PSEG

Interconnection Requirements for Transmission Facilities 69 kV and Higher

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Record of Revisions

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REV 4.01	June 10, 2022	All	Changed Manual Title from “Interconnection Requirements for Transmission Facilities 138 kV and Higher” to “Interconnection Requirements for Transmission Facilities 69 kV and Higher” Introduce 69 kV system in to the document.
REV 4.02	October 19, 2022	Title page and Chapter 1	Chapter 1 – Updated Table 1-4.
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Chapter 1 – Interconnection Requirements

1 Introduction

This document describes the requirements for interconnecting **Generation facilities, Transmission facilities** and **End User facilities** to the PSE&G Transmission system at all voltages 69 kV and higher, and describes the processes to validate that those interconnected facilities have met the prescribed requirements and have utilized acceptable vendors, contractors, components and systems. The PJM RTEP procedures and requirements contained in the PJM Tariff and other PJM agreements and documents shall also apply to all interconnection projects.

1.1 Requirements

All projects shall meet the following requirements:

1. PSE&G Technical Design Information (Section 2 through Section 14 of this document)
2. The National Electrical Code (**NEC**) and the National Electric Safety Code (**NESC**).
3. All applicable ANSI, IEEE, NEMA Standards and NERC, Reliability First, and PJM Guidelines.
4. The information contained in this document, and its attachments, is intended to supplement the standards listed above. It is not meant to supersede or conflict with any of these standards or the applicable federal, state, and local/municipal standards, guides, laws, ordinances, rules, codes, and regulations.
5. PSE&G Planning, Reliability and Engineering/Design criteria require that all interconnected facilities served by two or more transmission lines be built as either a ring bus or as breaker and a half configuration. Straight Bus configurations are not permitted unless the installation involves single-ended radial interconnections.
6. Interconnected transmission facilities can be either Air Insulated Substation (**AIS**) design or Gas Insulated Switchgear (**GIS**) design. GIS equipment shall meet all aspects of IEEE Standard C37.122-2021 (R2010), “High Voltage Gas Insulated Substations Rated Above 52 kV”. The use of gas insulated design will require some special considerations:
   a. In facilities that are fed via underground cable (either High Pressure Fluid Filled (**HPFF**), Ethylene Propylene Rubber (**EPR**) or Crossed Linked Polyethylene (**XLPE**), direct gas to cable terminations are not preferred. PSE&G’s operational and maintenance criteria prefer and require that cables be terminated using conventional cable terminators (pot heads) and connected to the GIS via open bus to air terminals. However, direct cable connection to the GIS is acceptable when supplemented with an additional GIS line disconnect switch with ground switch, a GIS voltage transformer, a cable/GIS testing port, capacitively coupled voltage detectors on the cable terminations, and GIS cable boxes for each phase.
   b. GIS facilities, specifically those that are fed from two or more lines, shall be designed to have sufficient gas zones, circuit breakers and disconnects, so in the case of a main bus fault, the faulted area can be isolated, degassed and repaired without de-energizing the entire facility and with minimal impact to undamaged portions of the facility.
7. Interconnections supplied by HPFF underground pipe-type cable will require piping and hydraulic equipment to be installed at the customer substation. This equipment will be either a pumping plant or a crossover valve, determined by a PSE&G Hydraulic Engineer per requirements at the specific service

location. Responsibility for design and construction of the hydraulic equipment required for HPFF underground service rests with PSE&G; customer responsibilities include provision of an adequate location within the substation footprint to install the hydraulic equipment, and provision of electrical power and fiber communications to the hydraulic plant. Typical dimensions for Pumping Plants are a length of 55 ft and width of 15 ft, and a height of approximately 12 ft not including the foundation. Crossover valve cabinets are typically 5 ft by 2 ft, with a height of 6 ft. Access to the hydraulic equipment should be taken in consideration during the site design phase, to accommodate for standard maintenance operations and/or equipment replacement.

In the event any of these interconnection requirements conflict with any of the above listed standards, written clarification shall be obtained from PSE&G in collaboration with PJM, prior to completing the applicable phase of the project.

All work performed on PSE&G's transmission system and/or property shall be in accordance with all applicable safety practices and OSHA requirements.

Furthermore, project documentation shall include, but not be limited to:

1. All design calculations.
2. Licensing and permitting documentation.
3. Bill of materials for major equipment, structures, and electrical buswork.
4. Manufacturers drawings, instruction books, and test reports.
5. DC and AC schematic diagrams of all controls and relaying systems.
6. Wiring diagrams for all equipment, racks, assemblies and equipment interconnection.

Note Wiring or cable tabulation lists are unacceptable.

SCADA and telecommunications requirements shall be as defined in Section 7. If the Interconnection Customer wishes to have PSE&G's Electric Systems Operation Center (**ESOC**) provide set points from PJM, additional requirements will be provided based on the type of service requested. This issue shall be resolved during the Facilities Study stage of the project.

All interconnection projects shall be governed by the above requirements as well as System Impact and Facilities studies conducted by PJM in coordination and collaboration with PSE&G.

Protective relay systems shall be redundant, and all control cable systems shall be electrostatically and electro-magnetically shielded.

1.1.1 Validation of Requirements

Consistent with the Standard Construction Terms and Conditions contained in Part VI, Attachment P, Appendix 2, Section 3 (schedule of Work) of the PJM Open Access Transmission Tariff (https://www.pjm.com/pjmfiles/directory/merged-tariffs/oatt.pdf), inspection and testing of the completed facilities is required. After the construction is completed, PSE&G reserves the right to validate the operational readiness of the equipment and satisfactory operation of the design, as well as to repeat any test that it chooses. If there are substantive differences between the initial test and industry accepted norms or PSE&G test results, the tests shall be repeated until satisfactory results are obtained.

1.1.2 Acceptable Vendors and Systems

Section 19 contains a listing of acceptable equipment vendor and Section 20 contains a listing of acceptable Architect-Engineering firms, constructors, and testing companies.

1.1.3 Modifications or Updates

PSE&G may modify and/or update these requirements to ensure compliance with all applicable standards as required.

When modifications and updates are performed, they shall be reviewed internally by the Electric and Gas Asset Strategy Department for technical content and reviewed by the Legal Department for conformance to the legal aspects of the NERC / RFC standard FAC-001.

After the internal technical and legal reviews are completed the document shall be signed by both the author of the revision who shall be a senior member of the Asset Reliability Department and then also signed by the Director – Electric and Gas Asset Strategy Department. A signed electronic PDF version of the revised document shall be sent to PJM for posting on the PJM website within 10 days after revision date and signature.

2 General Technical Requirements

Section 2 of this document provides the general technical requirements for the integration of transmission-connected facilities into the PSE&G system. However, Interconnection Customers should be aware that it may not cover all the details of such an interconnection, nor reference all the applicable standards (such as NEC, NESC, ANSI, IEEE, NEMA) and requirements (such as NERC, Reliability First, PJM, federal, state, and local/municipal) governing such an installation.

Transmission Owner Technical Guidelines & Recommendations below, formerly were referred to as the “PJM TSDS Technical Requirements”, previously published by the PJM Transmission & Substation Design Subcommittee (**TSDS**). Currently published by Transmission Substation Subcommittee (**TSS**).

The documents included here are still subject to PJM’s review and may thus change before being formally published pursuant to Section 1.2c of the PJM Open Access Transmission Tariff.

All of these documents can be found on the PJM website at http://www.pjm.com/planning/design-engineering/maac-to-guidelines.aspx

Transmission Owner Technical Guidelines and Recommendations

I. Introduction – Technical Requirements and Design Philosophy (12-2017)

II. Recommendations of Resilience and System Hardening Practices (7.22.2021)

III. Transmission System Design Criteria (12-2017)

IV. Substation Bus Configuration and Substation Design Requirements (12-2017)

V. Spare Equipment Philosophy (12-2017)

VI. Design, Application; Maintenance, and Operation Technical Requirements

a. Overhead Transmission Lines (12-2017)

b. Power Cables (12-2017)

c. Large Power Transformers (12-2017)

d. Circuit Breakers (12-2017)
e. Load Interrupting Switches (Circuit Switches) (12-2017)
f. Disconnects and Switches (12-2017)
g. Shunt Capacitors (12-2017)
h. Instrument Transformers (12-2017)
i. AC Station Service (12-2017)
j. Substation Batteries and Chargers (12-2017)
k. DC Substation Service (12-2017)
l. Substation Operation and Maintenance (12-2017)
m. Carrier Current Line Traps (12-2017)
n. Insulation Coordination and Surge Protection (12-2017)
o. Relay and Control Building Requirements (12-2017)
p. Static Var Compensators (**SVC**) (12-2018)

VII. Rating Guides

a. Bare Overhead Transmission Conductor Ratings (10.2022)
Overhead Transmission Conductor – Spreadsheet (04.26.2024)
b. Power Transformer (09.18.2024)
c. Circuit breakers (09.18.2024)
Circuit breakers – Spreadsheets (11.21.2024)
d. Air Disconnect Switches (12.11.2024)
e. Outdoor Substation Conductor Ratings (12.11.2024)
PJM Bus Rating – Spreadsheet (12.11.2024)
f. Current Transformers (04.11.2025)
g. Line Traps (03.2012)
h. Underground and Submarine Transmission Cable Rating Methodology (9.17.2015)

VIII. Installation and Commissioning (12.2017)

IX. Inspection, Testing and Acceptance (12.2017)

Annexes

A. System Phasing Diagrams (9.18.2024)
B. Definitions (06.2002)

The following Standard Specification published by the Institute of Electrical and Electronic Engineers (**IEEE**) are referenced and included in these requirements.

