NORTHEAST TRANSMISSION DEVELOPMENT
TRANSMISSION FACILITY
INTERCONNECTION REQUIREMENTS

04-19-2018

REVISION HISTORY

Rev #	Rev Date	Purpose
0	4/19/2018	Initial document provided to PJM per PJM Manual 14C, Section 6.1.3.2.

TABLE OF CONTENTS

NORTHEAST TRANSMISSION DEVELOPMENT
TRANSMISSION FACLITY INTERCONNECTION REQUIREMENTS[1]

1 Introduction

1.1 About Northeast Transmission Development

Northeast Transmission Development, LLC ("NTD") is presently a Designated Entity that executed a Designated Entity Agreement ("DEA") with PJM for the development of certain projects approved in PJM's Regional Transmission Expansion Plan.

Once the project is operational, NTD will become a Transmission Owner (TO) and an Interconnected Transmission Owner within PJM. It will also become a North American Electric Reliability Corporation (NERC) registered Transmission Owner (TO).

When NTD's transmission facilities become operational, PJM will be its NERC-registered Reliability Coordinator, Transmission Operator, Balancing Authority, Planning Coordinator, and Transmission Planner. NTD, like other Transmission Owners, will perform some of PJM TOP functions defined by the TO/TOP Matrix.

1.2 Background

This document provides information to assist any entity interested in connecting its facilities to NTD's facilities. The minimum technical requirements and procedures described herein were established to ensure that all requests for interconnection are treated in a consistent and comparable manner. However, due to the unique nature of each connection, NTD reserves the sole discretion to modify specific requirements to accommodate unusual circumstances, provided that reliability or safety is maintained. The information contained herein is subject to change and may be revised at any time.

[1] Unless noted, capitalized terms are defined in the PJM Tariff. Appendix A contains the PJM Tariff definitions used herein.

2 Purpose of this Document

This document was developed fulfill to current and future NTD obligations:

- It will fulfill NTD's current Designated Entity obligation described in PJM Manual 14C, Section 6.1.3.2.
- It will fulfill NTD's future PJM obligations (i) as an Interconnected Transmission Owner, to submit its Applicable Standards and Technical Requirements to PJM *and* (ii) as a Transmission Owner, to submit its List of Approved Contractors to PJM described in Attachment P to the PJM Tariff, Appendix 2, Section 3.2.3.5.
- It will fulfill NTD's future NERC TO obligation to comply with NERC Reliability Standard FAC-001-2 – Facility Interconnection Requirements. Two Requirements apply to a TO:

> R1. Each Transmission Owner shall document Facility interconnection requirements, update them as needed, and make them available upon request. Each Transmission Owner's Facility interconnection requirements shall address interconnection requirements for:
>
> 1.1. generation Facilities;
>
> 1.2. transmission Facilities; and
>
> 1.3. end-user Facilities.
>
> R3. Each Transmission Owner shall address the following items in its Facility interconnection requirements:
>
> 3.1. Procedures for coordinated studies of new or materially modified existing interconnections and their impacts on affected system(s).
>
> 3.2. Procedures for notifying those responsible for the reliability of affected system(s) of new or materially modified existing interconnections.

In R1 part 1.2, "transmission" Facilities[2] includes, within PJM, an entity requesting a new or materially modified connection of Merchant Transmission Facilities to NTD's Transmission Facilities. It also includes a Transmission Owner's new or materially modified connection of its Transmission Facilities to NTD's facilities.

- All Generation Interconnection Requests and Transmission Interconnection Requests[3] for new or modified interconnections must be made directly to PJM and processed through the PJM interconnection process described in PJM Manual 14A. This manual summarizes the guidelines, requirements, and procedures for Generation and Transmission Interconnection Requests, including required Interconnection Customer actions, Interconnected Transmission Owner's actions, and PJM actions. Interconnected Transmission Owners evaluate the impact of proposed interconnections as directed by PJM.
- The interconnection of a Transmission Owner's Transmission Facilities to another Transmission Owner's Transmission Facilities ("TO-to-TO interconnection") is handled by PJM through its Regional Transmission Expansion Plan (RTEP) described in Manual 14B. As part of the RTEP assessment process, solutions to identified reliability issues are proposed by RTEP participants and evaluated by PJM. A selected solution may require a new or modified interconnection between two or more Transmission Owners.

