Facility Connection Requirements

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Transmission Facility Connection Requirements

INTRODUCTION

This document was developed to comply with the North American Electric Reliability Council (NERC) Reliability Standard FAC-001-0, Facility Connection Requirements. Facility connection and performance requirements are established to avoid adverse impacts on reliability. These requirements address connection requirements for Generation facilities, Transmission facilities, and End-User facilities. For ease of use, the paragraph headings in this document use the requirements numbers in alignment with the FAC-001-0 standard. Except in cases where specifically delineated, the requirements within the document are applicable to Generation facility, Transmission facility, and End-User facility interconnections.

This document covers the requirements for interconnection to the transmission system within Vermont Transco, LLC (VT Transco) and Vermont Electric Power Company (VELCO) service territory in Vermont.

VT Transco is a member of ISO-New England (ISO-NE). The primary responsibility for the interconnection process and requirements is with ISO-NE. ISO-NE's Transmission, Markets, & Services Tariff address the interconnection process, planning study requirements, and facility connection requirements specific to the ISO-NE transmission system. VT Transco is an active participant in the process. The ISO-NE Transmission, Markets, & Services Tariff can be accessed by the use of the ISO-NE website at www.iso-e.com/regulatory/tariff/index.html. Interconnection Requestors should review the ISO-NE Tariff for specific ISO-NE requirements. This document is intended to highlight the VT Transco requirements and is not intended to fully replicate or to replace the ISO-NE documentation. In addition, the ISO-NE Tariff, Open Access Transmission Tariff (OATT) provides the Interconnection Services Agreement (ISA) that is utilized by VT Transco and includes several of the interconnection requirements. Normally all interconnection requests are directed to ISO-NE. ISO-NE Tariff, Transmission Service Agreement (TSA) and OATT are posted publically on the ISO-NE web site.

- Open Access Transmission Tariff (OATT) is intended to provide for comparable, nondiscriminatory treatment of all similarly situated Transmission Owners and all Transmission Customers, and it shall be construed in the manner which best achieves this objective. (http://www.iso-ne.com/regulatory/tariff/sect_2/oatt/sect_ii.pdf)

- Transmission Service Agreement (TSA) is a template for Transmission Service Agreement for Regional Network Service entered into by and between ISO-NE and said "Transmission Customer" (http://www.iso-ne.com/regulatory/tariff/sect_2/tsa/TSA.pdf)

- Schedule 20 – Other Transmission Facilities and Service details the terms and conditions for transmission service over the Other Transmission Facilities, which are currently limited to transmission service offerings under Schedule A – Phase I/II HVDC Transmission Facility Service. (http://www.iso-ne.com/regulatory/tariff/sect_2/sch20/index.html)

- Schedule 21 – Local Service provides for the terms and conditions for Local Service from the various Local Transmission Owners. (http://iso-ne.com/regulatory/tariff/sect_2/sch21/index.html)

- Schedule 22 – Standard Large Generator Interconnection Procedures provides the terms and conditions for interconnecting Large Generating Facilities (more than 20 MW) to the Administered Transmission System. (http://iso-ne.com/regulatory/tariff/sect_2/sch22/index.html)

- Schedule 23 – Standard Small Generator Interconnection Procedures provides the terms and conditions for interconnecting Small Generating Facilities (20 MW or less) to the Administered Transmission System. (http://iso-ne.com/regulatory/tariff/sect_2/sch23/index.html)

- Schedule 24 – Incorporation by Reference of NAESB Standards provides for the Incorporation By Reference of North American Energy Standards Board ("NAESB") Wholesale Electricity Quadrant ("WEQ") Standards. (www.iso-ne.com/regulatory/tariff/sect_2/sch24/index.html)

The ISO-NE Transmission Planning conducts studies to support the Regional System Plan and handles requests to change interconnection and transmission service. ISO-NE ensures Transmission Owners comply with requirements regarding changes to capacity or facilities. Generator and Transmission interconnection inquiries are referred to ISO-NE, and the ISO-NE interconnection process is followed. ISO-NE's Transmission, Markets, & Services Tariff, Section II on OATT provides a summary of the ISO-NE interconnection process; it also explains procedures electric energy suppliers must follow to access the region's transmission system to transport electricity throughout New England. Entities requesting interconnection of a generating facility (including increases to the capacity of an existing generating unit or decommissioning of a generating unit) or requesting interconnection of a merchant transmission facility within the ISO-NE RTO must do so within ISO-NE's defined interconnection process. Impacts to the system are determined by a series of studies which may include a Feasibility Study, System Impact Study, and Interconnection Facilities Study. The results are posted on ISO-NE's website and made available to those who have requested and been granted access.

The information contained in this guide is not intended to capture each and every specific equipment and installation requirement. It represents a typical installation. The minimal requirements specified in this document may need to be modified to meet the needs of unique installations. The intent of the requirements is to address all types of interconnections. As such, not all of the requirements will necessarily apply to all types of

interconnections. VT Transco reserves the right to determine which requirements apply to any specific requested interconnection. Specific requirements necessitated by the type of interconnection and the intended point of interconnection will be communicated to the Interconnection Requestor prior to the construction phase of the project.