IEEE Standard 1312-1993 (Reaffirmed 2004) – Preferred Voltage Ratings for Alternating Current Electric Systems and Equipment Operating at Voltages Above 230 kV Nominal.

NEMA/ANSI C84.1 - 2020 – Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)

3 Assurance of System Performance

The overall intent of this document and those referenced above are to describe the process utilized to ensure that continued transmission system performance and reliability is maintained throughout the continued development of the transmission system throughout the planning horizon.

PJM, the Transmission Operator, facilitates and coordinates the generation and transmission interconnection plan, through its Tariff, Manuals, and Agreements. PJM works with generators and transmission owners to ensure reliable operation of the Transmission system. PJM's coordination of this process is described in PJM Manual 14B, "PJM Region Transmission Planning Process." PSE&G, the Transmission Owner, provides technical requirements and performance considerations for connections to its system through its Interconnection Requirements (this document), and through its FERC Form 715 filing.

1. Procedures for coordinated joint studies of new or materially modified facilities and their impacts on the Interconnected Transmission System.

   The impact of new facilities on the interconnected transmission system must be understood; therefore coordinated studies are required per Part VI, Subpart A - System Impact Studies and Facilities Studies for New Service Requests of the PJM Open Access Transmission Tariff (https://www.pjm.com/pjmfiles/directory/merged-tariffs/oatt.pdf); PJM Manual 14A, Sections 1-3 PJM Support for New Service Customer (https://www.pjm.com/-/media/DotCom/documents/manuals/m14a.pdf); and PJM Manual 14E, Sections 1-3 -Customer Classifications (https://www.pjm.com/-/media/DotCom/documents/manuals/m14e.pdf), PJM will facilitate and/or perform these studies in coordination with the interconnection customer (generator, merchant transmission, or end- user) and the affected transmission system owners.

2. Procedures for application and notification for new or modified facilities to PJM (those responsible for the reliability of the Interconnected Transmission Systems) as soon as feasible.

   a. PJM Manual 14A guides the generation and/or transmission developers through the planning, facility construction and implementation processes in PJM markets.

   b. PJM, the Transmission Provider, per PJM Open Access Transmission Tariff Part IV, Subpart A – Interconnection Procedures, Clause 36 – Interconnection Requests, will coordinate and maintain a list of all generator or transmission interconnection applications. That list is made available to all parties responsible for the reliability of the interconnected transmission system. This information is provided on PJM's OASIS system as part of the New Services Queue.

3. Procedures for confirming with PJM (those responsible for the reliability of affected systems of new or materially modified transmission facilities are within a Balancing Authority (PJM) Area's metered boundaries.

   PJM assesses facilities within its Balancing Authority Area metered boundaries through the requirements in its PJM Open Access Transmission Tariff (**OATT**), rules around the PJM Regional Transmission Expansion Process, and the New Services Request process. All new or materially modified facilities that seek interconnection to or upgrade facilities in the PJM Balancing Authority area's metered boundaries (inclusive of all interconnections or upgrades to PSE&G Transmission Facilities) must come through PJM's New Services Queue. Only those projects that are within the PJM Balancing Authority will be considered for approval (and only PJM "approved" projects will be given an Interconnection Service Agreement that is submitted to FERC for review and approval). For additional information, see *PJM Compliance Bulletin CB028-NERC Standard FAC-001-4 – Facilities within the Metered Boundaries of a Balancing Authority,* which is posted on the PJM website.

4 Voltage Level, MW, and MVAR Capacity or Demand at Point of Connection

Nominal steady state system voltages for the PSE&G transmission system are 69,000 V nominal – 72,500 V maximum, 138,000 V nominal – 144,900 V maximum, 230,000 V nominal – 245,000 V maximum, 345,000 V nominal – 362,000 V maximum, and 500,000 V nominal – 550,000 V maximum. Voltage levels shall be controlled within these prescribed bands as required by PJM System Operations. For voltage 345,000 and greater see, "**IEEE Standard 1312-1993 (Reaffirmed 2004)** – Preferred Voltage Ratings for Alternating Current Electric Systems and Equipment Operating at Voltages Above 230 kV" and "NEMA/ANSI C84.1 - 2020 – Electric Power Systems and Equipment – Voltage Ratings (60 Hertz").

In order to ensure compliance with NERC / RFC Standard FAC-001, the PJM application and study process shall determine the actual MW, and MVAR Capacity or Demand at Point of Connection.

5 Circuit Breaker Duty and Surge Protection

5.1 System Short Circuit Duty

PSE&G will provide the short circuit data for a connection point in the system. The data will include both the three-phase and single-phase line-to-ground fault currents expected at the proposed interconnection location. To facilitate reconfiguration of the system, PSE&G requires that the minimum interrupting rating of all equipment be a minimum of 63 kA for 500, 345, 230 and 138 kV system voltages; and 50/63 kA for 69 kV system voltage. In some cases, 80 kA is required for 345, 230 and 138 kV system voltages. At a minimum, bus supports / bracing and ground systems shall be designed to match interrupting rating of all equipment for 500, 345, 230,138 and 69 kV system voltages. and the ground grid design shall consider the current split factor provided by PSE&G.

In certain situations and locations within the PSE&G transmission system, maximum fault currents have been identified as being currently greater than 63 kA Symmetrical for 500, 345, 230 and 138 kV system voltages and 50 kA for 69 kV system voltage or having the high probability of exceeding 63 kA Symmetrical for 345, 230 and 138 kV system voltages and 50 kA for 69 kV system voltage within a short period of time. In these cases, as identified by the PSE&G Planning Department, the Interconnection Customer shall be required to install equipment with a rating of 80 kA Symmetrical for 345, 230 and 138 kV system voltages and 63 kA for 69 kV system voltage.

5.2 Surge Protection

All line or cable entrance positions to a station shall have arrester protection installed on the line or cable side of the line or cable disconnect. Line entrance arresters located on cable circuits shall consider maximum voltages and energies that can result during cable operation and system restoration events.

All power transformers, autotransformers, reactors, shunt capacitor banks, and regulators or phase angle regulators shall have arrester protection for each winding and/or phase. Arrester protective margins shall not be less than 20% as determined by IEEE standards methods.

All surge arresters shall be polymer housed, station class, and of metal oxide type.

Table 1-1: Protective Equipment – Surge

System Voltage	500 kV	345 kV	230 kV	138 kV	69 kV
Lightning (Surge) Arresters					
Nameplate rating[1] in kV (duty cycle)	420	288	180	120	66
Equipment Protection Gaps in Inches (existing installations only)					
Bushings (where installed)	NA	NA	NA	NA	NA
Line Terminals	None	None	42	None	None
CTs and PTs	None	50	40	26	None

Note: 1. Surge Arrester ratings are for Metal Oxide Varistor (**MOV**) types only. Stations with extensive underground cable or shunt capacitor banks shall be evaluated individually.