PJM defines and coordinates the necessary studies required for determining a proposed new or

[2] In the NERC Glossary, "Facility" is defined, and, per NERC's practice, its plural usage is capitalized. In the PJM Tariff, "Transmission Facilities" is defined.

[3] "Transmission Interconnection Request" per the Tariff, is a request to interconnect Merchant Transmission Facilities.

modified interconnection's impacts and addresses these impacts with "Affected Systems," a PJM Tariff-defined term, per PJM Tariff Part VI, Section 202 Coordination with Affected Systems.

2.1 FAC-001-2 Clarifications

Because the procedures required by FAC-001-2 R3, parts 3.1 and 3.2 are addressed in the PJM Tariff and PJM Manuals that will apply to NTD when it is a NERC TO, the NTD requirements herein are limited to R1, parts 1.1, 1.2, and 1.3, with the clarifications and exceptions below.

1. NTD requirements do not attempt to duplicate the technical requirements in the PJM Tariff or PJM Manuals.
2. NTD does not have "end-user Facilities" interconnection requirements because it is not a retail electric utility; i.e., it does not directly serve retail load; hence, R1 part 1.3 is not applicable to NTD. NTD can only interconnect with entities that are or will become Generation Owners or Transmission Owners.
3. Unless noted in Section 3, the NTD requirements specified herein are applicable to Generation Interconnection Requests, Transmission Interconnection Requests, and TO-to-TO interconnections.
4. The minimal requirements contained herein are not intended to capture all equipment or installation requirements and may need to be modified to meet the needs of unique installations.
5. The scope of this document is limited to the description of the technical requirements of connecting facilities to the NTD transmission system. It does not address any of the legal, contractual, or liability issues. These issues are addressed within various agreements applicable to a proposed interconnection as defined in the PJM Tariff.

3 NTD Transmission Facility Interconnection Requirements

3.1 General Requirements

The Interconnection Facilities shall be designed, installed, operated, and maintained to meet all applicable requirements under expected conditions of service for the latest revisions of the National Electric Code (NEC), National Electric Safety Code (NESC), American National Standards Institute (ANSI) standards, Institute for Electrical and Electronics Engineers (IEEE) standards, National Fire Protection Association Standards, and any applicable federal, state, and local codes along with any applicable NERC, ReliabilityFirst (RF), and PJM requirements.

3.2 System Protection and Coordination

The Interconnection Facilities shall include fault-interrupting devices and associated protection systems that will (i) protect each party's equipment from disturbances initiating on the other party's facilities and (ii) minimize the effects of disturbances initiating from each party's facilities on the other party's facilities.

Protective relaying systems and associated communications systems for all facility interconnections shall be planned, designed, constructed, and maintained in accordance with applicable NERC, RF, and PJM standards. All protective relays shall meet or exceed ANSI/IEEE Standard C37.90. The design must provide coordination of speed and sensitivity in order to maintain power system security, stability, and reliability.

The protection system (protective relays, associated communication systems, voltage and current sensing devices, station batteries and DC control circuitry) arrangement selected by the interconnecting

entity must be compatible with the protections system used by NTD to protect the transmission grid. The interconnecting entity and NTD facilities may share a common zone of protection. Compatible relaying equipment must be used for a given zone of protection. Compatibility includes protection application, redundancy, operating speed, communication type, and communication medium. NTD and the interconnecting entity will work together to ensure their respective protection systems are properly coordinated.

The station battery shall be sized with enough capacity to operate all tripping devices after eight hours without a charger, per IEEE standards. An undervoltage alarm must be provided for remote monitoring by the facilities' owners, who shall take immediate action to restore power to the protective equipment.

Mechanical and electrical logic and interlocking mechanisms are required facilities to ensure safe and reliable operation of the interconnection. These include, but are not limited to, breaker and switch auxiliary contacts, synch-check relays, and physical locking devices.

