

# **TRANSMISSION FACILITIES INTERCONNECTION REQUIREMENTS**

**Corresponds to  
NERC Standard FAC-001-2**

**AMP Transmission  
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# AMPT TRANSMISSION FACILITIES CONNECTION REQUIREMENTS

## Preface

This document contains the facility connection requirements to facilitate the safe, efficient and reliable interconnection of any electrical transmission, generation, or end-user facility with the AMPT Transmission System. The following definitions apply for this document:

**Transmission Connection –**

An electrical connection between the AMPT Transmission System and another transmission system such as the facilities of an adjacent transmission owner or a load serving entity.

**Generation Connection –**

An electrical connection between the AMPT Transmission System and a generation facility. This does not include behind-the-meter generation.

**End-User Connection (Load Customer) –**

An electrical connection between the AMPT Transmission System and end-user facilities, i.e., load customer. These facilities may or may not operate as a networked transmission system and might include behind-the-meter generation.

The requirements specified in this document are intended to ensure compatibility of electrical designs and equipment and, thereby, contribute to the uniformity of service to all parties connected to the AMPT Transmission System. This document provides a written summary of the AMPT plans to achieve the required system performance throughout the planning horizon by establishing interconnection requirements for new and materially changed transmission, generation, and end-user facilities connected to the AMPT Transmission System.

In all cases, the AMPT standards are consistent with the requirements for Facility Interconnections as specified by the applicable NERC Reliability Standards, Reliability First (RF) reliability principles and standards, guides, procedures, and reference documents, and PJM agreements, documents and manuals. The requirements included in this document apply to all AMPT transmission facilities.

All transmission, end-user, generation interconnection customers connecting to the AMPT Transmission System must agree to comply with the applicable PJM documents, manuals and applicable NERC and RF standards as noted above.

Any party seeking to modify or establish a new connection to the AMPT Transmission System should use this document when planning an installation, but should be aware that it may not cover all details in specific cases. Its purpose is to provide a general reference for typical situations that can be utilized when evaluating any potential modification to the AMPT Transmission System. As such, the AMPT requirements presented in this document should be considered as the minimum acceptable requirements. Additional requirements may be necessary based on the results of AMPT's studies performed, or other regional requirements or agreements, which may be more restrictive.

The planning and implementation of new or modified transmission, generation, and end-user facilities connected to the AMPT Transmission System are coordinated with the interconnected transmission system through the 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](http://www.pjm.com)).

Initial Load Studies (ILS) and Detailed Load Studies (DLS) performed by AMPT in association with any proposed new or modified transmission system connections will only evaluate the impact on the AMPT Transmission System. These studies are performed for end-user connections and in some instances for transmission or generation connections. AMPT will notify adjacent transmission owners, transmission customers, RTOs or others that may be impacted by the proposed new or modified transmission, or end-user facilities as required by any existing tariff, interconnection agreement and the PJM processes. AMPT will share its study results and data with the impacted parties as appropriate within its established code of conduct. Any impacted party, at its discretion, may perform an independent evaluation of the impact of the proposed project. As a prerequisite to construction, the customer planning the new or modified connection to the AMPT Transmission System must resolve all disputed issues with any intervening party.

The processing of transmission system load connection requests or preliminary reviews of transmission connection requests includes an evaluation to determine if an ILS and/or a DLS is required to analyze the impact of the proposed load connection facilities on the transmission system.

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

- Power flow analysis
- Short circuit level at point of interconnection
- Consideration of special circumstances (PQ issues, i.e., power quality)
- Identification of direct connection requirements
- Identification of network upgrades needed
- Consideration of multiple connection alternatives
- Operational limitations
- Written report of results

A DLS is an engineering study conducted by AMPT. A DLS typically includes but is not limited to the following:

- Consideration of one ILS connection alternative
- Estimates of costs associated with direct connect and System upgrades
- Specification of protection requirements
- Specification of metering requirements
- Operational limitations
- Stability analysis as required
- Written report results

# AMPT TRANSMISSION FACILITIES INTERCONNECTION REQUIREMENTS

## 1. Service Application (Transmission, Generation, and End-User)

### 1.1 General

When information on the location and/or size of any new or modified transmission, generation or end-user load connection proposal has been determined, the transmission customer must complete the appropriate application and submit it, along with any required deposit, to AMPT or PJM.

AMPT will coordinate any resulting system upgrades required by the load interconnection with PJM as applicable. Applications for generation or transmission interconnection service is available electronically from the PJM website ([www.pjm.com](http://www.pjm.com)) as appropriate. Sections 14 and 15 contains more information about AMPT's generation connection and SCADA requirements.

## 2. Load Connection Requirements (End-User)

### 2.1 General

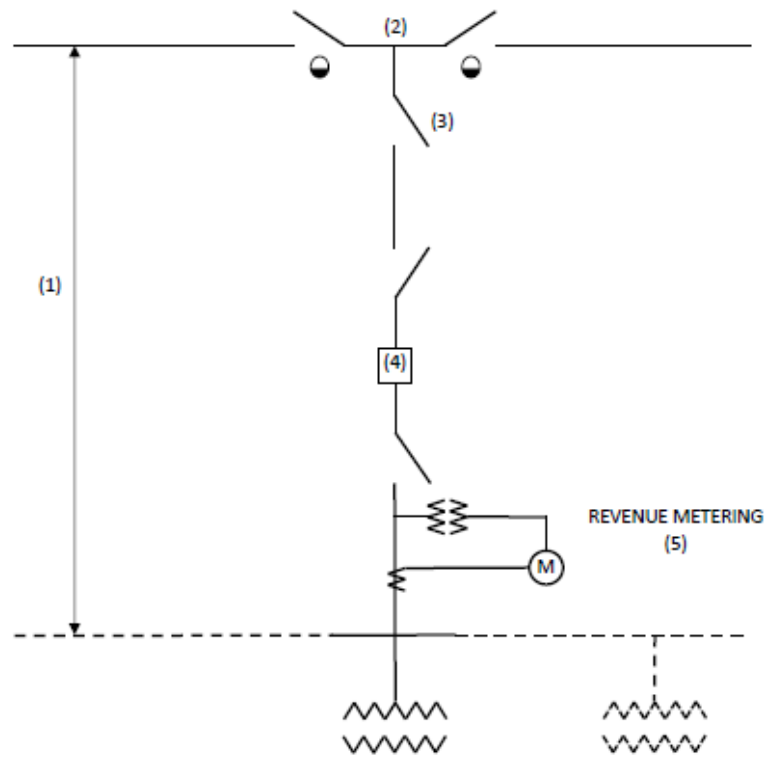
All connections to the AMPT Transmission System must be designed such that, under normal operating conditions, faults at the Interconnecting Party's facility will be cleared by a dedicated interrupting device(s) and will not result in an outage of any AMPT transmission line, bus, or transformer.

### 2.2 Tap Connection Definition and Requirements

A connection to the AMPT Transmission System that requires only the Connecting Party's load to pass through the interconnecting facilities under any condition is considered a tap connection.

The attached *Figure 1* illustrates a typical tap supply configuration, for AMPT transmission supply, and some of the basic connection requirements. As indicated, line switches will be required at the tap point to allow for sectionalizing the line without supply interruption to the customer. AMPT may require, on a case by case review, that motor operated mechanisms and SCADA control be installed with the switches in order to minimize the time required for restoration in the event of permanent line faults on the tapped transmission line. AMPT requires both mechanisms for all BES facilities. AMPT will accommodate tapped interconnections for loads less or generation totaling to 5 MVA's or less, or in accordance with AMPT's 35 MVA-mile FERC 715 requirements. For facilities or new interconnections with projected levels exceeding the 5 MVA or 35 MW-mile thresholds, AMPT will utilized looped connection requirements outlined in section 2.3.