RESPONSIBILITIES OF THE INTERCONNECTION REQUESTOR

The Interconnection Requestor is responsible for designing, installing, operating, and maintaining its own equipment in accordance with Good Utility Practice(s), the National Electrical Code (NEC), the National Electrical Safety Code (NESC), North America Electric Reliability Corporation (NERC), any applicable independent system operator, and all applicable laws and regulations. This includes installing, setting, and maintaining all protective devices necessary to protect the customer's facilities. The requirements specified in this document are designed to only protect VT Transco facilities and to maintain transmission system reliability. The interconnecting customer is responsible to coordinate with VT Transco during the engineering / detailed design phase of the project in order to ensure coordination of protective relay devices.

REQUIREMENTS

R1.1 Interconnection Customer

The Interconnection Customer (IC) includes Generation Facilities, Transmission Facilities and End-user Facilities per FAC-001-0. The IC is responsible for coordinating the design of its own facility with ISO-NE and VT Transco. VT Transco's functional relay requirements will be provided to the IC during the detailed design phase of the project. The information for the specific project will indicate the protective functions for which the IC is to provide relays and related equipment. The IC will indicate the specific relay type(s) and range proposed for each function. The IC must also provide proposed current and potential transformer ratios, connections, and locations as related to the electrical one-line diagram. Before proceeding with construction under the option to build, the IC must furnish six sets of final design documents to ISO-NE and VT Transco for review and acceptance. IC design documents (electrical prints, relay settings, etc.) will be reviewed by VT Transco in coordination with ISO-NE. Project delays due to untimely submittal of complete design documents are the responsibility of the IC. When submitting an interconnection request to VT Transco, the requesting Entity should provide as much of the following information as possible to help expedite the design or review process.

- One-line diagram showing the connections between the Transmission Customer and the VT Transco system
- Three-line diagrams showing current and potential circuits for protective relays
- Physical arrangements of existing and proposed facilities
- Geographic location of the proposed interconnection, including maps showing land ownership and zoning – if available. If a tap, indicate adjacent structure numbers
- Description of the proposed routing, approximate lengths and conductor size of transmission line additions or modifications, and dimensions and configurations of new structures. Proposed transmission route(s) and service arrangements between resources and loads.

- Description and ratings of any proposed transformers, winding connections, impedances, circuit breakers, switches, metering, associated communications, relaying and other related equipment.
- Description of the generating resources or loads to be served by the interconnection and the proposed transmission route(s) and service arrangements between resources and associated loads, where applicable. The description should include the following:
    - Power output or load requirements, including 10-year projections, by delivery points, orwinter and summer peaks for loads served or generation supplied through the point of interconnection;
    - Size, type and ratings of large equipment;
    - Reliability and special operation requirements; impedance, frequency, voltage, real and reactive power and protective relaying characteristics of the interconnecting resource or load.
- Appropriate revenue and telemetering equipment specifications. The data should include load control boundary metering, current and potential transformer ratios and register and contract initiator ratios and multipliers.
- Copies of relevant planning or operational studies and proposed construction schedule.
- Copies of relevant environmental impact assessments, permits, reports, or projections; or description of anticipated scope of environmental review.
- Relay tripping and control schematic diagram
- Instruction books for relays

Additional engineering meetings may be necessary to discuss the design documents. If changes are necessary, the IC must incorporate all changes and corrections and resubmit six sets of corrected prints to VT Transco before proceeding with construction.

R2.1 Written Summary of Plans to Achieve Required System Performance

The impact of the IC on the reliability of the interconnected transmission system shall be evaluated. Studies are performed by VT Transco in conjunction with ISO-NE and in accordance with established ISO-NE's Transmission Planning Criteria. (http://www.iso-ne.com/rules_proceds/isone_plan/pp03/index.html) Any deviation from aforementioned planning criteria will be included in the study results when provided.

Generation and Merchant Transmission Interconnection Requests

During the ISO-NE defined study phases for the interconnection of Generation and Merchant Transmission (as described in ISO-NE Tariff) a series of studies is performed to determine the impact of the interconnection request to the system. The study results include identification of solutions to any identified reliability violations. The results of these targeted studies are posted to the ISO-NE website and available once requested access is granted. (http://www.iso-ne.com/trans/rsp/2012/rsp_Final_110212.docx)

Transmission Interconnection – Transmission Owner to Transmission Owner

ISO-NE performs annual studies to evaluate system reliability as described in ISO-NE Tariff. As part of the evaluation process it may be determined that there is a need for additional

system reliability support across multiple interconnected transmission owner facilities. Solutions to identified reliability issues are developed by the affected transmission owners in coordination with ISO-NE. The study results and resultant solutions identified are documented in the ISO-NE annual Regional Study Plan and posted to the ISO-NE website. (http://www.iso-ne.com/trans/rsp/2012/2012_rsp_final.pdf))

End-User Interconnection Requests

End-User requests are evaluated by VT Transco to determine if any system reliability impacts may result from the interconnection of the customer to the transmission system. Studies are primarily conducted to determine if there is available capacity at the interconnection point to accommodate the request. If additional system reinforcements are identified during the study the results will be made known to the requestor and solutions will be proposed to address the issue.