6 System Protection and Coordination

1. All protective relays shall be of the multifunction, programmable, micro-processor based type and meet or exceed ANSI/IEEE Standard C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus". All protective relays shall be provided with external rack mounted test switches on all inputs and outputs of the relay, including the DC supply. Relays shall be designed for operation in a nominal 125 VDC system (140 VDC Float), which provides both the power source for the relay as well as all control power for operating and tripping devices. Transmission breakers require independent redundant trip circuits and protection (i.e., two relays (Primary and Back-up), two trip coils, two of all ancillary components, and independent wiring and cabling).
2. All protective relays, switches, wiring and cabling, and current transformers shall be designed to operate continuously at any of the normal or 4 hour temperature sensitive ratings for a 3,000 or 4,000 A position as described in Table 1-5 and Table 1-6, Current Transformer (**CT**) ratings shall be adjusted for tap position, and shall not exceed the CTs thermal capabilities for these ratings. Current transformers may have to be specified with higher current ratings and/or higher Rating Factors (IEEE C57.13-2016 R2008) to meet these requirements.
3. All relay Voltage Transformer (**VT**) and CT secondary circuits shall be constructed with only a single ground point located at the relay rack. The ground connection shall be clearly identified and easily accessible to facilitate testing.
4. All the requirements of the PJM Manual 07: PJM Protection Standards shall be followed. The documents listed below can be found at:
   a. PJM Manual 07: PJM Protection Standards

      https://www.pjm.com/-/media/documents/manuals/m07.ashx
   b. PJM Compliance Bulletin CB001 - NERC Standard PRC-001-1 System Protection Coordination

      https://www.pjm.com/-/media/library/whitepapers/compliance/prc001-compliance-bulletin.ashx?la=en

5. Interconnection Customers shall contact PSE&G's System Protection Group as early as possible in the project schedule to facilitate the development of a protective relay one line; and for approval of all relay types and styles for use by both the Interconnection Customer and PSE&G for facility design and construction. Contact Information is given below:

   Public Service Electric and Gas Company
   Electric and Gas Asset Reliability
   Manager – System Protection
   80 Park Plaza Mail Code T-17
   Newark, NJ 07101

   PSE&G shall perform or review, as necessary, all testing of all relays that impact the reliability of its transmission system.

7 Metering and Telecommunications

7.1 Revenue Metering

1. Metering Instrument Transformer configuration will depend on the voltage class and arrangement of the Customer substation. In general, instrument transformers will be located in radial connections coming off a ring bus going to customer load or generation. Instrument Transformers should not be located on line connections to a ring bus.
   a. 69 kV, 138 kV and 230 kV connections will be metered with combined instrument transformers.
   b. 345 kV and 500 kV air insulated substations will be metered with CVTs and CTs.
   c. 345 kV and 500 kV gas insulated substation will be metered using inductive VTs in GIS and bushing current transformer on Gas to Air bushings. (VT burden shall be managed to ensure 0.3 accuracy class performance or better.)
2. PSE&G specified and/or approved Instrument Transformers or a dedicated Metering Unit shall be used exclusively for revenue metering. The Interconnection Customer's ammeters, voltmeters, pilot or indicating lamps or any other current-consuming devices may not be connected to any revenue metering devices.
3. The customer's substation shall include instrument transformer mounting structures and associated primary bus work and secondary wiring conduits and terminal boxes to providing revenue grade metering of the interconnection facility. These units will provide only voltage transformation and current transformation and connect directly to the PSE&G supplied electric meter and associated components.
4. Switches or other means of visible disconnect shall exist on both line and load sides of the instrument transformers to allow maintenance access to the instrument transformers without interrupting neighboring electrical services. Switches or other means of visible disconnect must be arranged so that when open, any live parts are spaced sufficiently from the instrument transformers or access points to secondary wiring connections to meet OSHA requirements for personnel changing or maintaining instrument transformers.
5. The connections to the primary terminals of the voltage transformers shall be made on the line side of the current transformers. The VT primary connections will be direct and are not to be fused. Polarity will be observed in the connection of the current and voltage transformers. (Typically, this will mean that the H1 terminal will face the transmission grid. +kWh will represent energy coming from the PSE&G transmission system.)

6. The connections to the primary terminals of stand-alone current transformers shall be made with flexible conductor suitable to carry the continuous current and designed not exceed 90°C at full rated load on the CT primary terminal. The unsupported, flexible connections to the current primary terminals shall be designed to limit static and dynamic forces applied to terminals during faults or weather events.
7. The Interconnection Customer's contractor shall install these transformers in an approved manner on suitable foundations and support members, wire the high voltage side and connect the transformer equipment ground. VT primary terminal connections shall be made with aluminum conductor compatible with the main bus construction for all voltage level systems. The conductors shall be sized to limit corona, 350 kcmil minimum for 69 kV and 138 kV, 500 kcmil minimum for 230 kV, rigid 3 in. bus minimum for 345 kV and rigid 4 in. bus minimum for 500 kV systems. Equipment grounding connections will be made with minimum of 350 kcmil bare tin (**BTN**) copper conductor. The transformers shall be mounted on substantial supports adequate for the electrical and physical effects of experienced at the station. Instrument Transformers shall not be used as bus supports.
8. The metering transformers, secondary wiring and unmetered service conductors shall be mounted in a manner so as to be accessible for visual inspection while energized.
9. Types, mounting dimensions, and weights for revenue-metering transformers are provided in Table 1-2. Interconnection Customers with small loads that require low ratio CTs may require the use of optical CTs, contact PSE&G's Metering Group for additional information. PSE&G's Metering group shall determine the specific metering considerations at 345 kV and 500 kV systems. Contact Information is given below:

   Public Service Electric and Gas Company
   Electric and Gas Metering
   24 Brown Avenue
   Springfield, NJ 07081

Table 1-2: Revenue Metering Transformers Types, Dimensions, and Weights

Voltage (kV)	GE	Trench	Primary Terminal Height Above Base (inches)	Approximate Weight (lb)
69	JKW-350ER	–	52.4	593
69	JVY-350	–	41.9	605
138	KOTEF 145.ER	N5H-650-138-nnn*	95	1,650
230	KOTEF 245.ER	IVOKTA 245	133	2,720
Note: * nnn varies with CT ratio.				

10. The conduit for the secondary control cable from the instrument transformer secondary terminals to the meter panel will be supplied and installed by the generator / transmission interconnection entity. Threaded rigid steel conduit is required. PVC conduit is not acceptable. Grounded End Bushings will be installed on the ends of metal conduit.
    a. For underground runs, 2 in. diameter threaded, galvanized, rigid steel conduit shall be used; otherwise conduit will be at least 1-1/2 in. diameter.
    b. "Seal Tight" (waterproof flexible armored conduit) may be used in the last 5 ft to the instrument transformer secondary terminals and the last 2 ft to the meter enclosure. Transitions from rigid steel conduit must be at least 12 in. above grade, if "Seal Tight" is used, it should be mounted in plain sight.

c. The VT/CT secondary cables shall run in a dedicated conduit and shall not pass through either hand holes or manholes. A PSE&G representative must inspect underground conduit runs before concrete is poured or earth is backfilled.

d. PSE&G will furnish the VT/CT metering secondary trunk cable. The Interconnection Customer will install the metering secondary cables in the conduit. PSE&G will make connections at the secondary terminals of instrument transformers and test switches.

11. A panel for mounting meters will be installed by the Interconnection Customer.

a. The meter panel minimum dimensions shall be 36 in. wide by 48 in. high. When minimum dimensions are used, the bottom edge must be 24 in. above grade and the top edge shall not exceed 78 in. above grade.

b. Painted plywood is recommended for the meter panel. Thickness shall be 3/4 in. and a 1 in. air gap will be provided behind the wood to enhance dryness. Alternative materials may be used for the meter panel with advanced PSE&G approval.

c. The meter panel shall be located so that the wire run between the Current Transformers and the meter panel does not exceed 150 ft Interconnection Customer shall contact PSE&G for any exceptions to this requirement.

i. There must be 48 in. of clear space in front of the panel to provide space for installation and maintenance of equipment on the panel. Permanently mounted equipment may project 16 in. out from the front of the panel.

ii. There must be at least 36 in. of clearance between the meter panel and any gas meter or gas piping.

iii. When located outdoors, the meter panel shall be located in an approved location. This will not be directly under live conductors or bus.

d. The meter panel shall be located in a building or in a weatherproof, corrosion resistant, heated enclosure. If the Interconnection Customer elects to house the meter panel in a heated outdoor enclosure, such structure requires specific PSE&G approval. Heaters shall be powered by facility auxiliary power source. Electric heaters shall be rated at 240 VAC, but sized and operated at 120 VAC. Outdoor enclosures shall be NEMA 4X type. If mounted in an outdoor enclosure, the door of the enclosure shall have a three-point latch operated by one handle with provision for padlock.

i. Access to equipment installed on the meter panel shall be limited to PSE&G personnel by provision for PSE&G's barrel locks and seals on meter sockets or boxes containing test switches or communication equipment.

ii. The Interconnection Customer will have access to read the meter only.

e. A Copper Ground Bus shall be mounted at the meter panel and be connected to the station ground grid in accordance with the Article 250 of the NEC. This bus will be drilled and tapped as specified by the PSE&G Metering Group.

f. A 120/208 V, 4 wire circuit shall be provided from station service to power the meter during transmission maintenance outages. Circuit protection shall be 15 A or suitable rating for cable size.

g. A 120 V, 20 A GFCI outlet, fed from station service power shall be provided at the meter panel. Station service source shall be clearly and permanently marked.

h. When located indoors, lighting shall be available to facilitate meter reading, as well as installation and inspection of the metering equipment.

i. The PSE&G Metering Group shall provide meter sockets, relay enclosures, and any enclosures required for test switches. An arrangement plan for these enclosures shall be provided by PSE&G. Figure 1.1 and Figure 1.2 provide examples of simple installations (one set of instrument transformers with one meter). The Interconnection Customer shall mount these enclosures and provide the interconnecting conduit. PSE&G will install test switches, meters and other equipment on the meter panel.

j. Conduit and cable shall be provided to take outputs of at least four KYZ pulse initiation units from the meter panel to a SCADA RTU as specified in SCADA Section 7.2.