Notes:

- (1) Must meet AMPT Facility Connection Standards. AMPT will provide one span of conductor to pull into a connecting party's substation facility. Additional length to connecting party's substation to be approved by AMPT.
- (2) Switches at option of AMPT (typically required) at connecting party's expense. Supplemental interrupting devices (i.e. vacuum interrupter) may be required.  
 ● SCADA control optional
- (3) Switch may be required depending on tap length.
- (4) Fully rated interrupting device (i.e. breaker, circuit switcher, transrupter, or fuse)
- (5) Revenue metering per Section 12 of AMPT Transmission Connection Requirements.

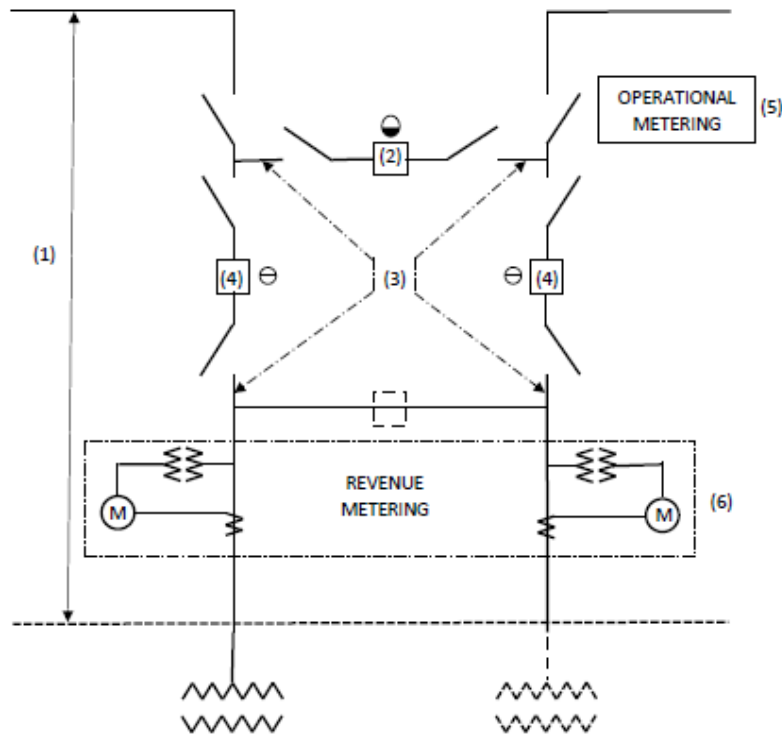
Tapped Load Supply 138kV and Below

Figure 1

### 2.3 Looped Connection Definition and Requirements

A connection to the AMPT Transmission System that requires AMPT transmission line load (through flow) to pass through the connecting facilities under any condition is considered a looped connection. Loop connected facilities have the potential to significantly affect the reliability and loadability of the AMPT Transmission System. If the Looped Connection is permitted by AMPT, the facilities must be designed in the most cost effective manner possible while ensuring acceptable system reliability and maintainability. As noted, AMPT will accommodate looped connections for any facilities with projected levels exceeding 5 MVA or AMPT's 35 MVA-mile threshold.

*Figure 2* illustrates a typical loop supply configuration and some of the basic connection requirements.



**Notes:**

- (1) Must meet AMPT Facility Connection Standards. AMPT will provide one span of conductor to pull into a connecting party's substation facility. Additional length to connecting party's substation to be approved by AMPT.
- (2) Breaker under AMPT SCADA control.
- (3) Transmission current path must be maintained to AMPT standards.
- (4) Where breakers are operated by connecting party,  $\ominus$  position indication sent to AMPT via SCADA.
- (5) SCADA (Operational Metering per Section 11.
- (6) Revenue metering per Section 12 of AMPT Transmission Connection Requirements.

Looped Load Supply

Figure 2

For looped supply configurations, a grounded wye high side transformer winding configuration may be acceptable (system study required) in addition to either a delta or ungrounded wye high side winding configurations for connecting substation transformers.

### **3. Network Connection Definition and Requirements (Transmission)**

A connection to the AMPT Transmission System that allows bi-directional energy and/or fault current flow between otherwise independent transmission systems is considered a network connection. Check with PJM tariffs and documentation for further clarification.

### **4. Voltage Levels, System Capacity, and Operational Requirements (Transmission, Generation, and End-User)**

The Interconnecting Party's facility will be supplied from AMPT's Transmission System, which planned to operate between the following percentages of nominal voltage under normal and single transmission element outage conditions.

- 95% - 102%: System Normal Conditions
- 92.0%-105%: System Emergency (Outage) Conditions

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. In addition, immediate action may be required to disconnect load from the AMPT Transmission System should voltage fall below the minimum percentage of nominal value listed above. The Interconnecting Party will be given advance notice of such action, to the extent possible, and will be expected to disconnect from the transmission system upon AMPT request until the initiating condition has been corrected.

The MW and MVAR capacity or demand at the point of connection is limited by the capabilities of the AMPT Transmission System. Analysis and documentation of these capabilities are provided through the connection processes referenced in the preface of this document. Operational issues associated with the proposed facilities will be analyzed and documented through the connection processes referenced in the preface of this document. All AMPT analysis will include detailed modeling of associated interconnection facilities to ensure the customers and AMPT's systems operation within acceptable limits

### **5. Load Power Factor Requirements (End User)**

Customers connected directly to the transmission systems should plan and design their systems to operate at close to unity power factor to minimize the reactive power burden on the transmission systems. AMPT requires the power factor at the point of interconnection to be controlled within the range of:

- 0.97 lagging to 0.99 leading.

Shunt capacitors are frequently used as a means to control the power factor of an Interconnecting Party's facility. However, there are several areas that should be addressed 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. The services of a qualified consultant should be obtained to review the specific application and provide recommendations in regard to control of these phenomena.

## **6. Frequency Range Requirements (Transmission, Generation, and End-User)**

The AMPT Transmission System typically operates at a nominal 60 Hz with a variation of  $\pm 0.05$  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 Requirements (Transmission, Generation, and End-User)**

### **7.1 Harmonics and Flicker**

Certain electrical equipment located at an Interconnecting Party facility (arc furnaces, cycloconverters, inverters, etc.) may generate flicker and harmonics that can negatively impact the utility power system.

The Interconnected 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".

Flicker shall be measured 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". Pst is a measure of short-term perception of flicker obtained for a ten-minute interval. Plt is a measure of long-term perception of flicker obtained for a two-hour period calculated from 12 consecutive Pst values. The connected facility shall be designed and operated such that Pst does not exceed 0.8 and Plt does not exceed 0.6 for 1% of the time (99% probability level) using a minimum assessment period of one week.

Voltage flicker for infrequent events such as large motor starting will be evaluated based upon the resulting percent voltage dip per event (see Annex A of IEEE Std. 1453-2004 or the most recent revision).

AMPT may initially, or in the future, require the installation of a harmonic and/or flicker monitoring system in order to permit ongoing assessment of compliance.

