q}	________
Open Circuit Subtransient	T''_{do}	________	T''_{qo}	________

Time Constant Data (Sec)

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

MW Capability and Plant Configuration
Armature Winding Resistance Data (Per Unit)

Positive	R_1	_______
Negative	R_2	_______
Zero	R_0	_______

Rotor Short Time Thermal Capacity I_2^2t = _______
Field Current at Rated kVA, Armature Voltage and PF = _______Amps
Field Current at Rated kVA and Armature Voltage, 0 PF = _______Amps
Three Phase Armature Winding Capacitance = _______microfarad
Field Winding Resistance = _______ ohms _____ °C
Armature Winding Resistance (Per Phase) = _______ohms _______ °C

Inverter Based Resource

Unit Ratings

Individual Inverter Nameplate Capability: _______ MVA @ _______˚F
Number of Inverters: _______
Gross Facility Capability: _______ MVA @ _______˚F
Power Factor: _______Leading / _______ Lagging
Station Service Load: _______ MW _______ MVAR

Battery Energy Storage System Specific

Individual Storage Unit Rating: _______ MW _______ Hours
Gross Energy Storage Rating: _______ MW-Hr
Maximum State of Charge: _______ PU
Minimum State of Charge: _______ PU

Collector System Equivalent

Collector System Voltage: _______ kV
Collector System Equivalent Rating: _______ MVA @ _______ ˚F
Collector System Equivalent Impedance (values can NOT be provided in Ohms):

1. R_1 = _______ PU on 100 MVA base (positive sequence)
2. X_1 = _______ PU on 100 MVA base (positive sequence)
3. B_1 = _______ PU on 100 MVA base (positive sequence)
4. R_0 = _______ PU on 100 MVA base (zero sequence)
5. X_0 = _______ PU on 100 MVA base (zero sequence)
6. B_0 = _______ PU on 100 MVA base (zero sequence)

Inverter Step-Up Transformer

Number of Transformers: _______

Two-Winding Step-Up Transformer Data (as applicable):

Rating (ONAN/ONAF/ONAF): _______ / _______ / _______ MVA
Nominal Voltage for each winding (High / Low): _______ / _______ kV
Winding Connections (High / Low): [Delta/Wye/Wye-Ground] / [Delta/Wye/Wye-Ground]
Available Tap Positions: _______ /_______ /_______ /_______ /_______ kV or _______ % _______ # of taps

Positive Sequence Impedance Z_1: _______ %, _______ X/R on self-cooled (ONAN) transformer MVA base
Zero Sequence Impedance Z_0: _______ %, _______ X/R on self-cooled (ONAN) transformer MVA base

Three-Winding Step-Up Transformer Data (as applicable):

	H Winding	X Winding	Y Winding
Rated Voltage (kV)			
Winding Connection (Delta/Wye/Wye-Ground)			
Ratings (MVA) ONAN/ONAF/ONAF	____/____/____	____/____/____	____/____/____
Tap Positions Available	____/____/____ ____/____ kV	____/____/____ ____/____ kV	____/____/____ ____/____ kV

	H-X Winding Data	H-Y Winding Data	X-Y Winding Data
Base for Impedances (MVA)			
Positive Sequence Impedance (Z_1)	_____%_____X/R	_____%_____X/R	_____%_____X/R
Zero Sequence Impedance (Z_0)	_____%_____X/R	_____%_____X/R	_____%_____X/R

Facility Equipment Data

Proposed Interconnection Tie Line

Line Voltage: _______ kV
Line Rating: _______ MVA @ _______ ˚F
Line Length: _______ Miles
Line Impedance (values can NOT be provided in Ohms):

1. R_1 = _______ PU on 100 MVA base (positive sequence)
2. X_1 = _______ PU on 100 MVA base (positive sequence)
3. B_1 = _______ PU on 100 MVA base (positive sequence)
4. R_0 = _______ PU on 100 MVA base (zero sequence)
5. X_0 = _______ PU on 100 MVA base (zero sequence)
6. B_0 = _______ PU on 100 MVA base (zero sequence)

Site Main Transformer

Number of Transformers: _______

Two-Winding Main Transformer Data (as applicable):

Rating (ONAN/ONAF/ONAF): _______ / _______ / _______ MVA
Nominal Voltage for each winding (High / Low): _______ / _______ kV
Winding Connections (High / Low): [Delta/Wye/Wye-Ground] / [Delta/Wye/Wye-Ground]
Available Tap Positions: _______ /_______ /_______ /_______ /_______ kV or _______ % _______ # of taps

