



# **Facility Connection Requirements**

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# VT TRANSCO Facility Connection Requirements

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## **INTRODUCTION**

As a Transmission-only utility, VT TRANSCO partners with its interconnected and interconnecting customers as well as neighboring transmission system owner(s) (Interconnection Party(ies)) for long-term, successful transmission interconnections. This Guide describes the minimum requirements for the connection of an Interconnection Party's facilities to the VT Transmission System or the modification of an existing transmission interconnection. Additional specific facility requirements will be identified during studies conducted in connection with the particular Interconnection Party-proposed project. This process is administered by VT TRANSCO under the auspices of the ISO -NE.

This document has been prepared to identify the technical requirements for connecting new facilities to the VT TRANSCO transmission system. It applies to new connections or substantial modifications of existing generating units or transmission interconnections as well as existing and new end user delivery points. Rather than give detailed technical specifications this document provides a general overview of the functional objectives and requirements to be met in the design of facility connections. These requirements are written to establish a basis for maintaining reliability, power quality, and a safe environment for the general public, power consumers, maintenance personnel and the equipment. The requirements and guidelines found in this document are consistent with those used by VT TRANSCO when installing new VT TRANSCO facilities or modifying existing VT TRANSCO facilities. This document is also written to comply with NERC Reliability Standards (FAC-001-0 Facility Connection Requirements) which requires entities responsible for the reliability of the interconnected transmission systems to maintain and make available a Facility Connections Requirements document to ensure compliance with NERC Reliability Standards and applicable Regional Reliability Organization, subregional, and individual Transmission Owner planning criteria and facility connection requirements. These standards also require those entities seeking to add facilities or connect to the interconnected transmission system to comply with the Facility Connection Requirements document. The NERC Planning Standards are posted on NERC's web site (<https://standards.nerc.net/>). This Facility Connection Requirements document is revised from time to time to reflect changes or clarifications in planning, operating, or interconnection policies.

Nothing in this document is intended to supercede ISO NE Large (LGIA) or Small (SGIA) Generator Interconnection Procedures or Agreement; and, if there is a conflict, ISO NE Procedures, as applicable, will control.

Any questions or requests for additional information concerning a transmission interconnection to the VT Transmission System should be directed to:

Engineering Department  
Vermont Electric Power Company  
[ENGDESIGN@velco.com](mailto:ENGDESIGN@velco.com)

## **II. COMMON REQUIREMENTS**

This section addresses the technical requirements that are common to the connection of generation, transmission and delivery point (end-user) facilities to the VT TRANSCO transmission system. General overviews of functional requirements are given in this section. This document is not intended to be a design specification. Final design of facility connections to the VT TRANSCO transmission system will be subject to VT TRANSCO review and approval on a case-by-case basis.