### **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 sensitive electrical equipment is to be supplied directly 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 electrical disturbances to sensitive electrical equipment such as computer, electronics, controls, and communication equipment cannot be tolerated, the Interconnecting Party shall furnish additional equipment as may be necessary to prevent equipment malfunctions. The supplier of such sensitive electrical equipment should be consulted regarding the power supply requirements or the remedial measures to be taken to alleviate potential misoperation of the equipment. A power quality consultant can also perform a site survey of the electric power supply environment and furnish recommendations to provide the acceptable level of reliability.

## **8. Interconnecting Party Substation Equipment Requirements**

### **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. The exact pull-off tensions will be determined 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 grounded to the steel structure and the station ground grid.

If the incoming high voltage lines will cross railroad tracks, such as a siding or main line, to reach the substation, it may be necessary to increase the tensions or provide additional height on the substation structure to meet railroad crossing requirements.

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 (NESC), latest revision.

### **8.2 Short Circuit Data & Interrupting Device Ratings**

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

- 3 Phase Fault in AMPS or MVA
- Single Line-Ground Fault in AMPS\*
- System Impedance on 100 MVA Base as Z1%, Z0%

\*Note: AMPT Transmission 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.

Substation equipment shall have interrupting and momentary ratings adequate for the short circuit conditions provided. 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. Connected parties are responsible for periodic review of existing and future fault conditions and for any future equipment upgrades/replacements that are required. PJM and AMPT would also analyze these situations if there is appropriate data to do so and work with customers owners to update their systems.

All gas insulated interrupting devices within the Connecting Party's facility having a direct connection to a AMPT transmission line shall be equipped with a low gas pressure 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.

### 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 ratings 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. MOV arrester application guide, IEEE Std C62.22, should be consulted to determine the maximum acceptable separation distance between the arresters and the protected equipment.

Consult manufacturer's catalog for details concerning arrester protective characteristics, ratings, and application.

#### 8.3.3 Ratings of Current Carrying Equipment

For tap supply 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. Minimum current ratings will be provided by AMPT for looped or network supply configurations.

#### 8.3.4 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 NESC or applicable state and local codes.

### 8.3.5 Insulators for Station

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 shall be used as needed to meet bus momentary short circuit withstand values.

### 8.3.6 Horn Gap Switch(es) and Disconnect Switch(es)

A gang operated horn gap switch shall be installed on each transmission line supply entrance to the Interconnecting Party's facility at a location which is accessible by AMPT personnel 24 hours a day. The switch shall be lockable in the open position with an AMPT padlock in order to provide for a visible electric isolation of the Interconnecting Party's facility and shall be identified with an AMPT designated equipment number.

A ground mat of 4' x 6' dimension shall be provided 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 horn gap switches 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 horn gap switches 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. A grounding device is to be furnished for the operating shaft and 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.

### 8.3.7 Substation Fence Safety Clearances

The fence safety clearances in the Interconnecting Party substation shall comply with NESC, Section 11 of IEEE Std C2.

### 8.3.8 Grounding System Design and Test

The grounding system shall be designed in accordance with IEEE Std 80 - latest revision, "IEEE Guide for Safety in AC Substation Grounding." The grounding system design and construction shall be verified by tests in accordance with IEEE Std 81, "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Surface Potentials of a Ground System."

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

Interconnecting Party equipment ground sources can contribute significant fault current independent of the ground fault values in Section 8.2. These ground sources shall be considered 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 Requirements (Transmission, Generation, and End-User)

### 9.1 AMPT Transmission System Protection

AMPT will provide functional specifications and relay settings for all 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 Transmission System. The criteria for these functional specifications and settings will be based upon methodologies set forth in PJM's protective Relaying Philosophy & Design Guidelines. 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 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 connecting party for use during the completion of power system studies.

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

## 9.2 Connecting 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 is coordinated with AMPT's 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 coordinate any relay changes with the connecting party as appropriate.

## 9.3 Automatic Underfrequency and Undervoltage Load Shedding

To the extent applicable, all Interconnecting Parties within the PJM portion of the AMPT system shall have an automatic underfrequency load shedding plan in effect that meets PJM Manual 37 requirements and RF Reliability Council agreements.

AMPT is required by NERC and RF to apply automatic undervoltage load shedding relaying as needed to prevent cascading transmission system outages. The specific locations where undervoltage load shedding relaying must be installed and the amounts of load to be shed are determined by special system studies. Wholesale and Retail Interconnecting Parties will be required to install undervoltage load shedding schemes as identified by AMPT through these special studies.

## **10. Remote Relay Access Requirements (Transmission, Generation, and End-User)**

### 10.1 Loop or Network Connected Substations

All digital relays which have the capability of recording system disturbance information and that are used for protection of AMPT transmission facilities shall be provided with the equipment necessary to allow AMPT to remotely retrieve this data.

### 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)**

### 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 below. 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 for all AMPT transmission lines connected to the facility, as well as ampere 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 communications protocol.

#### 11.2 Tap Connected Substations

AMPT may require tap-connected facilities with unusual or non-conforming load characteristics to install a SCADA RTU. Tap connected transmission load facilities do not normally require 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)**

AMPT approved revenue class metering equipment shall be installed to meter the aggregated load of the connected facility consisting of instantaneous bi-directional real and reactive power metering (MW and MVAR) and integrated hourly real and reactive energy metering (MWH and MVARH). The revenue meters shall be connected to current transformers (CT's) having IEEE Std C57.13 minimum metering accuracy rating of 0.3% at a burden designation of B-1.8. The voltage transformers (VT's) or coupling capacitor voltage transformers (CCVT's) must have IEEE Std C57.13 minimum metering accuracy rating of 0.3% at a burden designation of Y. VT's are preferred for revenue metering. CCVT's should only be used where there is a VT located within the same facility against which the CCVT can be periodically tested and calibrated. In cases where power flow varies significantly, extended range or high accuracy CTs may be required. In extreme cases, additional metering equipment may be required to properly measure energy delivered or received.

The instrument transformers used for revenue metering 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 connecting facility. Under special circumstances and with written approval from AMPT, revenue metering may be located on the secondary side of the step-down transformer and adjusted for transformer losses (compensated metering). Approval of compensated metering requires that the Interconnecting Party provide power transformer test data indicating transformer load and no-load losses, exciting current and impedance. This data shall be certified accurate to within 1%. If the transformer is equipped with a no-load tap changer, the test data shall be provided for all available taps. The Interconnecting Party must also demonstrate that accurate transformer loss compensation will be programmed into the revenue metering.

Compensated metering may be used with load tap changing (LTC) transformers if the transformer self-cooled rating is less than or equal to 25MVA and the forced-cooled rating is less than or equal to 35MVA. Compensated metering may not be used at facilities exporting power.

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 the public phone system. AMPT shall set the password and any other security requirements for remotely accessing the revenue meters so as to ensure the security of the meters and the meter data.

### **13. Communications Requirements (Transmission, Generation, and End-User)**

#### 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 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. Load reductions shall be implemented by reducing non-essential loads.

This type of reduction is usually conveyed through the local media. Contractual load reductions should already be in effect.

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 title, 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 facilities directly or indirectly connected to and operated in synchronism with the AMPT Transmission 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, will require detailed system studies to determine the feasibility of the proposed connection point and the specific connection requirements. The figures referenced in Section 14.5 show typical connections for generation owner substations and associated generation. Refer to Attachment C for additional information about the configuration of the connected facilities.

### **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 Transmission System. The generation owner is also responsible for meeting any applicable federal, state, and local codes. The minimum AMPT Transmission System connection design requirements for parallel generation are as follows.