On Going Reliability Analysis

VT Transco develops base cases in support of the annual ISO-NE Transmission Planning process. System models include interconnected customers. Studies performed on an annual basis in line with the VT Transco Transmission Planning Criteria are documented and retained for internal VT Transco use. Interconnections are evaluated to ensure that no Planning Criteria violations are identified.

The latest copy of the ISO-NE Transmission Planning Criteria is available on the ISO-NE website under the Transmission / Transmission Planning or Regional System Plans page. The VELCO Long-Range Transmission Plan can be accessed from the VELCO website under the Long Range Planning tab. (http://www.velco.com/LongRange/Pages/2012Long-RangeTransmissionPlan.aspx)

GICs are responsible for the submittal of applicable data, as requested, in compliance with NERC reliability standards MOD-010 through MOD-013.
(http://www.nerc.com/files/MOD-010-0.pdf)
(http://www.nerc.com/files/MOD-011-0.pdf)
(http://www.nerc.com/files/MOD-012-0.pdf)
(http://www.nerc.com/files/MOD-013-1.pdf)

R2.1.1. Procedures for Coordinated Joint Studies

VT Transco is a member of ISO-NE. One of the many functions of ISO-NE is to coordinate joint studies of new facilities and their impacts on the interconnected transmission system. VT Transco actively participates in this process. The process is described in the ISO-NE Tariff series of documents which are available on the ISO-NE website.

ISO-NE Tariff Generator and Transmission Interconnection Process includes attachments to the manual that define the data requirements for interconnection Feasibility and System Impact Studies. Generators and Transmission interconnection customers should refer to the manual for specifics. Data is to be submitted electronically via the ISO-NE website (actual link as provided in the ISO-NE Tariff).

Regional System Plans are ISO-NE's annual planning reports that determine resources and transmission facilities needed to maintain reliable and economic operation of New England's bulk electric power system over a ten-year horizon. The planning process includes the preparation of an annual Regional System Plan (RSP) in accordance with the ISO's Open Access Transmission Tariff (OATT) and other parts of the Transmission, Markets, and Services Tariff (ISO tariff), approved by the Federal Energy Regulatory Commission (FERC). Study results are publically published annually on ISO-NE's website. (http://www.iso-ne.com/trans/rsp/2012/2012_rsp_final.pdf)
Interconnection planning studies are conducted to meet the criteria established within the NERC TPL series reliability standards (http://www.nerc.com/page.php?cid=2%7C20), the ISO-NE Transmission, Markets, & Services Tariff (www.iso-ne.com/regulatory/tariff/index.html), and the VT Transco Transmission Planning Criteria.

Generator Interconnection – Stability Studies

Severe disturbances on the power system can cause a synchronous generator to lose synchronism with the power system. A large generator operating in this unstable manner can create large power and voltage fluctuations, and can severely stress the generator and power system equipment. Damage could result to the GIC equipment, the VT Transco transmission system, and other interconnected entity facilities. The stability studies will therefore verify that the GIC does not become unstable and that it does not cause neighboring generation to become unstable.

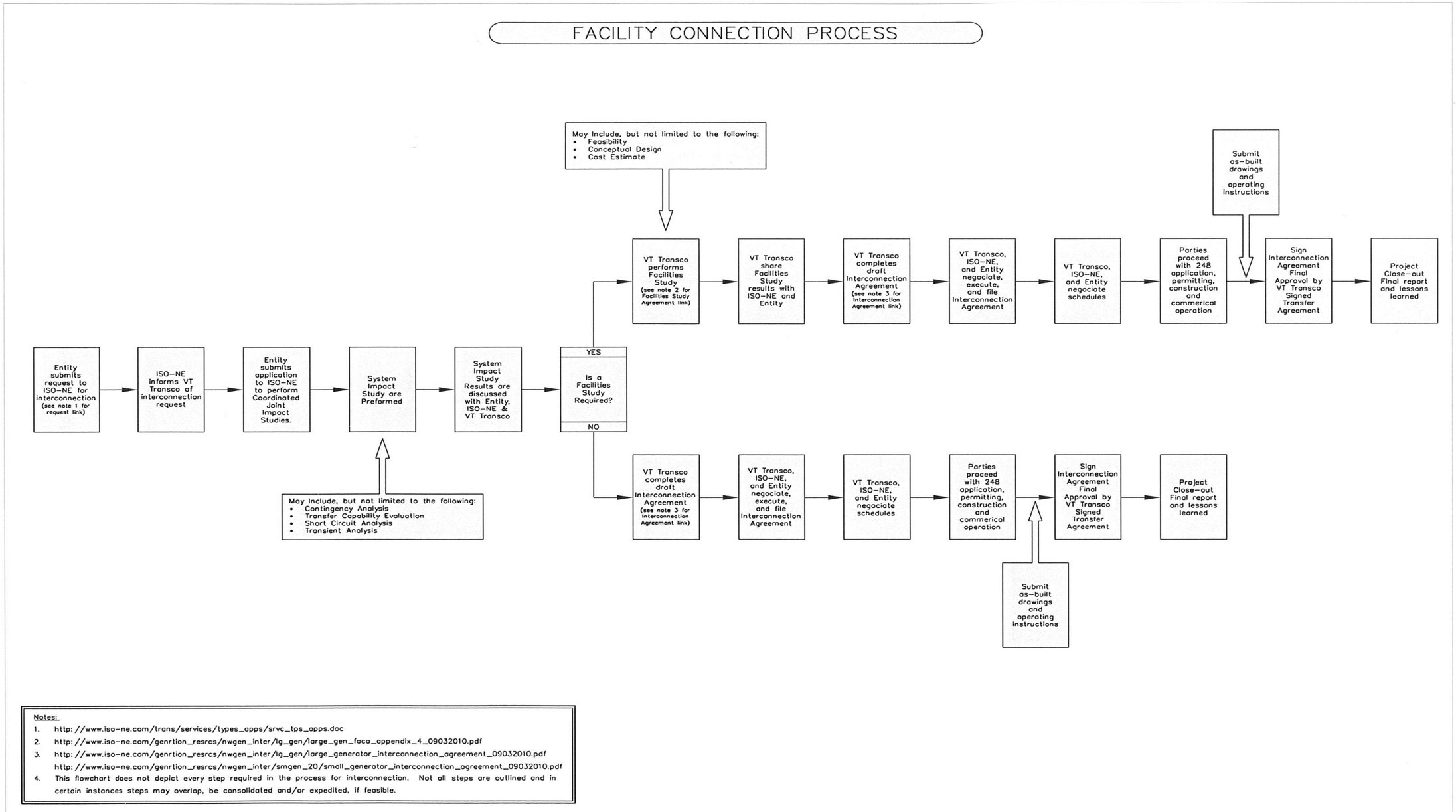
The following procedures will be used to insure that the interconnection design provides for an adequate stability margin.