3.2.1 Generator Protection Requirements

Generators connecting to NTD are responsible for protecting those facilities from electrical faults and other hazardous conditions. Generator interconnections must be equipped with circuit breakers or other appropriate interrupting devices to protect those facilities. The generator owner must provide and own the primary circuit breaker or other interrupting device that protects the facility and disconnects it from NTD's facilities. The primary purpose of this interrupting device is to protect the generating plant facility.

3.2.2 Transmission Protection Requirements

All transmission power systems shall have a dual protective relaying scheme that provides both primary and backup coverage of the remote bus. Communications-aided tripping using a dedicated communications channel may be required based on system stability determination. Communications redundancy may be required depending on critical clearing time. A transfer trip may be required for backup protection and islanding schemes.

Backup protective systems should provide additional coverage for breaker and relay failure outside the primary zone. Specific breaker-failure protection schemes shall be applied as required to meet NERC requirements, and, where local/remote backup does not provide adequate sensitivity or speed, specific relay failure backup shall also be provided. Backup systems shall operate for failures on either side of an interconnection point. Time and sensitivity coordination must be maintained to prevent misoperations.

Fiber optics is the standard means of relay communications; however, microwave and power line carrier may also be used in limited circumstances.

3.3 Metering and Telemetry

NTD's metering and telemetry requirements for an interconnecting entity are those required in the PJM Tariff, the PJM Manuals, and the Interconnection Service Agreement between the interconnected entity, PJM, and NTD.

3.4 Grounding and Safety Issues

A safe grounding design must accomplish two basic functions:

- Ensure that a person in the vicinity of grounded structures and facilities is not exposed to critical levels of step or touch potential, and
- Provide a path for electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting the continuity of service.

Accordingly, each electrical facility must have a grounding system or grid that solidly grounds all metallic structures and equipment in accordance with standards outlined in ANSI/IEEE 80, IEEE Guide for Safety in AC Substation Grounding, ANSI/IEEE C2, and NESC. Testing must be performed to ensure safe step and touch potential parameters have been met in accordance with IEEE 80.

When various switching devices are opened on an energized circuit, its ground reference may be lost if all sources are not effectively grounded. This situation may cause over voltages that can affect personnel safety and damage equipment. This is especially true when one phase becomes short-circuited to ground. Therefore, the interconnected transmission power system is to be effectively grounded from all sources. This is defined as X0/X1 < 3 and R0/X1 < 1. Interconnected generators should provide for effective system grounding of the high-side transmission equipment by means of a grounded high-voltage generation step-up transformer.

Safety is of utmost importance. Strict adherence to established switching, lock out/tag out procedures, and grounding procedures is required at all times for the safety of personnel. Any work carried out within a facility shall be performed in accordance with all applicable laws, rules, and regulations and in compliance with Occupational Safety and Health Administration (OSHA), NESC, and Good Utility Practice. Automatic and manual disconnect devices are to be provided as a means of removing all sources of current to any particular element of the power system. Only trained operators are to perform switching functions within a facility under the direction of the responsible dispatcher or designated person as outlined in the NESC.

3.5 Insulation and Insulation Coordination

Insulation coordination is the selection of insulation strength. Insulation coordination must be done properly to ensure electric system reliability and personnel safety. Basic switching surge levels, surge arrester, conductor spacing and gap application, substation and transmission-line insulation strength, protection, and shielding shall be documented and submitted for evaluation as part of the interconnection plan.

Interconnection Facilities to be constructed in areas with salt spray contamination or other type of contamination shall be properly designed to meet or exceed the performance of facilities not in a contamination area with regard to contamination-caused outages. Equipment basic insulation level (BIL) shielding and surge protection shall be designed to meet the latest IEEE C62 standards.

3.6 Voltage, Reactive Power, and Power Factor Control

NTD's requirements for voltage, reactive, and power factor control for an interconnecting entity are those required in the PJM Tariff, the PJM Manuals, and the Interconnection Service Agreement between the interconnected entity, PJM, and NTD.