#### **14.2.1 Reactive Power**

The Facility shall provide 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 outlined in PJM’s manuals. AMPT will coordinate with the Interconnecting Party to identify the appropriate 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. It must be capable of providing reactive output within the power factor range that meets PJM requirements outlined in PJM’s manual 14 series. Failure to meet PJM’s stated requirements will result in application of the mitigation process outlined in PJM’s manual 14 series, including but not limited to installation of power factor correction, dynamic reactive devices or other equipment at the generator at the interconnection customer’s cost. .

#### **14.2.2 Generator Frequency**

Connected generation shall be designed to produce balanced, three-phase, 60 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). The device shall interrupt all three phases simultaneously. The tripping control of the interrupting device shall be powered independently of the AMPT Transmission System ac source in order to permit operation upon loss of the AMPT supply.

### 14.2.4 System Grounding

For all connections of generation, the high side transformer 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, 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 for analysis by PJM.

### 14.2.7 Step-Up Transformer Requirements

All three-phase generators must be isolated from the AMPT Transmission System by a power transformer. AMPT will specify whether this power transformer must be delta-connected, wye- connected, solidly grounded, grounded through an impedance, or ungrounded at the interconnection line voltage.

## 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

A circuit shall be provided 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 excitation system is to be provided with a current limiting device, 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 not prevent the exciter from going to and remaining at the positive ceiling for 0.1 seconds following the inception of a fault on the power system.

### 14.3.3 Under excitation Limiter

A limiter to prevent instability resulting from generator under excitation is required.

### 14.3.4 Power System Stabilizer

Power system stabilizers shall be installed 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 generation owner 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 Center. A generation owner's parallel generation shall not supply power into the AMPT Transmission System unless a specific written agreement has been made to supply power into the AMPT Transmission System. The written agreement shall comply with the PJM interconnection process. Under no circumstances shall a generation owner energize AMPT Transmission System facilities that have been de-energized without authorization from the AMPT Transmission System Control Center. AMPT Transmission System circuits, which are electrically disconnected from the AMPT Transmission System and are energized by generation owner facilities, constitute 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 Transmission System.

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

### 14.4.1 Synchronization

The generation owner shall assume all responsibility for properly synchronizing their generation for parallel operation with the AMPT Transmission System. Upon loss of the AMPT supply, the generation owner shall immediately and positively cause the parallel generation to be separated from the AMPT Transmission System. Synchronizing of generation to the AMPT Transmission 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. As per the PJM Manuals, a steady-state deviation from this schedule between +3.5% to - 3.5% 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 a specified power factor for adherence to a specified voltage schedule. A steady state deviation from this power factor within +2% to -2% will be permissible.

Failure of the generation owner to maintain voltage or power factor within the scheduled range may result in penalties. Refer to the PJM Tariff Schedule 2 and/or Section 4.7 of Attachment O of the tariff details on reactive compensation/penalties.



#### 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. 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 AMPT Transmission System shall produce 60 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 Center, 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 PJM, 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 Transmission 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 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 14 series.

#### 14.4.7 Other Applicable Operating Requirements

In order to assure the continued reliability of the AMPT 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 PJM, 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

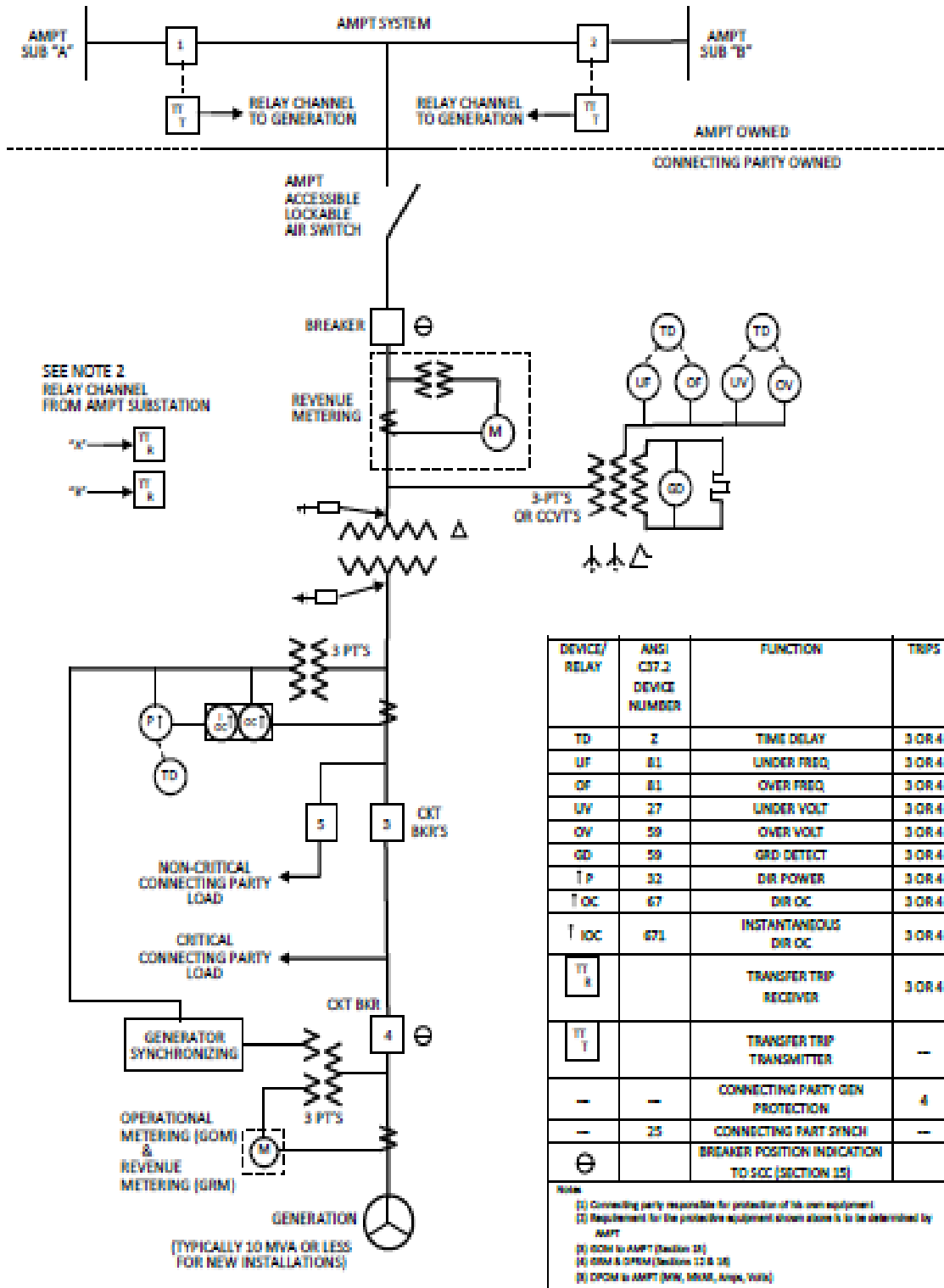
Situations necessitating generation curtailments or forced outages as the result of unavailability of facilities owned and/or operated by AMPT are to be coordinated with PJM.

#### 14.5 Generation Protection Requirements

The generation owner shall provide utility-grade relays for protection of the AMPT Transmission System. AMPT shall approve all relays specified for the protection of the AMPT Transmission System, including time delay and auxiliary relays. Relay operation for any of the functions listed in the table below that are required shall initiate immediate separation of the parallel generation from the AMPT Transmission System.