7.2 Telecommunications and SCADA

7.2.1 Transmission Control and Monitoring

PJM is charged with control and operation of the bulk power system in consultation and coordination with PSE&G's ESOC group. The PSE&G transmission system consists of all equipment operated at or having a high-voltage connection at 69 kV and above system voltages that is used to transmit power.

The following items are the minimum requirements for transmission and control monitoring for switching and substations on the PSE&G bulk transmission system:

1. PSE&G's ESOC requires ability to monitor, open and close all circuit breakers, motor operated disconnect switches, and circuit switchers for 100 kV and above system voltages and lower voltage devices that are necessary to isolate transmission assets (such as transformers); and ability to monitor all 69kV circuit breakers, motor operated disconnect switches, and circuit switchers. All voltage level capacitor banks (69, 138, 230, 345 and 500 kV) are required to be controlled by ESOC RTU. Additionally, PSE&G Division SCADA System requires ability to monitor, open and closed all circuit breakers, motor operated disconnect switches and circuit switchers for 69 kV system voltage.
2. The ability to open, but not close, all circuit breakers used to synchronize generators to the transmission system. (It is assumed that these circuit breakers will have synchronizing capability to allow for restoration during a system blackout.)
3. If the facility is equipped with Voltage Regulators or Load Tap Changing (**LTC**) transformers connected to the transmission system at 69 kV and above system voltages, those devices shall have the ability to transmit a tap position signal to the PSE&G ESOC Remote Terminal Unit (**RTU**).
4. The ability to monitor all 69 kV and above system voltage transformer and circuit breaker multi-trip (Lockout Relays) operations.
5. The ability to monitor the station mode control handle (local or remote).
6. The ability to monitor operational parameters of shunt capacitors and reactors that impact 138 kV and above system voltages. These parameters include breaker or circuit switcher open/closed, volts, amps and vars.
7. The ability to turn the "after trip" reclosing function on individual supply lines on or off locally.
8. The ability to measure three phase currents and phase angles in all 69 kV and above system voltage lines and circuit breakers, cables, transformers and low side loads (25 kV or higher). Multiple circuit breaker currents may be used to derive other currents.
9. The ability to measure all three phase voltages and phase angles at all station buses, load buses, and the line side of switching devices on all 69 kV and above system voltage lines and cables.

10. The ability to measure at revenue billing accuracy (0.3% accuracy) the MWHr metering at tie points, generator connections, and generation Station Light and Power (**SL&P**) transformer connections at least every 5 minutes. That metering shall provide MWHr consumed and peak MW during the time period.
11. The ability to obtain a time signal from the GPS satellite.
12. The ability to read the information and specific functions within the microprocessor protective relays used on the 69 kV and above system voltages consistent with PSE&G Cyber Security and NERC/RFC Critical Infrastructure Protection (**CIP**) requirements and ability to synchronize the clock in the RTU with the relay or any other clock. The minimum expected information is as follows:
    a. Three phase currents, voltages, and their respective phase angles.
    b. Frequency measured to the 0.01 Hz.
    c. Target(s).
    d. Sequence of event(s).
    e. Distance to fault(s).
    f. Oscillography.
    g. All carrier channel status.
    h. Other quantities defined by the relay vendor required for diagnosis of relay operation.
13. The status of the auxiliary systems in the station that are important to the continued operation of the bulk power elements.
    a. Alarms relative to all equipment 69 kV and above system voltage.
    b. Alarms relative to the primary and secondary batteries, auxiliary power systems, and on-site generation.
    c. PSE&G D-SCADA system shall receive environmental conditions such as fire detection.
    d. Sequence of event(s) for the above tied to GPS clock.
14. Monitoring of all critical operational parameters in underground transmission hydraulic systems for 138 kV and above system voltage HPFF cable systems.
    a. Customer shall install a multimode (**MM**) fiber optic cable between the PSE&G SCADA RTU in the substation control house and hydraulic pumping plant or crossover valve cabinet.
15. The ability for the generator to follow a load control signal from PJM/ESOC during system emergencies as required by PJM Generator Operational Requirements, Manual M-14D (see https://pjm.com/library/manuals.aspx manual section).
16. The ability for a generating station to have redundant voice communications with ESOC that are capable of functioning for at least 24 hours after a wide area black out as required by PJM Generator Operational Requirements, Manual M-14D (see https://pjm.com/library/manuals.aspx manual section).
17. The RTUs used to monitor and control the above functional requirements shall be SEL-3555/2240 Axion for ESOC and separate SEL-3555 for Division SCADA with Ethernet connection. An equivalent may be substituted as identified by the PSE&G System Reliability and Utility Technology Groups.
18. MPLS/4G communications links between the station and the appropriate control center shall be provided that are capable of operating for at least 24 hours after a wide area black out at a minimum continuous synchronous bi-directional data rate of 56 kbps.
19. The RTU shall be configured to provide Digital Fault Recorder (**DFR**) functionality by capturing all identified currents, voltages, and digital status points when one key trigger element exceeds its set point,

including 26 kV and 69 kV neutral traces where appropriate. The information will be automatically sent to a designated location for analysis.

The field connection between systems should be achieved through hardened computer interfaces. Fiber optic interfaces or hard-wired devices with full line isolation are required, and shall withstand the expected ground potential rises at the switching or substation facility.

For this discussion, transformers shall include shunt and series reactors, phase angle regulators, autotransformers, and distribution transformers with a high voltage winding 138 kV and above.

All SCADA, Telecommunications and systems capable of remote access shall be totally compliant with NERC/RFC CIP-001 (Critical Infrastructure Protection Standard).

8 Switching Devices for Power Transformers

PJM requires significant advance notification for any planned transmission equipment outage that disrupts power flow. This applies to the operation of all transmission voltage level circuit breakers, encompassing configurations such as ring, breaker-and-a-half, or double bus double breaker. Install a switching device on the high side of transformer when a power transformer is connected to the main substation bus system. For applications such as ring bus and breaker and half bus design, the transformer breakers or circuit switcher will be used for switching of the customer-controlled transformers. The stations with system voltages of 138 kV and above shall be equipped with dead tank circuit breaker with disconnect switches and the 69 kV system shall use a circuit switcher on the primary side of the transformers.

9 Grounding and Safety Issues

9.1 Grounding

All switching station and substation grounding grids shall be designed and constructed to meet the requirements of IEEE 80 - 2013, the IEEE Guide for Safety in AC Substation Grounding to establish safe step and touch potentials for a 110 lb (50 kg) person wearing normal street clothing. A grounding grid study, which demonstrates the requirements of IEEE 80, is required, and the resistance to remote earth, of the completed ground grid, shall be tested.

All switching and substation grounding grids shall be constructed with 4/0 AWG or larger, bare tin copper conductors, and shall be installed a minimum of 18 in. below grade. All pigtail connections to equipment and structures shall be made with 350 kcmil BTN copper conductors, and all equipment and structures shall be connected by at least two connections to the ground grid.

All below grade connections shall be either exothermically welded or utilize a “Swage” type ground connection system. All equipment and structure grounding connectors shall meet the requirements of IEEE 837-2024, IEEE Standard for Qualifying Permanent Connections for use in Substation Grounding. All metallic fences, platforms, and railings within a station shall be grounded by cable connections and not rely on mechanical contact with supporting structures for all painted structures but the galvanized structures can rely on the mechanical contact, all discontinuous pieces shall have two connections to the ground grid.

Ground systems in high crime areas shall make use of special materials and techniques to deter copper theft. Contact PSE&G Electric and Gas Asset Strategy for information and assistance in this area.

9.2 Site Conditions and Access

All Transmission facilities must be constructed on land free of any environmental and safety issues. If the land has had any previous contamination issues, the land shall be fully mitigated and certified safe for the intended use without any restrictions.

PSE&G access to all Transmission facilities must be unfettered and directly accessible from a public road. Controlled access to the facility via Private Property is not permitted. PSE&G shall have its own lockable gate. If a second party is required to have access to the facility, that access shall be via another gate and in no way interfere with PSE&G access to the facility for operational and maintenance needs.