Using Planning Procedure 3 (PP3) – Reliability Standards for the New England Area Bulk Power Supply System Scope of Study for System Impact (http://www.iso-ne.com/rules_proceds/isone_plan/pp03/pp3_r6_final.pdf)VT Transco in conjunction with ISO-NE will perform stability analysis in order to verify that the generator installation meets ISO-NE and VT Transco criteria. In this criterion, faults that could credibly occur near the generator will be analyzed. Scenarios include, but are not limited to, three-phase faults with failed breakers and three-phase faults during maintenance outages. If the GIC owned generator or other nearby generation loses synchronism for a scenario, additional system upgrades may be necessary to prevent the generator from becoming unstable. ISO-NE and VT Transco will complete the initial stability analysis of the interconnections and will identify equipment requirements and any system upgrades required for the interconnection design.

Stability analysis performed by ISO-NE and VT Transco will not evaluate the risk to the GIC's equipment due to unstable operation of its own generator. It is the responsibility of the GIC to assess these risks and protect their equipment accordingly.

If subsequent generation is added to the ISO-NE system near the GIC's interconnection, it is ISO-NE's and VT Transco's responsibility to assess the risks of these changes. Any subsequent generation added must follow the ISO-NE Interconnection process described in The ISO-NE Transmission Regional System Plans. If necessary, ISO-NE and VT Transco will re-verify that the generator installation meets ISO-NE and VT Transco's interconnection and Transmission Planning Criteria requirements.

R2.1.2 Procedures for Notification Process Flow Chart



Notes:

1. http: //www.iso–ne.com/trans/services/types_apps/srvc_tps_apps.doc
2. http: //www.iso–ne.com/genrtion_resrcs/nwgen_inter/lg_gen/large_gen_faco_appendix_4_09032010.pdf
3. http: //www.iso–ne.com/genrtion_resrcs/nwgen_inter/lg_gen/large_generator_interconnection_agreement_09032010.pdf
   http: //www.iso–ne.com/genrtion_resrcs/nwgen_inter/srngen_20/small_generator_interconnection_agreement_09032010.pdf
4. This flowchart does not depict every step required in the process for interconnection. Not all steps are outlined and in certain instances steps may overlap, be consolidated and/or expedited, if feasible.

Procedures for Notification

Any additions or modifications to existing facilities that have the potential to affect an interconnection require the customer to notify their VT Transco point of contact as soon as feasible. VT Transco will assess the potential impact of the modifications and contact the appropriate affected parties. The significance of any impact has the potential to vary over a broad range. Changes that could affect the operating limits on the interconnected system may require engineering studies and the involvement of ISO-NE. Changes that modify power output must follow the requirements of The ISO-NE Transmission, Markets, & Services Tariff.

Any surveillance/testing activities of equipment located in, or associated with, the Substation/Switchyard that are performed by the interconnected customer that result in abnormal, irregular, or unusual conditions detected during such activities shall be promptly reported by the interconnected customer to the appropriate VT Transco Transmission Operator/Dispatcher.

Notification of major/minor alarms received and protective relay targets (mechanical flags and indicating lights) detected, at the facility concerning the Substation/Switchyard, shall be reported by the interconnected customer to the appropriate VT Transco Transmission Operator/ Dispatcher by telephone as soon as identified.

Periodic operator tests of protective relay communication channels shall be conducted by the Interconnected Customer in accordance with written guidelines furnished by VT Transco and as reasonably requested by VT Transco in coordination with VT Transco operators at the remote end terminals of transmission lines. The Interconnected Customer shall record all test, alarm and relay target data as required and notify VT Transco of abnormalities as necessary. Sequence of event recording shall be made available to VT Transco upon request.