Positive Sequence Impedance Z_1: _______ %, _______ X/R on self-cooled (ONAN) transformer MVA base
Zero Sequence Impedance Z_0: _______ %, _______ X/R on self-cooled (ONAN) transformer MVA base

Three-Winding Main Transformer Data (as applicable):

	H Winding	X Winding	Y Winding
Rated Voltage (kV)			
Winding Connection (Delta/Wye/Wye-Ground)			
Ratings (MVA) ONAN/ONAF/ONAF	____/____/____	____/____/____	____/____/____
Tap Positions Available	____/____/____ ____/____ kV	____/____/____ ____/____ kV	____/____/____ ____/____ kV

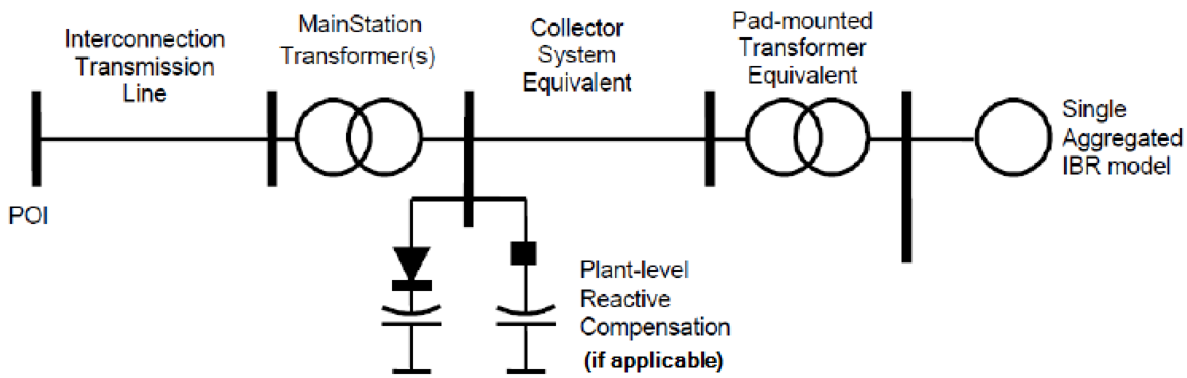
	H-X Winding Data	H-Y Winding Data	X-Y Winding Data
Base for Impedances (MVA)			
Positive Sequence Impedance (Z_1)	_____%_____X/R	_____%_____X/R	_____%_____X/R
Zero Sequence Impedance (Z_0)	_____%_____X/R	_____%_____X/R	_____%_____X/R

Plant Reactive Power Compensation
(if applicable)

Type of Reactive Compensation Device(s): _______________
Individual Fixed Shunt Reactive Device Type: ______________
Number and Size: _______ x _______ MVA
Dynamic Reactive Control Device (e.g. SVC, STATCOM): ______________
Control Range: _______ MVAR (lead) to _______ MVAR (lag)
Control Mode (e.g. voltage, power factor, reactive power): _______
Regulation Point: _______

Short Circuit Contribution at POI
Maximum Three Phase Fault Current: _______ Amps & _______ MVA
Duration: ____________
Maximum Single Line–Ground Fault Current: ______ Amps & _______ MVA
Duration: ____________
Fault X/R Ratio: _______
Inverter Equivalent Base: _______ MVA
Short-Circuit Equivalent Positive Sequence Resistance: _______ PU
Short-Circuit Equivalent Positive Sequence Reactance: _______ PU
Short-Circuit Equivalent Negative Sequence Resistance: _______ PU
Short-Circuit Equivalent Negative Sequence Reactance: _______ PU
Short-Circuit Equivalent Zero Sequence Resistance: _______ PU
Short-Circuit Equivalent Zero Sequence Reactance: _______ PU

Modeling Requirements



Facility modeling data must be provided for use in PSSE v35, however it is the Interconnecting Party's responsibility to verify the latest software version being utilized. All equipment ratings and impedance data must be provided within the model file. An example of an IBR SMIB model is displayed above for reference.

Documentation Requirements

Provide as much documentation as possible as is applicable to the generation technology utilized.