9.3 Station Fencing – Safety Requirements

All substation fences shall meet or exceed the requirements of National Electric Safety Code C2, IEEE Std. 80, and IEEE Std. 1119. The local municipality shall also be contacted to determine any applicable special requirements. In general: fences shall be at least 6 ft high made of tight mesh galvanized steel or aluminum chain link with an applicable 1 ft top structure to discourage climbing. Fences shall be equipped with both top and bottom rails to discourage entry. Fences shall be grounded in accordance with the above listed codes and all gates shall utilize woven mesh straps to ensure continuity at all hinged joints. The Facility shall be provided with a minimum of two access gates: one 4-ft gate for pedestrian access and one 16-ft gate for vehicular/equipment access.

9.4 Yard, Driveway and Entrance Requirements

All driveways in the station shall have a minimum 16 ft width. Driveways shall be constructed of at least 3 in. of machine rolled Hot Highway Grade Fine Aggregate Bituminous Concrete (**FABC**) over at least 4 in. of compacted 3/4 in. blue stone. Entrances from public streets and/or highways to the PSE&G gates shall also be constructed with Highway Grade FABC, and shall also meet Municipal and State of New Jersey requirements from the street and/or highway to the gate. Furthermore, all driveways and entrances shall have adequate width and load bearing capability for transportation of all station equipment and PSE&G vehicular traffic.

All switching and substation yard areas shall be covered with a minimum of 4 in. of 3/4 in., clean crushed blue stone or approved equal. Stone shall pass the following screening criteria: 100% passing the 1-1/4 in. screen, 45% to 75% passing the 3/4 in. screen, 25% to 45% passing the 1/2 in. screen, and 0% to 10% passing the 1/4 in. screen.

In addition to specific equipment or task lighting, the overall yard area shall be illuminated as required in the National Electric Safety Code. Overall lighting shall meet local municipality requirements. Switched upwardly directed lighting shall be provided for all disconnects, ground switches, circuit switchers or any other device where visible verification of operation or position is needed. Industrial Grade Light Emitting Diodes, Metal Halide or High-Pressure Sodium fixtures shall be used in this application.

9.5 Disconnecting Devices and Grounding Switches

1. Three-phase ganged disconnects with grounding blades shall be provided on each Transmission supply entrance to an interconnection facility. These disconnects provide both a visible break to confirm isolation and mechanical grounding for worker safety.
2. Three-phase disconnects with grounding blades shall be provided on each side of a circuit breaker. These disconnects provide both a visible break to confirm isolation and mechanical grounding for worker safety.

3. The use of Portable Protective Grounds shall not be used as the primary method of grounding lines, equipment and bus sections to assure worker safety.

9.6 Mechanical Keyed Interlocks

Mechanical keyed interlocks of the type manufactured by Kirk or Superior shall be used to interlock the switching of breakers, disconnects and ground switches to assure worker safety as required by OSHA.

9.7 AC/DC Power Systems

All interconnection facilities shall be equipped with two independent separate sources of AC auxiliary power (auxiliary power transformer derived, main transformer tertiary derived, distribution source, diesel / natural gas back-up generator, etc.) and be capable of operating on batteries for 12 hours without external electric power (345 and 500 kV Stations shall be equipped with primary and backup batteries); and shall be designed to allow safe maintenance of any piece of equipment, control system, or structure without requiring outages of other equipment or systems. All DC Power Systems shall be equipped with two 100% Capacity Chargers fed from separate AC sources.

For facilities with HPFF service, two independent separate sources of AC power (normal station light and power, and emergency backup i.e., emergency generator) must be provided from the substation to the hydraulic equipment. Hydraulic pumping plants typically required 208 V three-phase AC power, crossover valves typically require 120 V single-phase and forced-cooling units 480 V three-phase.

10 Standard Spacing, Minimum Clearance and Insulation Coordination Basic Impulse Level (BIL)

Standard spacing, minimum clearances and required BIL levels are provided in Table 1-3.

Table 1-3: Standard Spacing, Minimum Clearance and Insulation Coordination (BIL)

	Operating kV								
	500	**345**	**230**	**138**	**69**	**26**	**18/20**	**11/13**	**4**
Basic Impulse Insulation Level (BIL) kV									
Rigid Bus	1,800	1,300	900[4]	650	350	200	150	110	75
Disconnecting Switches	1,800	1,300	900[4]	650	350	200	150	110	75
Circuit Breakers	1,800	1,300	900[4]	650	350	200[1]	150	110	75
Transformers	1,550[3]	1,050	750	550	350	200	150	110	75
Current Transformers	1,800	1,300	1,050	650	350	200	150	110	75
Potential Transformers / CCVT	1,800	1,300	1,050	650	350	200	150	110	75
Capacitor Banks	1,800	1,300	900	650	350	200	150	110	75
Spacings and Clearances[2]									
Phase-to-Phase (inches)	300	180	144	96	60/72[5]	36	30	24	16

Table 1-3: Standard Spacing, Minimum Clearance and Insulation Coordination (BIL) (Cont'd)

	Operating kV								
	500	**345**	**230**	**138**	**69**	**26**	**18/20**	**11/13**	**4**
Phase-to-Phase Spacing for Side Break Circuit Switchers (feet)	25	NA	12	NA	NA	NA	NA	NA	NA
Minimum Clearance[2] for Rigid Parts (inches)									
Phase-to-Phase	222	120	89	62	31	18	15	12	7
Phase-to-Ground	144	108	71	50	25	13	10	7	5.5
Minimum Clearance[2] for Rigid Parts (feet)									
to grade inside Substation	30	18	15	13	12	10	10	10	10
to Roadway inside Substation	30	30	27	23	23	22	22	20	20
to railways	41	41	35	31	30	30	30	28	28
to fence (*per Section 110 NESC)	*	*	*	*	*	*	*	*	*

Note: 1. Specially protected equipment's BIL may be reduced to 150 kV.
2. Clearance is the distance between conducting parts.
3. Arrester ratings are for metal oxide valve (**MOV**) types only. Stations with extensive underground cable or shunt capacitor banks shall be evaluated individually.
4. Use 1,050 kV BIL tie bus insulators at old stations.
5. 72 in. phase spacing is required where disconnect switches are installed.

11 Voltage, Reactive Power and Power Factor Control

Reactive power shall be maintained within the limits required by Part VI, Attachment O, Appendix 2, Section 4.7.1 of the PJM Open Access Transmission Tariff Effective Date: 4/1/2020 - Docket #: ER19-1958-000 (https://www.pjm.com/pjmfiles/directory/merged-tariffs/oatt.pdf).

1. Generators – Power Factor / Voltage 0.90 Lag (Produce VARs as to increase voltage at the POI) to 0.95 Lead (Absorb VARs as to decrease the voltage at the POI) through the use of wide range continuously variable Generator Field Controls (Voltage Regulator).
2. Merchant Transmission and End Users – Power Factor 0.95 Lead (Produce VARs as to increase voltage at the POI) to 0.95 Lag (Absorb VARs as to decrease the voltage at the POI). Merchant Transmission and End Users shall maintain a minimum Power Factor of 0.95 Lag through the use of either step switched capacitor banks or continuously variable Static VAR Compensators. Reactive compensation must be designed to limit voltage step rises to 2.0 V on a 120 V base to minimize disturbances to solid state controls and variable frequency drives connected to the system and be equipped with inrush reactors to limit switching transients. Generally, practical sizing for stepped capacitor switching is: 10 MVAR at 69 kV, 50 MVAR at 138 kV, 125 MVAR at 230 kV and 200 MVAR at 500 kV.

12 Power Quality Impacts

1. Steady state voltages at transmission stations that are connected to transmission customers shall be in accordance with ANSI C84.1-2016 American National Standard for Electric Power Systems and Equipment – Voltage Ratings (60 Hz) or the most current version thereof. At stations that do not have directly connected customers, such as switching stations and generating plants, the PJM, LLC standard voltage range shall apply.
2. Voltage flicker or dips, attributable to the start-up and operation of large customer loads such as motors or arc furnaces, shall be limited as indicated by the following or their most current version:
   – IEEE 1453-2015 - Recommended Practice for the Analysis of Fluctuating Installation on Power Systems.
   – IEEE 1453.1-2012 - IEEE Guide-Adoption of IEC/TR 61000-3-7:008, Electromagnetic compatibility (EMC) - Limits-Assessment of emission limits for the connection of fluctuating installations to MV, HV, and EHV power systems.
3. These voltage criteria will not be applied during PJM imposed voltage reductions or other emergent system conditions.
4. Under normal conditions, the range of voltage variation is not intended to represent the maximum variation as a result of a sudden load increase or the single correction by a voltage regulating device. Rather, the range represents an acceptable bandwidth within which customer equipment should operate properly. Single step changes in voltage level either as a result of load changes or voltage regulating devices should be limited to as small an incremental change as can be reasonably obtained with commercially available techniques. Typically, limiting single step changes to 2% or less of nominal voltage is recommended (See Section 12 Paragraph 2. above).
5. The maximum harmonic limits for electrical equipment shall be in accordance with IEEE 519 - 2022 (R2014) or the most current version. The objective of IEEE 519 is to limit the maximum individual frequency voltage harmonic to 1% of the fundamental frequency and the voltage Total Harmonic Distortion (**THD**) to 1.5% on PSE&G side of the point of common coupling.