R2.1.3. Voltage Level and MW and MVAR Capacity or Demand

After the customer supplies ISO-NE/VT Transco with the approximate geographic location and the desired megawatt (MW) and megavolt-amp reactive (MVAR) capacities at the point of interconnection, ISO-NE/VT Transco will exercise engineering judgment and the results of engineering studies to determine appropriate voltage levels, interconnection points, and system capabilities for the point of interconnection, since the most practical voltage and interconnection points are site and project specific.

R2.1.4. Breaker Duty - Surge Protection

All facilities and equipment must equal or exceed the fault duty capability necessary to meet system short-circuit requirements as determined through short-circuit analyses and should fully comply with the latest American National Standards Institute (ANSI)/Institute for Electrical and Electronics Engineers (IEEE) C37 collection of standards for circuit breakers, switchgear, substations, and fuses.

In order to maintain transmission reliability, each fault-interrupting device must be rated for full fault-interrupting capability to satisfy the short-circuit level requirements at the point of interconnection. Full fault-interrupting capability is per the latest IEEE C37, C57, and C62 collections of standards. As a general rule, neither party should depend on the other for the protection of their respective equipment.

R2.1.5. System Protection and Coordination

Protective relaying systems and associated communications systems for all facility interconnections shall be planned, designed, constructed, and maintained in accordance with applicable NERC, NPCC, and ISO-NE standards. Utility grade protective relays and fault clearing systems are to be provided on the interconnected power system. All protective relays shall meet or exceed ANSI/IEEE Standard C37.90. Adjoining power systems may share a common zone of protection between two parties. 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 customer must be compatible with the protections system used by VT Transco to protect the transmission grid. Compatible relaying equipment must be used for a given zone of protection. Compatibility includes protection application, redundancy, operating speed, communication type, and communication medium.

A power source for tripping and control must be provided for the protection system by a DC storage battery. The battery is to be sized with enough capacity to operate all tripping devices after eight hours without a charger, per IEEE standards. An under-voltage 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 between interconnected facilities to ensure safe and reliable operation. These include, but are not limited to, breaker and switch auxiliary contacts, synch-check relays, and physical locking devices.

The facility owner (generator, transmission, end-user) is responsible for providing a protection system that will protect its equipment against disturbances on VT Transco's system and minimize the effects of disturbances from its facilities on VT Transco equipment and transmission system. Entities connecting to the VT Transco transmission system shall investigate and keep a log of all protective relay actions and mis-operations, as required by NERC and ISO-NE. In addition, the interconnecting entities must have a maintenance program for their protection systems in accordance with NERC. Documentation of the protection maintenance program shall be supplied to VT Transco, ISO-NE, RFC, and NERC upon request. As outlined in the maintenance program, test reports are to be made available for review by VT Transco. At intervals described in the documented maintenance program and following any apparent malfunction of the protection equipment, the Interconnecting Customer shall perform both calibration and functional trip tests of its protection equipment as outlined by NERC.

<u>Generator Protection Requirements</u>

Generators connecting to the VT Transco transmission system 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 the

VT Transco transmission system. The primary purpose of this interrupting device is to protect the generating plant facility.

Synchronous or wind turbine generators connected to the VT Transco transmission system shall be able to withstand certain temporary excursions in voltage, frequency, and reactive and real power output without tripping. A System Impact Study will determine if the generator will trip during temporary excursions. Generation must ride through temporary excursions to support the grid and avoid cascading events. It is recognized that certain circumstances may exist that necessitate the imposition of performance criteria that is considered more stringent than the default criteria specified above. Such circumstances shall be identified during the conduct of the System Impact Study or operational study for each particular generator.

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 through the use of 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 mis-operations.

Fiber optics is the preferred means of relay communications; however, microwave and power line carrier may also be used. Audio tone over phone line is the least preferred method because it may not meet requirements for speed and reliability.

Each fault-interrupting device must be rated for full fault-interrupting capability to satisfy the short-circuit level requirements at the point of interconnection. Neither party shall depend on the other for the protection of their respective equipment.

R2.1.6. Metering and Telecommunications

Metered data shall be telemetered to a location designated by ISO-NE and location as designated by VT Transco unless alternate satisfactory telemetered locations are agreed to by the VT Transco and Interconnection Customer.

Interconnecting Customers that will be a market participant shall install metering that shall be of sufficient quality to meet the requirements as defined by VT Transco and ISO-NE in the ISO-NE Transmission, Markets, & Services Tariff, Section II.

Metered data shall be telemetered to a location designated by VT Transco unless alternate satisfactory telemetered locations are agreed to by VT Transco and the IC. All generation and auxiliary retail load metering shall have the ability to connect to an Automated Meter Reading (AMR) system.

Before the purchase or fabrication of revenue metering equipment, four sets of each of the following information must be submitted to VT Transco for review and acceptance:

- Overall Electrical Single-Line Drawing, showing location of revenue metering equipment.
- Switchgear Single-Line Drawing, showing location of revenue metering transformer compartment.
- Physical Metering Transformer Compartment drawing, showing the layout of revenue metering current transformers and potential transformers.
- If the installation utilizes a stand-alone current transformer cabinet, the manufacturer's drawing, showing the catalog number and address at which its use is intended.
- Estimated generation capacity and auxiliary retail loads.