1. Facility One-Line Diagrams
2. Generation Equipment Datasheets
3. Reactive Capability Curve
4. Temperature Correction Curves
5. Saturation Curve

Attachment D

END USER CONNECTION REQUEST FORM

Applicant Information

Municipality/Customer Name: ____
Phone No: (___) ___ - ______ Email: _____________________________
Project Description:
____
____
____

Load Connection Information

Existing Load: ______ MVA @ ______ %PF
or ______ MW ______ MVAR

Load Addition #1: ______ MVA @ ______ %PF
or ______ MW ______ MVAR
Requested Date: ___________

Load Addition #2: ______ MVA @ ______ %PF
or ______ MW ______ MVAR
Requested Date: ___________

Load Addition #3: ______ MVA @ ______ %PF
or ______ MW ______ MVAR
Requested Date: ___________

Total Requested Load: ______ MVA @ ______%PF
or ______ MW ______ MVAR

New Load Source (List new load in kW – Enter “0” if none)

Load Type	**Type / Description**	**Load Amount (kW)**
Lighting		
Air Conditioning		
Heating		
Motors*		
Other*		
Other*		

*See Additional Information and Documentation item 2 below

Transmission Interconnection Line or Facility

1. Transmission Line / Facility Name: ______________________________ _____ kV
2. Transmission Line / Facility Name: ______________________________ _____ kV

Additional Information and Documentation:

1. Detailed map of the project area with the project location clearly identified and a one-line schematic diagram of the proposed facility including, at minimum, the following information:
    a. Property area and property lines
    b. Distance to nearest intersection
    c. Location of proposed and/or existing driveways
    d. Distance to the road & property lines
    e. Location and orientation of new and existing structures
    f. Location and orientation of electric panels / substations
    g. Location and orientation of all new and existing customer owned facilities, such as wells, water lines, septic/sewer lines, gas lines, etc.
2. Details of any non-conforming load that may significantly impact the AMPT system. For example: Harmonic producing loads (ASD's, SCR's, etc.), Flicker producing loads (large motors, arc furnaces, etc.).
3. Backup requirements (loop feed versus tap, etc.).
4. Details on any proposed power factor correction equipment.

TABLE 1

Substation Electrical Clearances and Insulation Levels

Rated Maximum Voltage Between Phases (rms)

Item	**72.5 kV**	**145 kV**	
Electrical Clearance Min. (inches)	**@ 350 BIL**	**@ 550 BIL**	**@ 650 BIL**
Ground	25	42	50
Live Part (metal to metal)	31	53	63
Electrical Clearance Design (inches)			
Ground	29	45	52.5
Live Part (phase spacing) (see note 1 and 2)	60	84	96
Disconnect Switches Phase Spacing (inches)			
Vertical Break	60	84	96
Side Break	72	108	132
Switches w/ Arcing Horns	84	120	144
Vertical Clearance of Unguarded Live Parts	10’-5”	11’-7”	12’-2”
Horizontal Clearance of Unguarded Live Parts	4’-11”	6’-1”	6’-8”
Current Carrying Equipment			
Momentary Asymmetrical Withstand[7]	40 kA	40 kA	40 kA
Switch Rated Maximum Voltage	72.5 kV	145 kV	145 kV
Surge Arresters			
MCOV	48 kV	84 kV	84 kV
Duty Cycle	60 kV	108 kV	108 kV
Insulators			
Standard Cantilever Strength	1500 (Tech Ref # 216)	1700 (Tech Ref # 286)	1700
High Cantilever Strength	3000 (Tech Ref # 278)	2600 (Tech Ref # 287)	2600

Notes for Table 1:

1. For “Electrical Clearance” – Clearances are given for rigid conductors and live parts. Non-rigid conductors (e.g. strain bus) must be located such that any possible movement will not create conditions which cause the clearance to be less than the minimum values shown.

Notes for Table 1 (continued):

2. For "Electrical Clearances" and for "Phase Spacing" – These values are based on ANSI C37.32 – 1996.

3. For "Clearance of Unguarded Live Parts" – These values are based on the NESC, Accredited Standards Committee C2-2002. These clearances are to any permanent supporting surface for workers. The vertical clearance to the unguarded bottom of any past of indeterminate potential (e.g., insulator or surge arrester) shall be not less than 8"-6".

4. Horn gap switches applied as disconnect switches should use the disconnect phase spacing.

5. BIL – Rated Basic Impulse Insulation Level

6. MCOV – Momentary Current Over Voltage

7. To be determined or studied on a case-by-case basis.
8. 4893-4040-0328, v. 1