3.7 Power Quality Impacts

At no time shall the operation of the interconnecting entities' facilities, including associated generators or any of their auxiliary devices as applicable, result in an electrical output in which harmonic distortion exceeds the recommended limits contained in IEEE Standard 519, which defines voltage waveform and harmonic content.

3.8 Equipment Ratings

All fault-interrupting device ratings must equal or exceed the fault interrupting capability necessary to meet system short-circuit requirements as determined through short-circuit analyses and shall fully comply with the latest ANSI/IEEE C37 standards for circuit breakers, switchgear, substations, and fuses.

All current-carrying equipment and devices shall be rated in accordance with applicable NERC standards, PJM Tariff, and PJM Manual requirements.

Equipment BILs, shielding, and surge protective device application must meet requirements as determined by the latest IEEE C62 standards. NTD will provide the BIL for its facilities in the interconnection area.

3.9 Synchronizing of Facilities

The interconnecting entity shall obtain PJM's approval prior to either synchronizing its facilities with the NTD facilities or energizing them, as applicable. Once synchronized, PJM approval for disconnecting is required except in an emergency condition. The interconnecting entity shall coordinate such synchronizations, energizations, and disconnections with NTD.

If necessary, synchronization points/locations shall be noted on the project plans or relay plans developed during the detailed design/construction phase of the project. The synchronization points are defined as locations that have the capability and are the preferred locations for synchronization for paralleling a synchronous generator, or if needed during a recovery from a black start or islanding event. In addition to manual synchronization points, "synchro-check" relays shall also be noted on the project plans or relay plans. Generators shall have a method of synchronizing so that NTD will not have to operate its breakers for generation synchronization.

3.10 Maintenance Coordination

NTD and the interconnected entity agree to confer regularly to coordinate the planning, scheduling and performance of preventive and corrective maintenance that requires scheduling an outage of the Interconnection Facilities. Such outages shall be scheduled with PJM as described in PJM Manual 38.

3.11 Interpersonal Communication Capability

Each party shall have interpersonal communication capability that will permit direct communication with each other for normal and emergency operations as required by the NERC standards, the PJM Manuals, and the Interconnection Service Agreement.

3.12 Interrupting Device/Breaker Duty

Fault interrupting devices and associated protection systems are required between NTD's transmission facilities and the Interconnection Customer's facilities for the purpose of both protecting the Interconnection Customer's equipment and preventing faults on the Interconnection Customer's facilities from removing NTD's facilities. The device(s) shall isolate the Interconnection Customer's facilities from NTD's facilities for all faults, loss of NTD supply, or abnormal operating conditions as long as any of the Interconnection Customer's Interconnection Facilities are electrically connected to NTD's.

This fault interrupting device shall be capable of interrupting the greater of the maximum available fault current at that location available from the Transmission System or from the Interconnection Customer's facilities. NTD will provide the following short circuit data for the Point of Interconnection: (i) three-phase fault MVA and (ii) single line-to-ground fault amps.

The three-phase device shall interrupt all three phases simultaneously and shall have a maximum operation time of two cycles or less from time of energization of the trip coil(s). The protective trips to the interrupting device should be arranged into two independent trip circuits including separate relay trips, separate DC control busses, and two trip coils.

Generally, automatic reclosing of this interrupting device is not desired. If the Interconnection

Customer's facilities' configuration requires automatic reclosing, NTD will provide the specific reclosing times. It is the Interconnection Customer's responsibility to design and maintain its interrupting device(s), contingent on NTD's approval, to properly isolate the Interconnection Customer's facilities upon loss of the NTD connection until the appropriate facilities are returned to service.

3.13 Surge Protection

All line or cable entrance positions to a station shall have arrestor protection installed on the line or cable side of the line or cable disconnect. Line entrance arrestors 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 arrestor protection for each winding and/or phase. Arrestor protective margins shall not be less than 20% as determined by IEEE standards methods.

3.14 Disturbance Monitoring

The Interconnection Customer's facility shall have disturbance monitoring equipment as required by NERC or RF standards.