Revenue Metering Guidelines

For the purposes of this document, revenue metering shall refer to the meter or meters used for billing purposes and the associated current transformers and potential transformers (collectively known as "instrument transformers"), communications equipment, and wiring between these devices. The basic configuration consists of directional revenue grade metering (import and export) at each point of interconnection with the VT Transco system. Additional separate revenue metering for the gross output of the generation and for auxiliary retail loads may be required, depending on the generation capacity, telemetry requirements, applicable contractual provisions and associated tariffs. All generation and auxiliary retail load metering shall have the ability to connect to an Automated Meter Reading (AMR) system.

Before the purchase or fabrication of revenue metering equipment, four sets of each of the following information must be submitted to VT Transco for review and acceptance:

- Overall Electrical Single-Line Drawing, showing location of revenue metering equipment.
- Switchgear Single-Line Drawing, showing location of revenue metering transformer compartment.
- Physical Metering Transformer Compartment drawing, showing the layout of revenue metering current transformers and potential transformers.
- If the installation utilizes a stand-alone current transformer cabinet, the manufacturer's drawing, showing the catalog number and address at which its use is intended.
- Estimated generation capacity and auxiliary retail loads.

R2.1.7. 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, National Electrical Safety Code (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.

R2.1.8. Insulation and Insulation Coordination

Insulation coordination is the selection of insulation strength. Equipment basic impulse surge levels (BIL) shielding, surge protection and general insulation coordination shall be designed to meet the latest IEEE C62 and 1313 standards, along with VT Transco standards. 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.

R2.1.9. Voltage, Reactive Power, and Power Factor Control

<u>Generator Interconnection</u>

ISO-NE is responsible for ensuring the stability and reliability of its electric Transmission and Distribution (T&D) system. In turn, all GICs are responsible for operating their units in a stable manner while those units are connected to the VT Transco system. Generator excitation and prime mover controls are key elements in ensuring electric system stability and reliability. To meet its responsibility, ISO-NE must have the ability to establish voltage

and governor control requirements for all generators connected to its system. These requirements may vary depending on the location, size, and type of generation installed.

GICs are required with oversight by ISO-NE to follow the current NERC and NPCC standards and guides for generator operation, protection, and control. ISO-New England's procedures to inform generators of operating and reliability requirements can be found via the following link: http://www.iso-ne.com/rules_proceds/operating/index.html

- All synchronous generators connected to the interconnected transmission systems shall be operated with their excitation system in the automatic voltage control mode unless approved otherwise by ISO-NE.
- ISO-NE/VT Transco shall be notified any time a voltage regulator is taken out of service.
- Generators shall maintain a network voltage or reactive power output as required by VT Transco, with governance by ISO-NE, within the reactive capability of the units. Generator step-up and auxiliary transformer shall have their tap settings coordinated with electric system voltage requirements.
- Temporary excursions in voltage, frequency, and real and reactive power output that a generator shall be able to sustain shall be defined and coordinated on a regional basis.
- Voltage regulator controls and limit functions (such as over and under excitation and volts/hertz limiters) shall coordinate with the generator's short duration capabilities and protective relays.
- Prime mover controls (governors) shall operate with appropriate speed/load characteristics to regulate frequency.

Power factor requirements for new generator interconnection requests and increase to existing generators are documented in The ISO-NE Transmission, Markets, & Services Tariff Generation and Transmission Interconnection Process in the Additional Generator Requirements section.

Specific requirements for voltage regulators, power system stabilizers, governor controls, and remote control and telemetry of such devices will be determined during the System Impact Study. The specific requirements for a generator will become part of the Interconnection Service Agreement.

Transmission Facilities

The transmission system must be capable of moving electric power from areas of generation to areas of load under a wide variety of expected system conditions. Adequate reactive power supplies are of paramount importance to the capability of the transmission system to reliably support a wide variety of transfers. Transmission facilities must be designed to minimize excessively high voltages during light transmission loading conditions, yet have adequate reactive supplies to support system voltage during heavy transmission loading conditions.

End-User Facilities

VT Transco will supply End-User facilities within the voltage requirements as stated in the applicable state tariffs. End-User facilities connected directly to the transmission system

should plan and design their systems to operate at close to unity power factor to minimize the reactive power burden on the transmission system.

R2.1.10. Power Quality Impacts

At no time shall the operation of the IC facility, 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.

R2.1.11. Equipment Ratings

All circuit breakers and other fault-interrupting devices shall be capable of safely interrupting fault currents for any fault they may be required to interrupt. Application of circuit breakers shall be in accordance with the ANSI/IEEE C37 collection of standards.

All current-carrying equipment and devices shall be designed to carry the maximum loads that are predicted and used in load flow analysis tested against all applicable NERC standards, NPCC standards, ISO-NE and VT Transco Transmission Planning Criteria. Loads exceeding nameplate or normal design capacities are acceptable only when allowed by manufacturers' design documentation or standard industry practice.