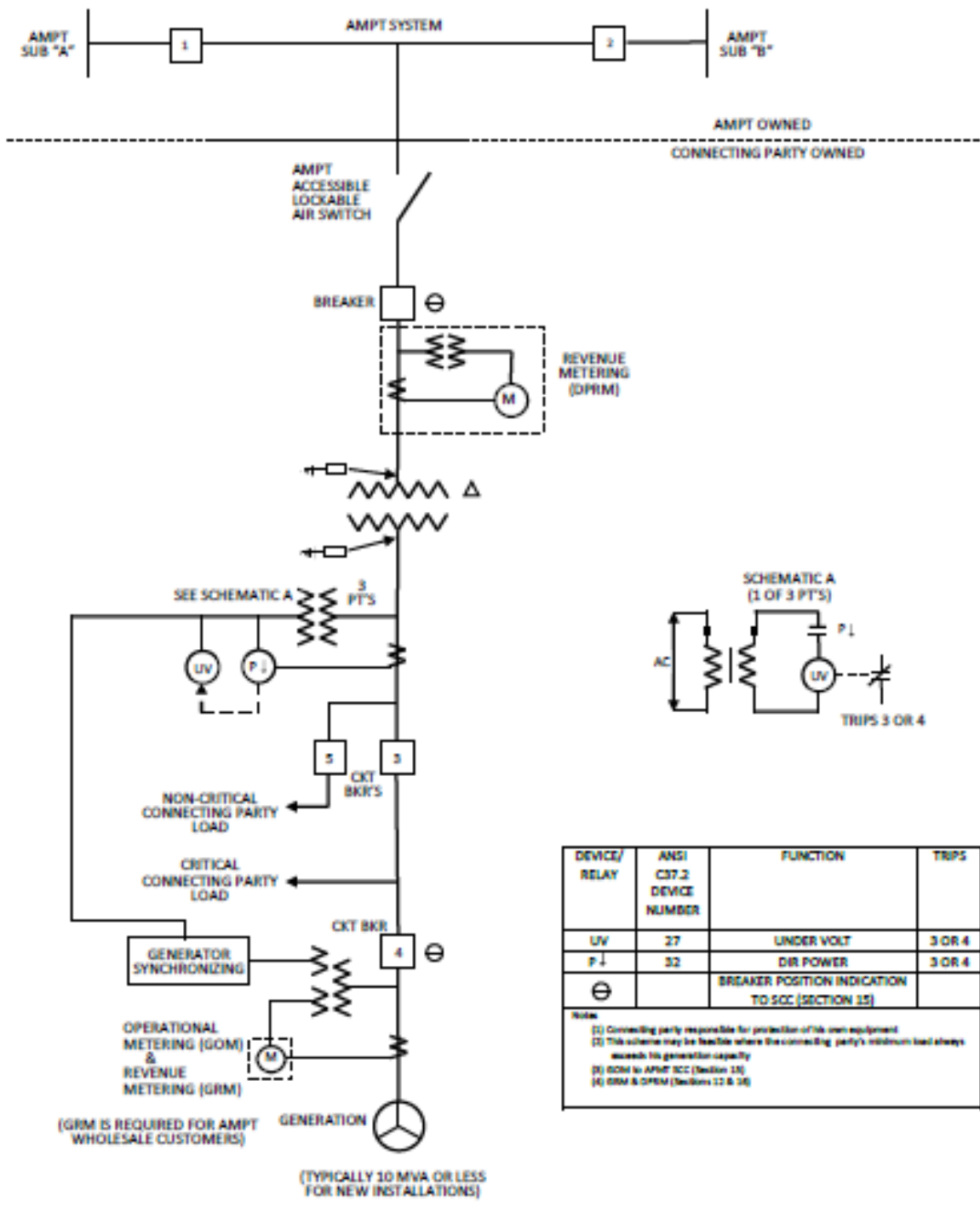
<b><u>Relay</u></b>	<b><u>Function</u></b>
Frequency	To detect under-frequency and over-frequency operation
Over-voltage	To detect over-voltage operation
Under-voltage	To detect under-voltage operation
Ground Fault Detector	To detect a circuit ground on the AMPT Transmission System
Phase Fault Detector	To detect phase-to-phase faults on the AMPT Transmission System
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the AMPT supply circuits.
Directional Power	To detect under all system conditions a loss of AMPT primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

In order to provide adequate protection to the AMPT Transmission System, AMPT may require that the generation owner furnish and install at their expense 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 generation owner'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 generation owner's facility, including any lease fees for the communications channel. Finally, Special Protection Schemes (Remedial Action Schemes) may be required in accordance with PJM rules and documents.