13 Equipment Ratings – Interrupting, Momentary, Continuous and Operating

All interconnecting station equipment shall have the minimum interrupting and momentary ratings adequate for the currents mentioned in Section 5 but in no case shall these ratings, or the continuous current ratings be less than less than those in Table 1-4.

In certain situations and locations within the PSE&G transmission system, maximum fault currents have been identified as being currently greater than 63 kA Symmetrical or having the high probability of exceeding 63 kA Symmetrical within a short period of time. In these cases, as identified by the PSE&G Planning Department, the Interconnection Customer shall be required to install equipment with a rating of 80 kA Symmetrical.

If the Generation/Interconnection Customer facility has the ability of increasing fault duties above 80 kA, extraordinary means may be required to hold the line at 80 kA. These means may include series reactors,

high impedance transformers or HVDC equipment. Please contact the PSE&G Transmission Planning Department for further information.

Table 1-4: Minimum Interrupting and Momentary Ratings[1]

System Voltage (kV)	Interrupting Duty (kA)	Momentary Duty (kA)	Continuous Current (A)
500	63	164	3,000
230	63	164	3,000
138	63	164	3,000
69	50/63	130/164	2,000
Note: 1. Table is of minimum values, higher ratings may be required.			

All interconnecting substation equipment including circuit breakers, transformers, disconnect switches, bus, strain bus, current transformers, line traps, and equipment connecting leads shall have temperature sensitive ratings calculated per PJM rating methodologies and applied for system operation. As per the requirements of FERC/RFC FAC-008 and FAC-009, the interconnection customer is responsible for and shall supply ambient adjusted substation equipment ratings for all equipment to PJM and PSE&G.

The rating methodology documents can be found at http://www.pjm.com/planning/design-engineering/maac-to-guidelines.aspx and are listed on page 4 of this document and relisted below.

VI. Rating Guides

VI.a Bare Overhead Transmission Conductor Ratings (10.2022)

Overhead Transmission Conductor Rating – Spreadsheet (4.26.2024)

VI.b Power Transformer (9.18.2024)

VI.c Circuit breakers (9.18.2024)

Circuit breaker Rating - Spreadsheets (11.21.2024)

VI.d Air Disconnect Switches (12.11.2024)

VI.e Outdoor Substation Conductor Ratings (12.11.2024)

PJM Bus Rating – Spreadsheet (12.11.2024)

VI.f Current Transformers (4.11.2025)

VI.g Line Traps (03.2012)

VI.h Underground and Submarine Transmission Cable Rating Methodology (9.17.2015)

PJM considers and requires temperature sensitive ratings for continuous, Short-Term Emergencies (**STE**) and Long-Term Emergencies (**LTE**), and 15 minute load dump conditions. PSE&G utilizes 4 hour ratings for both STE and LTE ratings. The minimum required temperature sensitive ratings for 3,000 and 4,000 A breaker and/or bus, sections, and line positions are provided in Table 1-5 and Table 1-6. The ratings of each device as calculated by PJM methods may be different, but shall not be less than the values in Table 1-5 and Table 1-6.

Table 1-5: 3,000 A – Bus, Breaker, or Line Position Minimum Ambient Adjusted Ratings

Ambient Temperature		Ratings (Amps)		
°C	°F	Normal	4 Hour	Load Dump
0	32	3,483	3,856	4,435
5	41	3,426	3,805	4,346
10	50	3,369	3,753	4,316
15	59	3,310	3,701	4,256
20	68	3,250	3,648	4,195
25	77	3,190	3,593	4,132
30	86	3,128	3,539	4,069
35	95	3,065	3,482	4,004
40	104	3,000	3,367	3,872

Table 1-6: 4,000 A – Bus, Breaker, or Line Position Minimum Ambient Adjusted Ratings

Ambient Temperature		Ratings (Amps)		
°C	°F	Normal	4 Hour	Load Dump
0	32	4,644	5,141	5,913
5	41	4,568	5,073	5,834
10	50	4,492	5,004	5,755
15	59	4,413	4,934	5,675
20	68	4,334	4,863	5,593
25	77	4,253	4,791	5,510
30	86	4,170	4,718	5,426
35	95	4,086	4,643	5,339
40	104	4,000	4,489	5,162

13.1 Current Transformers

All CTs and any connected meters, auxiliary current transformers, ancillary equipment, protective relays, switches, wiring and cabling, shall be designed to operate continuously at any of the Normal or 4 hour temperature sensitive ratings for a 3,000 or 4,000 A position as described in Table 1-5 and Table 1-6. CT ratings shall be adjusted for tap position, and shall not exceed the CTs thermal capabilities for these ratings. Current transformers may have to be specified with higher current ratings and/or higher Rating Factors (C57.13) to meet these requirements.

14 Synchronizing of Facilities

14.1 Generation Facilities

The Generation Interconnection Customer (**GIC**) shall equip and maintain their facilities with synchronizing equipment. If the GIC is directly connected to a PSE&G facility and utilizes the circuit breakers physically in PSE&G's facility to connect the generator to the PSE&G system, the GIC shall install and maintain single phase synchronizing potential transformers or potential devices on the "system" side at each synchronizing breaker in the yard. The generator side synchronizing potential shall be sensed on the generator side of the breaker(s) at the same voltage level and phase utilizing either potential transformers or potential devices on equipment bushings. In addition to the generator synchronizing potential sensing equipment the synchronizing system shall be equipped with a synchro-check relay, synchro-scope, synchronizing potential lamps and direct connected breaker control switch to initiate supervised manual synchronizing as required.

14.2 Radial Connection at Transmission Voltage

Generation Facilities that are connected the PSE&G system with a radial connection at transmission voltage, connection generation equipment via a remote Generator Step Up transformer, synchronize their generators at a voltage other than the interconnection voltage and/or utilize a separate synchronizing circuit breaker not physically located in a PSE&G yard shall also equip and maintain their facilities with synchronizing equipment. The GIC shall install and maintain single phase synchronizing potential transformers or potential devices on the "system" side at each synchronizing breaker. The generator side synchronizing potential shall be sensed on the generator side of the breaker(s) at the same voltage level and phase utilizing either potential transformers or potential devices on equipment bushings. In addition to the generator synchronizing potential sensing equipment the synchronizing system shall be equipped with a synchro-check relay, synchro- scope, synchronizing potential lamps, voltmeters for voltage balancing and direct connected breaker control switch to initiate supervised manual synchronizing as required.

14.3 Transmission Facilities

Transmission Interconnections between areas controlled by different Independent System Operators (**ISO**) and between the facilities of different Transmission Owners (**TO**), even if controlled by the same ISO will require full synchronizing facilities just as in the case of GICs directly connected to PSE&G facilities as described in Section 14.1. The synchronizing equipment will be designed to monitor, check, synchronize from control of PSE&G. Synchronizing equipment (if required) for Transmission interconnections utilizing AC/DC to DC/AC technology will be evaluated PSE&G during the detailed system study phase of the application evaluation as described in Section 3, Paragraph 1.

14.4 End User Facilities (with Generation)

End User Facilities with generation capability that can run synchronized with the PSE&G system whether or not the facility has the potential for power export shall be equipped with the same level of synchronizing apparatus as described in Section 14.2. In addition to the equipment described in Section 14.2 this type of facility shall also be equipped with reverse power relays, under/over voltage relays, over/under frequency relays that will trip the generation clear of the PSE&G system under abnormal conditions or during inadvertent power export.

14.5 End User Facilities (without Generation)

End User Facilities without generation capability will generally not require synchronizing equipment. The only exceptions may be, a facility equipped with very large induction and/or synchronous motors that may cause potential system disturbances, if the transmission supply source is equipped with reclosing capability. In this case, the reclosing circuits shall be supervised by a synchro-check relay. If the End User Facility is supplied from two or more lines, synchronizing equipment will facilitate faster restoration during system emergencies and may be considered.