Equipment BILs, shielding, and surge protective device application must meet requirements as determined by the latest IEEE C62 standards. VT Transco will provide the BIL for the system in the interconnection area. Also, equipment must meet all applicable ANSI/IEEE standards and specifications communicated by ISO-NE and VT Transco.

Voltage ratings shall be in accordance with the latest IEEE C84 standards.

R2.1.12. Synchronizing of Facilities

The IC shall obtain ISO-NE's approval prior to either synchronizing with the transmission system or energizing, as applicable per the determination of ISO-NE, the Customer Facility or, except in an emergency condition, disconnecting the Customer Facility from the transmission system, and shall coordinate such synchronizations, energizations, and disconnections with VT Transco.

Protection personnel from VT Transco and the IC shall jointly develop protection schemes for inter-tie lines. Protective scheme prints, settings and tests are jointly shared and reviewed for coordination and fault-modeling information is exchanged.

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. Synchronization shall be in accordance with the latest IEEE/ANSI 1547 standards.

R2.1.13. Maintenance Coordination

The interconnection parties agree to confer regularly to coordinate the planning, scheduling and performance of preventive and corrective maintenance on the Customer Facility, the Customer Interconnection Facilities and any attachment facilities owned by VT Transco.

On occasion, VT Transco must remove its lines from service for maintenance.
These planned outages are for purposes such as: testing relays, rearranging, modifying or constructing lines, and maintaining lines or station equipment. The IC, VT Transco, and ISO-NE will coordinate for these planned outages.

Generator Interconnection

On occasion, the GIC may not be allowed to operate in parallel with the VT Transco transmission system or, in the case of a GIC with multiple interconnection points, may be permitted to operate only in parallel with specific lines so VT Transco can perform “Liveline Maintenance” on the facilities serving the GIC. The GIC, VT Transco (and possibly ISO-NE) will coordinate with these conditions and requests.

R2.1.14. Operational Issues (Abnormal Frequency and Voltages)

ISO-NE is the Regional Transmission Operator (RTO) for the VT Transco transmission system. The interconnection will be operated consistent with VT Transco requirements and procedures. Specific transmission conditions and procedures for operation of Transmission Facilities within VT Transco are in VELCO Operating Procedure OP-7 in accordance with ISO-NE Operating Procedure #7 used to determine actions in an emergency for voltage and frequency excursions.
(http://iso-ne.com/rules_proceds/operating/isone/op7/op7_rto_final.pdf).

Generator Interconnection

The Transmission System is designed to automatically activate a load-shed program as required by ISO-NE in the event of an under-frequency system disturbance. A GIC shall implement under-frequency and over-frequency relay set points for the GIC as required by ISO-NE to ensure ‘ride through’ capability of the Transmission System. The GIC Facility is to stay connected to and synchronized with the transmission system during system disturbances within a range of under-frequency and over-frequency conditions, in accordance with Good Utility Practice. The response of a GIC’s Facility to frequency deviations of predetermined magnitudes; both under-frequency and over-frequency deviations are studied and coordinated with ISO-NE and VT Transco in accordance with Good Utility Practice.

R2.1.15. Inspection Requirements for Existing or New Facilities

Each party to the interconnection agreement shall perform routine inspection and testing of its facilities and equipment in accordance with good utility practice and regulatory requirements to ensure the continued interconnection of the facilities with VT Transco’s transmission system.

Each party shall, at its own expense, have the right to observe the testing of any of the other party’s facilities and equipment whose performance may reasonably be expected to affect the reliability of the observing parties’ facilities and equipment. Each party shall notify the other party in advance of facility and equipment testing, and the other party may have a

representative attend and be present during such testing. If a party observes any deficiencies or defects on or becomes aware of a lack of scheduled maintenance and testing with respect to the other party's facilities and equipment that might reasonably be expected to adversely affect the observing party's facilities and equipment, the observing party shall provide notice to the other party that is prompt under the circumstance, and the other party shall make any corrections required in accordance with good utility practices and as required by regulatory agencies.

VT Transco will review the general design of the protection scheme for an interconnection site. The IC is responsible for the design of protection that involves the customer's facilities.

The IC must furnish to VT Transco the proposed settings for relays specified. If requested, VT Transco will provide system data needed to determine the relay settings. Before parallel operations with the VT Transco system, the installation must be witnessed and inspected by VT Transco. VT Transco will set the testing requirements. VT Transco has the right to witness the tests and inspect before energizing the equipment. The interconnecting customer must notify VT Transco fourteen (14) days before energizing the equipment. The IC is responsible for providing qualified personnel who will complete all required tests. VT Transco will not perform any of the testing unless contracted to do so.

The IC is responsible for ensuring that all circuit breakers, controls, relays and other protective devices are adjusted and functioning correctly. The IC shall provide test equipment and qualified personnel to perform the required tests. VT Transco will provide a list of proposed tests to be witnessed. The witness test list for a given site will be the ultimate governing document. Interconnecting representatives shall work with the VT Transco project team representatives to schedule resources for witness testing and review of testing documentation.

Initial energizing of high voltage circuits will not be allowed until the site design has been approved and all requirements of the ISO-NE Tariff have been satisfied. Energizing equipment without required approval may result in disconnection from the VT Transco system.