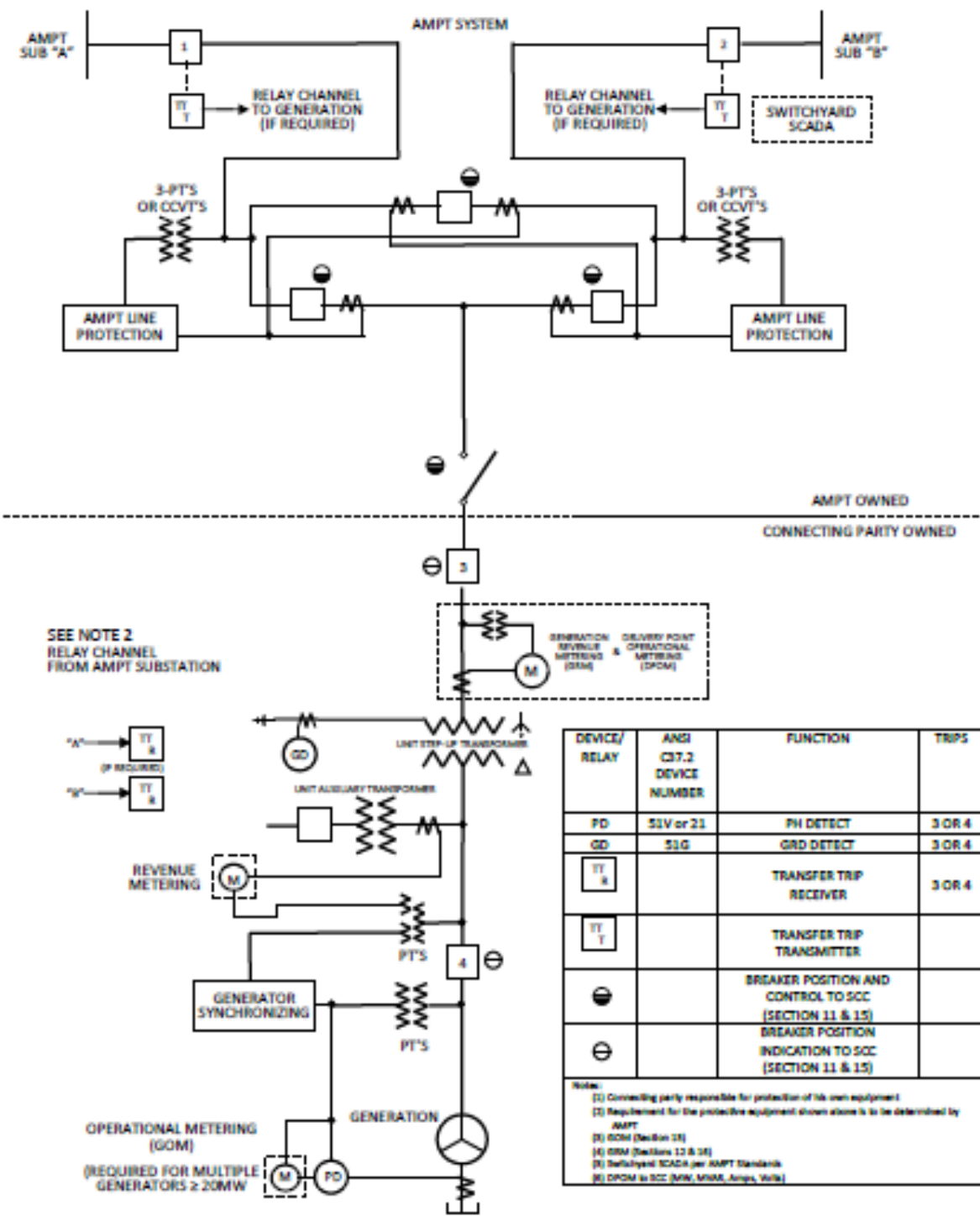
COMBINED LOAD & GENERATION FACILITY

FIGURE 3

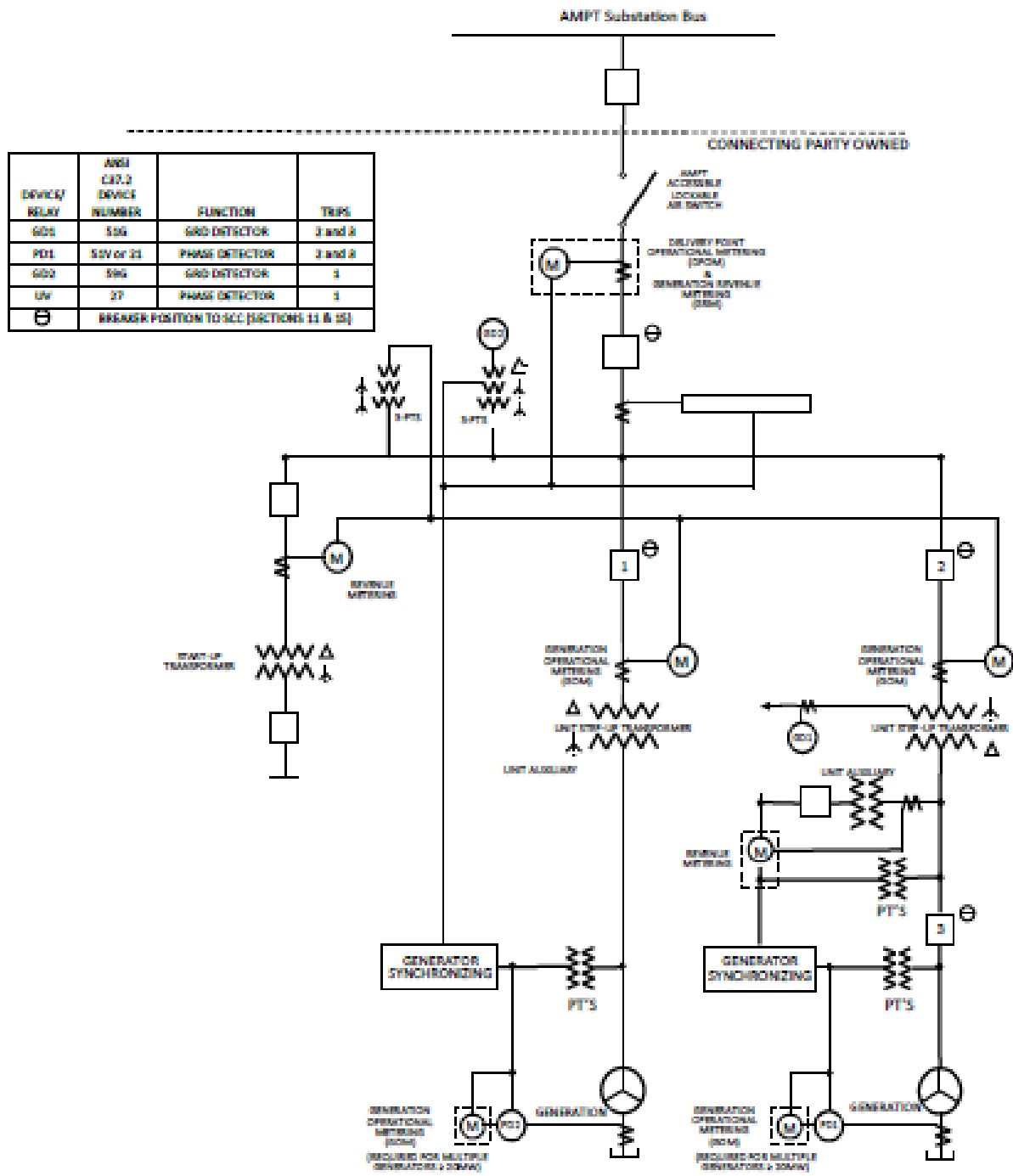


COMBINED LOAD & GENERATION FACILITY

FIGURE 4



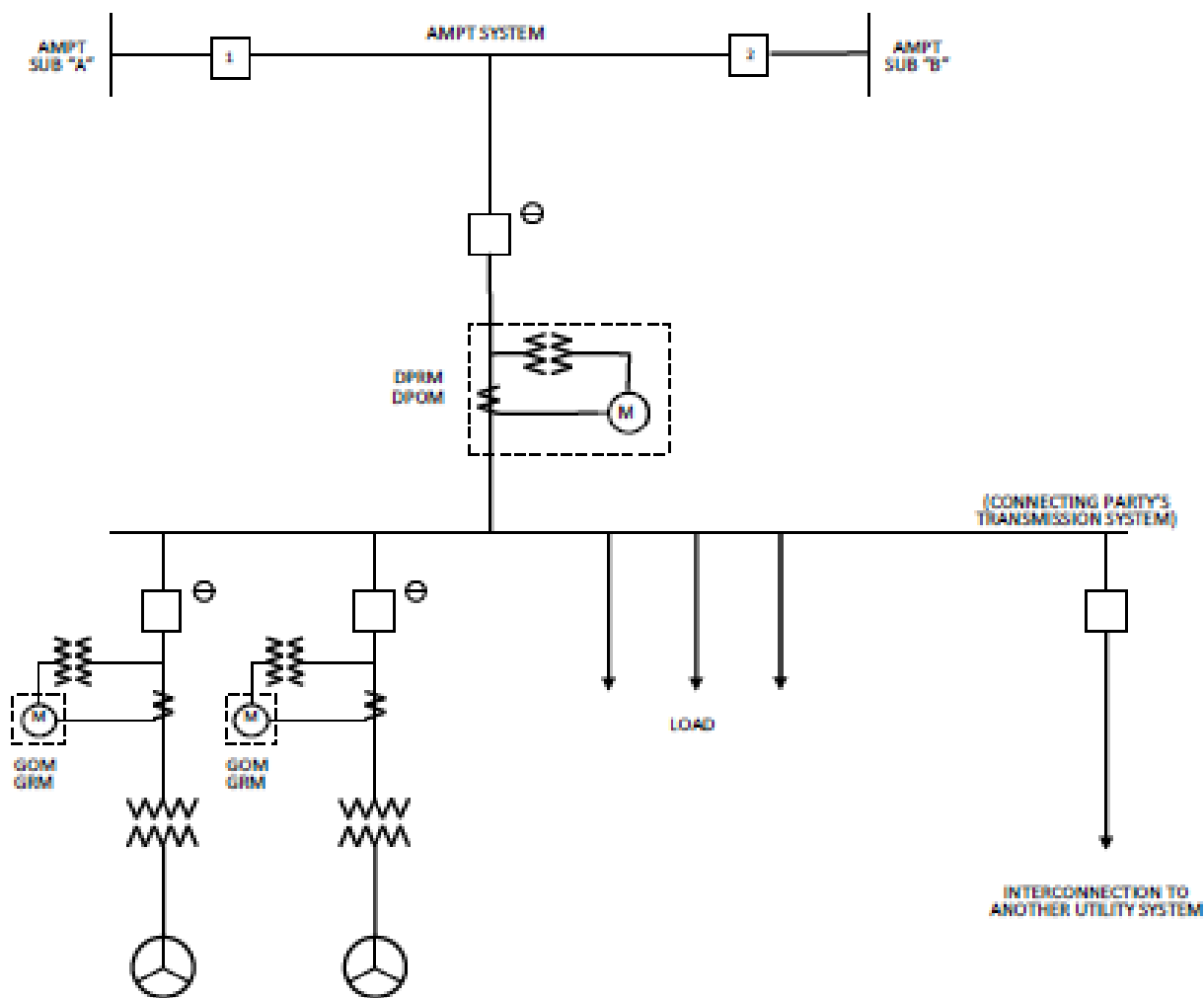
GENERATION FACILITY  
 FIGURE 5



- Notes
- (1) Connecting party responsible for protection of its own equipment
  - (2) SCC (Section 15)
  - (3) GRM Revenue Metering (Sections 12 & 14)
  - (4) DPOM to AMPT (3MW, 10MVA, Amps, Volt)

**BUS CONNECTED MULTIPLE GENERATION ENERGY EXPORT**

**FIGURE 6**



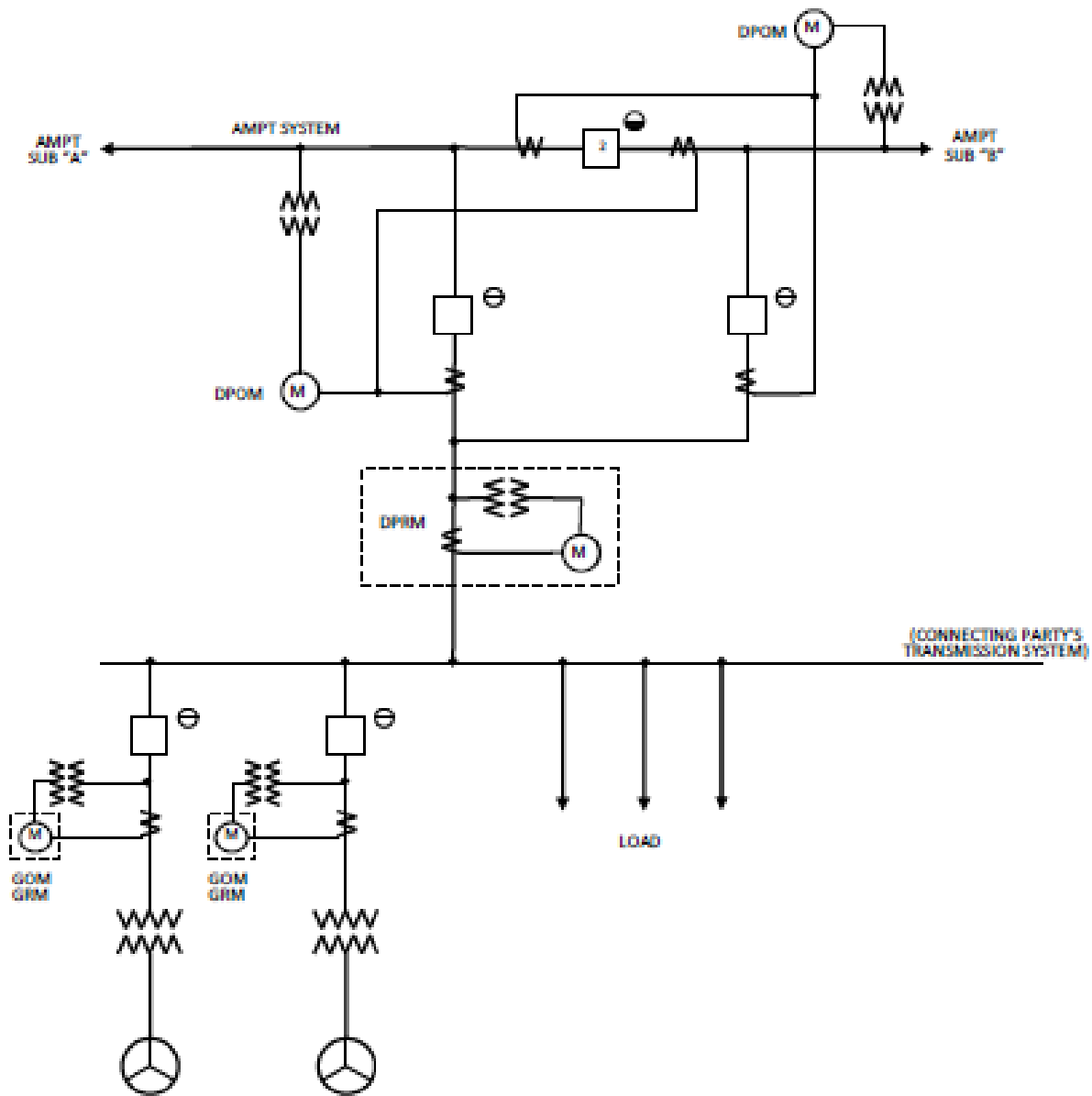
- ⊖ - Breaker Position Indication to SCC (Sections 11 & 15)
- GOM - Generation Operational Metering and AGC to SCC (Section 15)
- DPOM - Delivery Point SCADA (Operational Metering) to SCC (Section 11)
- DRPM - Delivery Point Revenue Metering (Section 12)
- GRM - Generation Revenue Metering (Sections 12 & 16)

Notes:

- (1) DPOM required only if backfeed is possible from internal generation or if connecting party's system also connects to another utility system
- (2) This configuration is only for existing delivery points subject to AMPT approval per Section 15

TAP TO PARTY WITH TRANSMISSION AND GENERATION

FIGURE 7



- ⊕ - Breaker Position Indication to SCC (Sections 11 & 15)
- ⊖ - SCADA Breaker Control and Position and Indication to SCC (Section 11)
- GOM - Generation Operational Metering and AGC to SCC (Section 15)
- DPOM - Delivery Point SCADA (Operational Metering) to SCC (Section 11)
- DRPM - Delivery Point Revenue Metering (Section 12)
- GRM - Generation Revenue Metering (Sections 12 & 16)

LOOP TO PARTY WITH TRANSMISSION AND GENERATION

FIGURE 8



## **15. Additional SCADA (Operational Metering) Requirements for Generation Facilities**

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

For all generation facilities connected directly to the AMPT Transmission System of any MW capacity, AMPT requires the SCADA equipment specified in Section 11.1 plus additional SCADA equipment needed to provide operational metering and status points for the following:

1. Net generator MW and MVAR and Volts 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 are required.
3. Generator breaker position(s) sufficient to verify that the AMPT transfer trip, when installed, has tripped the generator breaker(s) are required.