15 All Transmission Maintenance and Coordination

A Substation Maintenance Program shall be developed that follows the outline prescribed in the PJM Transmission Substation Technical Requirements Section V. Design, Application, Maintenance and Operational Technical Requirements Subsection L. Substation Operation and Maintenance. The guideline requires that the facility's owner develop and implement a maintenance program that follows good utility practice and assures unscheduled outage performance at least as good as that of the Transmission Owner to which the facility is connected. PSE&G Substation Maintenance Requirements and Schedules are listed in the PSE&G *Substation Maintenance Manual*: Maintenance Schedules; General, which will be provided upon request.

Maintenance of the hydraulic equipment for substations served by HPFF underground pipe-type cable service will be the responsibility of PSE&G and does not need to be included in the customer's substation maintenance program. PSE&G will perform periodic inspections and maintenance of the hydraulic equipment as per Underground Transmission Operation & Maintenance Standard (verify with PSE&G Hydraulic Engineer for latest guidelines).

For information contact:

Public Service Electric and Gas Company
Electric and Gas Asset Strategy
Manager – Technical Support
80 Park Plaza
Mail Code T-17
Newark, NJ 07101

All facility maintenance shall be coordinated with PSE&G Electric System Operations at (732) 537-5716, 5718. PSE&G shall coordinate the planned or emergency maintenance with PJM and assure that the maintenance is properly scheduled and listed on the PJM OASIS Posting Board.

16 Operational Issues (Abnormal Frequency and Voltage)

Operation of the interconnected electric system and all interconnected individual facilities during emergency or abnormal operating conditions shall be governed policies, procedures and communication protocols as described in PJM - Manual 13 Emergency Operations Revision 95 revised 02/20/2025 https://www.pjm.com/-/media/DotCom/documents/manuals/m13.pdf. Generally, PJM shall communicate Emergency Operational Directives through PSE&G's Electric System Operations Center, which in turn shall communicate all necessary instructions to the interconnected facilities.

All interconnected facilities have system protection requirements specific to the type of facility, equipment and load serviced. In the event of a rapidly occurring abnormal system operating event, either localized or wide spread, it is expected and required that the facility protective devices function as to safely shut down the facility and or trip equipment to prevent vital equipment damage as a result of said event.

Protective functions such as over/under frequency and over/under voltage are primary protective functions but are not primary control functions. The interconnected generation facility shall have the current, "Best Available Technology" to control unit; voltage (Power Factor), load and response, and frequency regulation and response during both normal operating and transient operating conditions. Merchant and End User Transmission interconnected facilities shall employ, "Best Available Technology" to control; voltage (Power Factor) through the use of LTCs and switched capacitors to provide the necessary control and support as was determined in the facility initial design requirements.

17 Inspection Requirements for Existing or New Facilities

1. Initial Inspection, Testing and Acceptance of new or existing facilities shall follow requirements described in PJM Transmission Substation Design Subcommittee (**TSDS**), now the Transmission and Substation Subcommittee, (**TSS**) VIII. Inspection, Testing and Acceptance (12.2017).
2. PSE&G shall be permitted to inspect and observe construct during normal work hours at any phase during the construction process. PSE&G shall notify the project site manager not less than 24 hours before such inspection shall be conducted. PSE&G shall be notified when the facility is ready to begin pre-operational testing. PSE&G may elect to take an active part in equipment functional and relay test activities. The extent of PSE&G involvement shall be determined by the terms of the Interconnection Agreement and level of PSE&G contractual obligations, if any, for switching and relay maintenance.
3. Follow-up Inspections of new and existing facilities shall be conducted as part of the facility maintenance plan. The plan shall include a minimum annual Infrared (**IR**) inspection and a monthly detailed walk down of the entire facility. The annual IR inspection of the entire facility shall include: transformer tank temperatures, LTCs, and all bolted connections. The facility operator at a minimum shall conduct detailed monthly walk downs of the facility following a predetermined route/plan. The walk down shall inspect, record and retain the typical following information: Breaker internal temperatures and pressures (SF_6 and Hydraulic), breaker hydraulic oil levels, breaker hydraulic pump run hours, transformer and LTC oil levels, transformer high/low top oil and winding temperatures, transformer current top oil and winding temperatures, LTC operations counters, highest and lowest LTC positions, current LTC position, breaker operations counter, spill retention basin levels, oil leaks if present on all equipment including transformers and CCVTs, visual inspection of ground connections (copper theft) and perimeter fence integrity (intrusion), recording of any station alarms. Any discrepancy found during the regular minimum monthly walk down shall be used to generate a corrective maintenance work order.

18 Communications and Procedures During Normal and Emergency Operating Conditions

The primary point of communications between the interconnected transmission facility operator and PSE&G shall be through PSE&G's ESOC. The facility operator shall provide PSE&G ESOC the phone numbers of critical operations personnel, such as Operating Engineers and Shift Supervisors. These are the personnel that must be able to quickly and accurately respond to operations directives given by PJM and transmitted by PSE&G. A list of all responsible operations and engineering personnel and their 24 hour access phone numbers shall also be provided and updated as soon as changes are made. The PSE&G ESOC 24 hour

access phone numbers and email addresses shall be provided as part of the Facility Interconnection Agreement.

All communications and Procedures during normal operations and emergency operating conditions shall follow the requirements outlined in:

- PJM Manual 03: Transmission Operations Revision 68 – Effective Date: May 21, 2025
- PJM Manual 13: Emergency Operations Revision 95 – Effective Date: February 20, 2025

  These documents, current and past revisions can be found on the PJM website at: https://www.pjm.com/library/manuals.aspx

19 Listing of Approved Major Equipment Suppliers

The following list is not an endorsement of any specific vendor or contractor.

(Alphabetical Order)

Circuit Breakers

- Hitachi/ABB
- GE/Alstom
- Siemens

Transformers

- Delta Star
- EFACEC
- GE-Prolec
- Hitachi/ABB
- Howard
- Hyundai
- Mitsubishi
- Niagara
- Pennsylvania Transformer
- Siemens
- Smit
- WEG

Disconnect Switches

- Cleveland Price
- Pascor – Atlantic
- Southern States
- USCO

Capacitor Banks

- Hitachi/ABB
- GE
- NEPSI

Transmission Voltage Coupling Capacitors, and Current Transformers

- GE Grid (Alstom Grid)
- Trench

Surge Arresters

- ABB
- GE
- Ohio Brass

Protective Relays

- GE Multilin
- Schweitzer Engineering Laboratories

Gas Insulated Switchgear

- ABB
- Siemens

20 Listing of Approved Engineering, Construction and Testing Firms

(Alphabetical Order)

Architect-Engineering Firms

- Applied High Voltage
- Burns & McDonnell Engineering Company
- Black & Veatch
- GE
- Imperia Engineering Partners
- Sargent and Lundy
- Worley - Parsons

Constructors

- Electrical
  - Ell Inc.
  - LB Electric
  - Matrix NAC
  - McPhee Electric
  - Riggs Distler
  - Valiant/SME
- Civil
  - Ferreora Construction Company
  - Furino & Son
  - Henkels & McCoy
  - J. Fletcher Creamer & Sons

- Testing, Calibration and Commissioning Companies
  - American Electrical Testing
  - Burlington High Voltage
  - JET Electrical Testing Inc.
  - North Central Electric
  - Scott Testing
  - TRC Companies Inc.