4 NTD's List of Approved Contractors

Appendix B attached hereto provides NTD's List of Approved Contractors.

Appendix A – PJM Tariff Definitions Used In Document

Affected System: An electric system other than the Transmission Provider's Transmission System that may be affected by a proposed interconnection or on which a proposed interconnection or addition of facilities or upgrades may require modifications or upgrades to the Transmission System.

Applicable Standards and Technical Requirements: Those certain technical requirements and standards applicable to interconnections of generation and/or transmission facilities with the facilities of an Interconnected Transmission Owner or, as the case may be and to the extent applicable, of an Electric Distributor (as defined in Section 1.8 of the Operating Agreement), as published by Transmission Provider in a PJM Manual provided, however, that, with respect to any generation facilities with maximum generating capacity of 2 MW or less for which the Interconnection Customer executes a Construction Service Agreement or Interconnection Service Agreement on or after March 19, 2005, "Applicable Technical Requirements and Standards" shall refer to the "PJM Small Generator Interconnection Applicable Technical Requirements and Standards." All Applicable Technical Requirements and Standards shall be publicly available through postings on Transmission Provider's internet website.

Designated Entity: "Designated Entity" shall have the same meaning provided in the Operating Agreement.

> *From the Operating Agreement:* An entity, including an existing Transmission Owner or Nonincumbent Developer, designated by the Office of the Interconnection with the responsibility to construct, own, operate, maintain, and finance Immediate-need Reliability Projects, Short-term Projects, Long- lead Projects, or Economic-based Enhancements or Expansions pursuant to Section 1.5.8 of Schedule 6 of this Agreement.

Generation Interconnection Request: A request by a Generation Interconnection Customer pursuant to Subpart A of Part IV of the Tariff to interconnect a generating unit with the Transmission System or to increase the capacity of a generating unit interconnected with the Transmission System in the PJM Region.

Good Utility Practice: Any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region; including those practices required by Federal Power Act Section 215(a)(4).

Interconnected Transmission Owner: The Transmission Owner to whose transmission facilities or distribution facilities Customer Interconnection Facilities are, or as the case may be, a Customer Facility is, being directly connected. When used in an Interconnection Construction Service Agreement, the term may refer to a Transmission Owner whose facilities must be upgraded pursuant to the Facilities Study, but whose facilities are not directly interconnected with those of the Interconnection Customer.

Interconnection Customer: A Generation Interconnection Customer and/or a Transmission Interconnection Customer.

Interconnection Facilities: The Transmission Owner Interconnection Facilities and the Customer Interconnection Facilities.

Interconnection Service Agreement: An agreement among the Transmission Provider, an Interconnection Customer and an Interconnected Transmission Owner regarding interconnection under Part IV and Part VI of the Tariff.

List of Approved Contractors: A list developed by each Transmission Owner and published in a PJM Manual of (a) contractors that the Transmission Owner considers to be qualified to install or construct new facilities and/or upgrades or modifications to existing facilities on the Transmission Owner's system, provided that such contractors may include, but need not be limited to, contractors that, in addition to providing construction services, also provide design and/or other construction-related services, and (b) manufacturers or vendors of major transmission-related equipment (e.g., high-voltage transformers, transmission line, circuit breakers) whose products the Transmission Owner considers acceptable for installation and use on its system.

Merchant Transmission Facilities: A.C. or D.C. transmission facilities that are interconnected with or added to the Transmission System pursuant to Part IV and Part VI of the Tariff and that are so identified on Attachment T to the Tariff, provided, however, that Merchant Transmission Facilities shall not include (i) any Customer Interconnection Facilities, (ii) any physical facilities of the Transmission System that were in existence on or before March 20, 2003 ; (iii) any expansions or enhancements of the Transmission System that are not identified as Merchant Transmission Facilities in the Regional Transmission Expansion Plan and Attachment T to the Tariff, or (iv) any transmission facilities that are included in the rate base of a public utility and on which a regulated return is earned.