For generation facilities that are indirectly connected to the AMPT Transmission System through the power system facilities of a wholesale or retail customer, AMPT requires the SCADA equipment specified in Section 11.1 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 5MVA or greater.
3. The total generating capacity of a group of generators is 5MVA 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 5MVA capacity and connected to a common generation bus or generator step-up transformer. If AMPT determines that control of the generation is to be contracted, SCADA/automatic generation control (AGC) equipment is required for the following:

1. AGC control status (on, off)
2. Desired generator MW set point(s)
3. Generator availability
4. Generator minimum and base MW capability
5. Generator high and low MW limits.

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 and 16. 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)**

Before an Interconnecting Party's Facility can be energized, it must pass a final inspection by AMPT. This inspection will include all 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, 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 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. Coordination with Other Codes, Standards, and Agencies (Transmission, Generation, and End-User)**

The information contained in this document is supplementary to and does not intentionally conflict with or supersede the National Electrical Code (NEC), the 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.

## **18. Indemnification (Transmission, Generation, and End-User)**

The use and reliance upon this information shall in no way relieve the Interconnecting Party from the responsibility to meet NEC, NESC, NERC, RFC, PJM or other requirements governing their design, construction, operation, and materials.

## **19. Revisions**

### **19.1 Revision Process**

All revisions of this document will be reviewed and approved by AMPT Executive Management.

1. 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.
2. The date of change, the reason for the change, and revision author are recorded in the Revision History.
3. 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.

19.2 Revision History

**DOCUMENT APPROVAL**

<b>Action</b>	<b>Name(s)</b>	<b>Title</b>	<b>Signature</b>
Prepared by:	Ryan C. Dolan	Director Transmission Planning	
Reviewed by:	Edward Tatum	Vice President	
Reviewed by:	Lisa McAlister	General Counsel	
Approved by:	Pam Sullivan	President	

**DOCUMENT CHANGE/REVISION HISTORY**

<b>Version:</b>	<b>Prepared By:</b>	<b>Summary of Changes:</b>	<b>Date:</b>
1 (issued as Rev 1)			
2 (issued as Rev 2)			

## **Attachment A**

### **Procedure for Connecting New Substation or Lines to AMPT Facilities**

1. A party desiring to connect to an AMPT facility will sign a Construction Service Agreement and an Interconnection Service Agreement (for a wholesale customer) after the Initial Load Study (ILS) and Detailed Load Study (DLS) and other required studies have been completed. The Construction Service Agreement and the Interconnection Service Agreement will define the project scope and facility ratings. The Construction Service Agreement and the Interconnection Service Agreement 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.
2. Following receipt of the signed Construction Service Agreement and an Interconnection Service Agreement for a customer, AMPT will appoint a project engineer to oversee the connection details and act as AMPT's representative to ensure the connection meets AMPT's electrical and safety standards.
3. At the conclusion of the design process, the AMPT will supply a functional one-line showing devices, wire 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. For projects which are not being engineered by AMPT, the connecting party is responsible for providing the functional one-line to AMPT. "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, equipment numbers will be assigned to devices in the current path of the connection.
4. Following development of the functional one line, AMPT will prepare a check list detailing those items which will need to be checked or tested prior to final release and energizing of the new facilities. AMPT will supply this list to the connecting party and insure that all items on the list are checked and tested to the satisfaction of AMPT prior to releasing the equipment. (This check-off and testing can be performed by the connecting party or their representative). AMPT 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.
5. For all connections, the connected equipment and check list will be inspected and released by AMPT. For new connections involving circuit breakers or circuit switchers, AMPT 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, AMPT will observe the phasing test. If deemed necessary, AMPT has the authority to observe or conduct any test required by the check-off list.
6. After being satisfied that the connected facilities have been properly inspected and released, AMPT will notify the customer that it is permissible to energize the new facilities – provided all of the AMPT Transmission System Control Center 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 AMPT. 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	BY	DATE
1. Substation Ground Resistance (remote earth)	Review Test Results	_____	_____
2. Safety and equipment grounding	Visual Inspection	_____	_____
3. Ground grid point-to-point checks	Review Test Results	_____	_____
	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. Hipot 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	_____	_____

## Attachment B

### CONNECTING SUBSTATION -- EXAMPLE Substation Checkout Guide

ITEM	ACTION/INFORMATION	BY	DATE
1. Substation Ground Resistance (remote earth)	Review Test Results	_____	_____
2. Safety and equipment grounding	Visual Inspection	_____	_____
3. Ground grid point-to-point checks	Review Test Results	_____	_____
4. AMPT ID Nameplates for Breakers & Switches	Visual Inspection	_____	_____
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			
b. 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			
c. CS_____kV Transformer			
1. Hipot Test	Review Test Results	_____	_____
2. Timing Tests	Review Test Results	_____	_____
3. Ductor	Review Test Results	_____	_____
8. Fuses			
d. _____kV Transformer			
1. Rating/Type (as specified)	Visual Inspection	_____	_____
2. Air Flow Test	Review Test Results	_____	_____
9. Power Transformers			
e. TR#_ _ kV_ _MVA			
1. CT Ratio & Polarity	Review Test Results	_____	_____
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 Transformerr Selector Switch			
1. Functional test (make before break)	Review Test Results	_____	_____
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

### BREAKER RING BUS DECISION PROCESS – GENERATION FACILITY CONNECTIONS

#### Main Concepts for Applying a Breaker Ring Bus

- Where a breaker ring bus is mentioned in this Attachment, a breaker and a half configuration is an acceptable alternative.
- Problem at a customer facility does not impact the AMPT system.
- Maintenance of an AMPT line/sub does not require a customer facility outage.
- Proposed connection does not compromise the protection of AMPT facilities.

#### Criteria for Requiring a Breaker Ring Bus

- For generation connected to the AMPT system at a nominal voltage of 138kV, a ring bus is required regardless of the MVA rating of the generation.
- For generation connected to the AMPT Transmission System at a nominal voltage of 69kV or less, a ring bus is required for facilities with a total generating capacity rated 5 MVA or greater.
- For generation connected to the AMPT Transmission System at a nominal voltage of 69kV or less, a ring bus is required for facilities with a total generation capacity and exposure that would equate to greater than 35 MVA – mile.

#### Process for Evaluating the Remaining Installations

All other installations must be evaluated for the need of a breaker ring-bus. The installation will also be evaluated to determine the transformer winding connections and winding grounding that are required for the generation facility interconnecting transformation. This technical evaluation will include the following:

- Verification that the protection of AMPT facilities can be maintained by the line relaying at the remote terminals considering the effects of fault current sources from the generation facility. These fault currents tend to reduce the sensitivity of the line relaying at the remote terminals.
- Verification that the AMPT system can accommodate the overvoltage to ground associated with ground faults if the AMPT system is not effectively grounded when supplied only from the generation facilities.

**TABLE 1**  
Substation Electrical Clearances and Insulation Levels

<u>Item</u>	<u>Rated Maximum Voltage Between Phases (rms)</u>		
	<u>72.5 kV</u> <u>@ 350 BIL</u>	<u>145 kV</u> <u>@ 550 BIL      @ 650 BIL</u>	
Electrical Clearance Min. (inches)			
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)	60	84	96
(see note 1 and 2)			
Disconnect Switches Phase Spacing (inches)			
Vertical Break	60	84	96
Side Break	72	108	132
Horn Gap Switches	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			
Continuous Amps	600 A	600 A	600 A
Momentary Asymmetrical Withstand	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	1700	1700
High Cantilever Strength	3000	2600	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.

continued:

**TABLE 1**  
Substation Electrical Clearances and Insulation Levels  
(continued)

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 part 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