Figure 1.1: Typical Meter Panel Enclosure Arrangement – Indoor Meter Panel

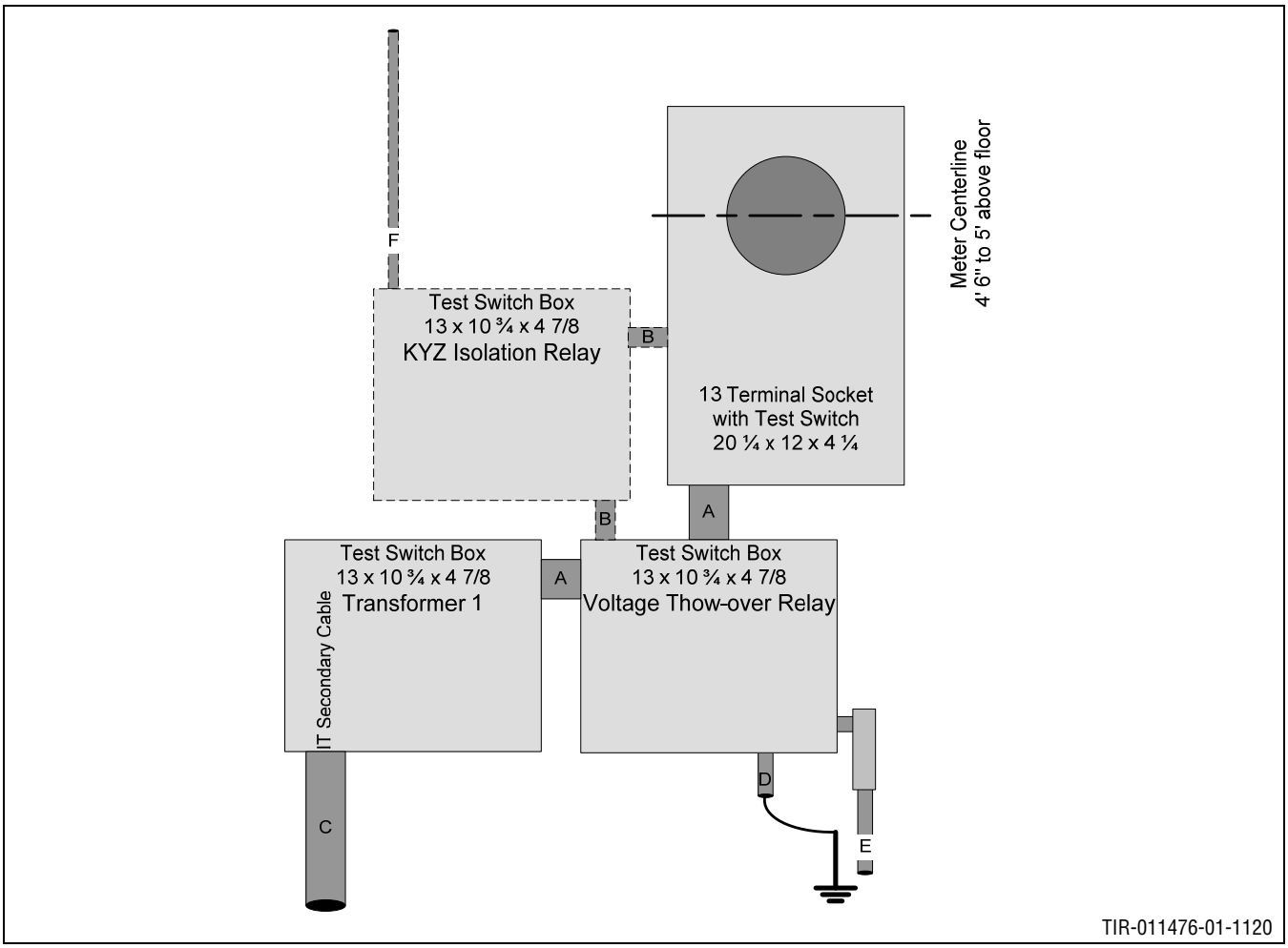

Table 1-7: Figure 1.1 Notes

Note	Conduit Size	Comment
A	2 in. RGS nipple	With 4 lock nuts and grounding bushings or use lock nuts with piercing screw and plastic bushing
B	1 in. RGS nipple	With 4 lock nuts and plastic bushings
C	2 in. RGS	For instrument transformer secondary connections
D	3/4 - 1 in. EMT or PVC	Ground Connection – # 8 or larger connection to ground bus
E	3/4 - 1 in. EMT or PVC	120 V, 3-phase, 20 A Station Power
F	1/2 - 1 in. EMT or PVC	KYZ to Customer – Suggest < 10 ohm loop resistance

Note: Equipment to be mounted on 48 in. x 48 in. painted plywood attached to the wall using uni-strut to provide an air space behind plywood.

Boxes shall be mounted and connected to allow doors and covers to open without binding on adjacent boxes. Typical spacing between boxes should be 1 to 3 in.

Figure 1.2: Typical Meter Panel Enclosure Arrangement – Outdoor Meter Panel

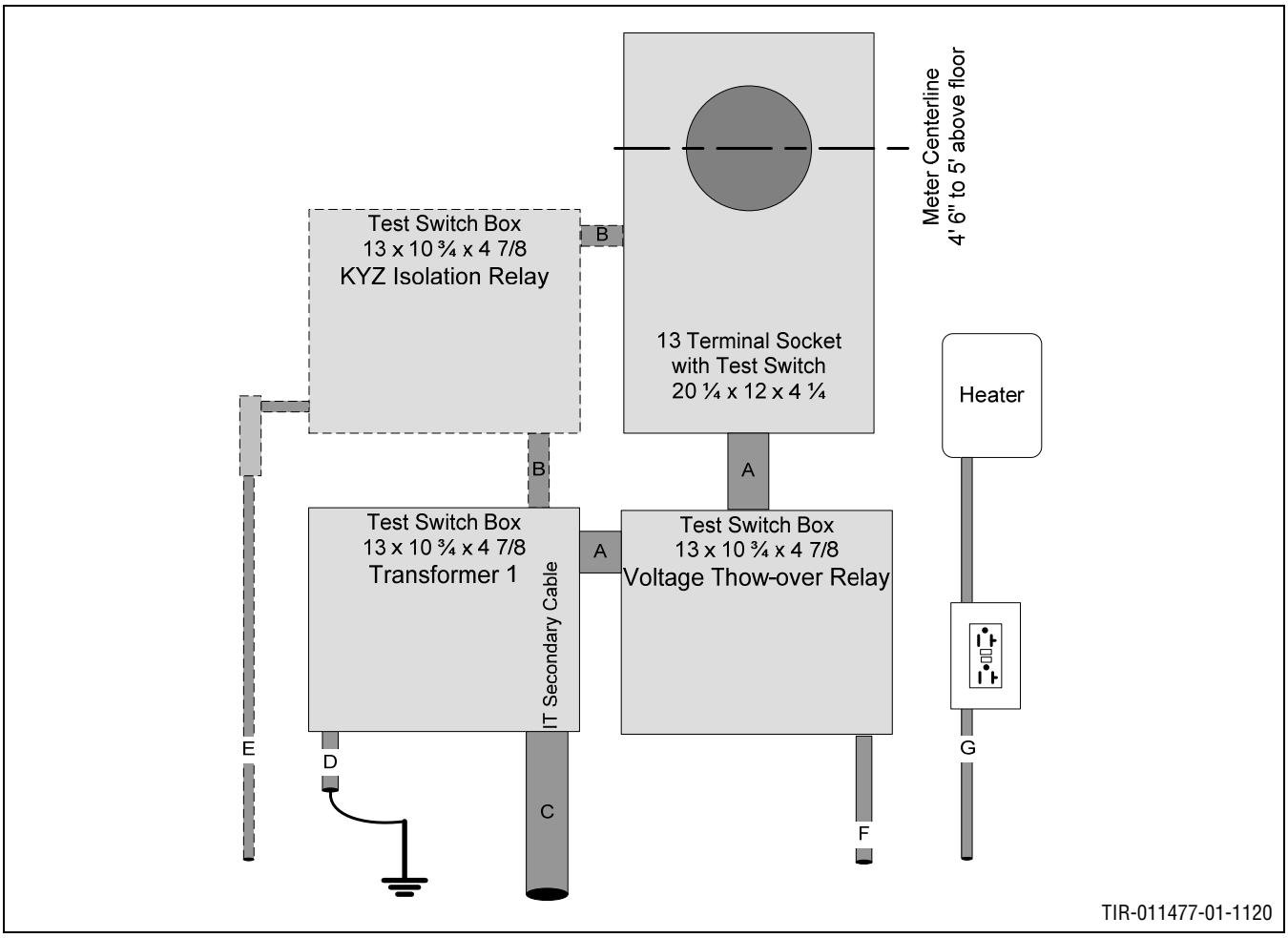

Table 1-8: Figure 1.2 Notes

Note	Conduit Size	Comment
A	2 in. RGS nipple	With 4 lock nuts and grounding bushings or use lock nuts with piercing screw and plastic bushing
B	1 in. RGS nipple	With 4 lock nuts and plastic bushings
C	2 in. RGS	For instrument transformer secondary connections
D	3/4 - 1 in. EMT or PVC	Ground Connection – # 8 or larger connection to ground bus
E	1/2 - 1 in. EMT or PVC	KYZ to Customer – Suggest < 10 ohm loop resistance
F	3/4 - 1 in. EMT or PVC	120 V, 3-phase, 20 A Station Power
G	1/2 - 1 in. EMT or PVC	120 V AC, 20 A Station Power

Note: Outdoor installations shall be in a 42 in. x 36 in. x 12 in. (minimum) corrosion resistant enclosure with a 3 point latch on the door. Equipment to be mounted on 32 in. x 38 in. metal panel. Enclosure attached to the wall or free standing using uni-strut to allow air circulation.

Boxes shall be mounted and connected to allow doors and covers to open without binding on adjacent boxes. Typical spacing between boxes should be 1 to 3 in.

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