R2.1.16. Communications and Procedures During Normal and Emergency Operating Conditions

Complete, precise, and timely communication is an essential element for maintaining reliability and security of a power system. Under normal operating conditions, the major link of communication with various interconnects shall be by telephone lines.

VT Transco and the IC shall maintain communications which shall include, but not be limited to:

- system paralleling or separation
- scheduled or unscheduled shutdowns
- equipment clearances
- periodic load reports
- maintenance schedules
- tagging of interconnection interrupting devices
- meter tests
- relay tests

- billing
- other routine communication

In case of emergency or abnormal operating conditions, various communication channels may be used depending on the interconnect category. Emergency telephone numbers should be agreed upon by both parties prior to the actual connect date.

Each Interconnection Party shall notify the other parties promptly when it becomes aware of an emergency condition that may reasonably be expected to affect operation of the Customer Facility, the Customer Interconnection Facilities, the VT Transco Interconnection Facilities, or the transmission system.

Interconnection Customer Obligations

The IC shall install and maintain satisfactory operating communications with ISO-NE's system dispatcher or its other designated representative and with VT Transco system dispatcher. The Interconnection Customer shall provide standard voice line, dedicated voice line, and facsimile communications at its Customer Facility control room through use of the public telephone system.

The IC also shall provide and maintain backup communication links with both ISO-NE and VT Transco for use during abnormal conditions as specified by ISO-NE and VT Transco, respectively. The IC further shall provide the dedicated data circuit(s) necessary to provide IC data to the ISO-NE and VT Transco as necessary to conform to applicable technical requirements and standards.

Transmission service and energy scheduling are arranged between the IC and VT Transco by using the VT Transco's transmission outage application system. VT Transco will then communicate scheduling to ISO-NE utilizing ISO-NE's Crow applications.

Each IC will be required to provide a contact name and method of communication within the IC's operation to VT Transco Transmission System Operations Control Center/Dispatcher.

At the ICs expense, the IC shall maintain satisfactory operating communications with VT Transco Transmission System Operator/Dispatcher or representative, as designated by VT Transco. The IC shall provide standard voice line, dedicated voice line and facsimile communications at its facility control room through use of the public telephone system. The IC shall also provide the dedicated data circuit(s) necessary to provide necessary generator/transmission/end-user data to VT Transco. The data circuit(s) shall extend from the IC Facility to a location(s) specified by VT Transco. Any required maintenance of such communications equipment shall be performed at the IC's expense.

The IC's operator is required to communicate to the VT Transco Transmission System Operator/Dispatcher their intention to perform any operational step(s) that could have an influence on the transmission system. The IC's operator is required to follow VT Transco instruction during emergency conditions (e.g. restoration). Participation in drills conducted by ISO-NE or VT Transco is required upon request.

Advance Notification of IC Facilitated Equipment Status Changes

The IC's operator is required to communicate to the VT Transco Transmission System Operations/Dispatcher their intention to perform any operational step(s) that could have an influence on the transmission system. This notification is to be made prior to actually performing the configuration changes to their on-site equipment. This advance notification requirement also applies to 'bring a generator on' or 'taking a generator off' the bus. Whenever possible, as in the case of switching activities related to scheduled maintenance work, the advance notice to VT Transco should be done a few days prior to the day of the actual switching activities. Scheduled maintenance work must be coordinated with VT Transco to meet VT Transco advanced outage notification requirements.

REVIEW/REVISION HISTORY

Rev #	Rev Date	Purpose
0	**04/06/2009**	**Original Document**
1	**09/01/2010**	**Main Document Review and Updates**
2	**12/05/2011**	**Main Document Re-write**
3	**12/26/2012**	**Annual Review. Verified and updated all hyperlinks.**
4	**09/12/2013**	**Annual Review. Verified and updated all hyperlinks.**

GLOSSARY/DEFINITIONS

CELT - ISO-NE's annual 10-year forecast of capacity, energy, loads and transmission is a source for assumptions for planning and reliability studies. (http://iso-ne.com/trans/celt/index.html)

Entity or Interconnection Customer (IC)– Refers to Generation Facility, Transmission Facility, and End-User Facility Interconnection Customer

FERC – Federal Energy Regulatory Commission (http://www.ferc.gov)

GIC – Generator Interconnection Customer

Good Utility Practice – shall mean any of the applicable practices, methods and acts:

- Required by FERC, NERC, NPCC, ISO-NE, or the successor of any of them, whether or not the party whose conduct is at issue is a member thereof,
- Required by applicable law or regulation,
- Otherwise 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 the 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 practice, reliability, safety and expedition. Good Utility Practice is not intended to be limited to optimum practice, method or act to the exclusion of all others, but rather is intended to include acceptable practices, methods, or acts generally accepted in the region.

IC – Interconnection Customer

IEEE - Institute of Electrical and Electronics Engineers (http://www.ieee.org)

NERC – North American Electric Reliability Council (http://www.nerc.com)

NPPC – Northeast Power Coordinating Council (http://www.npcc.org)

NESC – National Electric Safety Code

Transmission System – Facilities owned, controlled, or operated by the Regional Transmission Owners, for the purposes of providing transmission service, including services under the ISO-NE Tariff and Interconnection Service.

Transmission Customer (TC) – Any entity requesting or utilizing transmission service on the VELCO Transmission System.