Transmission Interconnection Request: A request by a Transmission Interconnection Customer pursuant to Part IV of the Tariff to interconnect or add Merchant Transmission Facilities to the Transmission System or to increase the capacity of existing Merchant Transmission Facilities interconnected with the Transmission System in the PJM Region.

Transmission Owner: Each entity that owns, leases or otherwise has a possessory interest in facilities used for the transmission of electric energy in interstate commerce under the Tariff. The Transmission Owners are listed in Attachment L.

Appendix B – List of Approved Contractors

Northeast Transmission Development, LLC ("NTD") provides the following lists of Approved Contractors and Approved Vendors pursuant to requirements under PJM Tariff, Attachment P, Appendix 2, Section 3.2.3.5. NTD reserves the right to revise these lists without notice and as such, requires that project developers electing the option to build contact NTD directly to verify the lists' accuracy. Companies provided in these lists are done so alphabetically, without regard to preference or ranking.

Approved Contractors

Substation Engineering/Design

- ABB (system studies)
- Black & Veatch
- Burns & McDonnell
- Commonwealth & Associates
- General Electric
- POWER Engineers
- Sargent and Lundy
- Siemens PTTI (system studies)

Substation Construction

- Black & Veatch Construction, Inc. / Overland Contracting, Inc.
- Henkels & McCoy
- MasTec
- MYR Group
- Quanta Services

Transmission Line Engineering/ Design

- Apogee Engineers
- Black & Veatch
- Burns & McDonnell
- Commonwealth & Associates
- POWER Engineers
- Sargent and Lundy

Overhead Transmission Line Construction

- Henkels & McCoy
- MasTec
- MYR Group
- Quanta Services
- Utility Lines (Asplundh)

Testing/Inspection

- CE Power Solutions
- Electric Power Systems
- Emerson HVM
- Power Testing and Energization
- Service Electric Co.

Approved Vendors

Breakers

- ABB
- Alstom
- GE-HVBI
- Mitsubishi Electric
- Siemens

Disconnect Switches

- Alstom
- Cleveland Price
- Pascor
- Southern States
- USCO
- Royal Switchgear

Conductor

- General Cable
- Midal
- Southwire

Underground Transmission Cables

- ABB
- General Cable
- LS Cable
- Nexans
- Okonite
- Prysmian
- Taihan

Transformers

- ABB
- Alstom
- Delta Star
- GE Prolec
- HICO
- Hyundai
- Mitsubishi Electric
- PTTI
- Royal SMIT Nijmegen
- Siemens
- SPX/Waukesha

Relay Protective Devices

- ABB (Relays)
- ABB (Test Switches)
- Basler (Relays)
- GE Multilin (Relays)
- Schweitzer Engineering (Relays)

Capacitors

- ABB
- Cooper Power Systems
- Eaton
- GE Energy
- Shallbetter

Reactors

- ABB
- Alstom
- Siemens
- Trench

CVT's

- ABB
- Alstom
- Siemens
- Trench

CT/Metering Units

- ABB
- Alstom
- Siemens
- Trench

Surge Arrestors

- Cooper Power Systems
- Hubbell Power Systems
- Joslyn
- Maclean Power Systems

Steel Poles

- Sabre/FWT
- TAPP
- Trinity/Meyer
- Valmont

Substation Steel Structures

- Distran
- Klute
- MD Henry
- Sabre/FWT
- Trinity/Meyer
- Valmont

Insulators and Hardware

- Hubbell Power Systems
- MacLean Power Systems
- NGK/Locke
- Salvi
- Seves Group

Modular Control Enclosures

- Crown Technologies
- System Controls
- Electrical Power Products

Communications and RTU

- Schweitzer Engineering Laboratories (Gateways/Fireways)
- Schweitzer Engineering Laboratories (RTU/SCADA)
- Schweitzer Engineering Laboratories (Ethernet Switches)
- General Electric (Gateways/Firewalls)
- General Electric (RTU/SCADA)
- Siemens (RTU/SCADA)
- Siemens (Gateways/Firewalls)
- Siemens (Ethernet Switches)
- Cisco (Ethernet Switches)
- Cisco (Gateways/Firewalls)