### **II. A. Responsibilities**

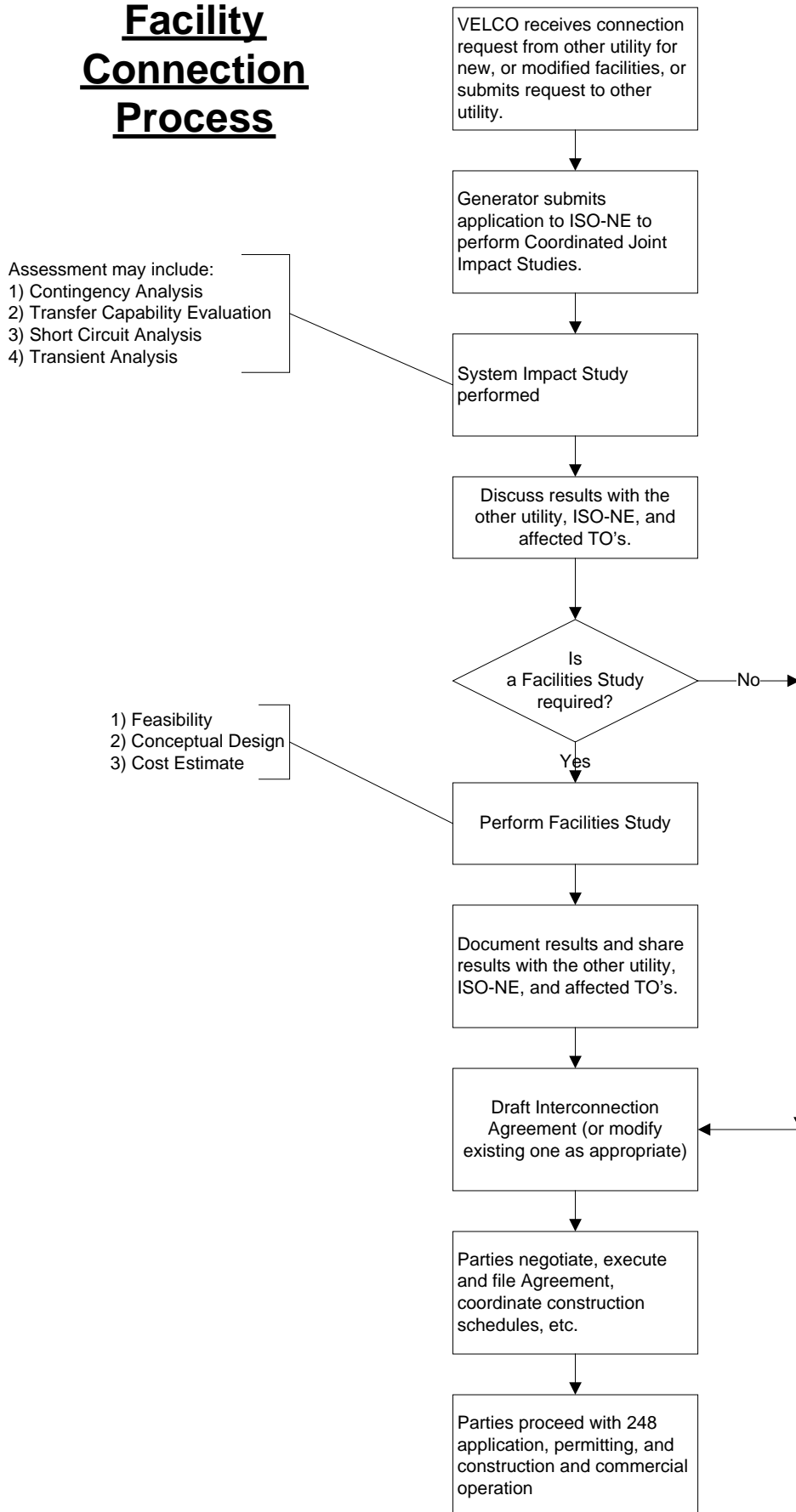
It is the responsibility of the facility owner to provide all devices necessary to protect the customer's equipment from damage by abnormal conditions and operations that might occur on the interconnected power system. The facility owner shall protect its generator and associated equipment from overvoltage, undervoltage, overload, short circuits (including ground fault conditions), open circuits, phase unbalance, phase reversal, surges from switching and lightning, over and under frequency conditions, and other injurious electrical conditions that may arise on the interconnected system.

It is the responsibility of the facility owner to provide for the orderly re-energization and synchronizing of their high voltage equipment to other parts of the electric system. Appropriate operating procedures and equipment designs are needed to guard against out of synch closure or uncontrolled energization. Each owner is responsible to know and follow all applicable regulations, industry guidelines, safety requirements, and accepted practice for the design, operation and maintenance of the facility.

### **II. B. Process**

The connection of non-VT TRANSCO generation, transmission, or Delivery Point (End-user) facilities to the VT TRANSCO transmission system should follow the Facilities Connection Process outlined in Figure 1. Either VT TRANSCO or both entities jointly will begin a System Impact Study to determine the effect of the proposed connection on the VT TRANSCO transmission system. If necessary, a Facilities Study will be initiated to determine the cost of the connection and all VT TRANSCO equipment improvement needed to accommodate the new connection.

# Facility Connection Process



**Figure 1- Transmission Facility Connection Process**

## **II B.1. Initial Studies and Agreements**

During the performance of the initial studies, an **Initial Engagement Agreement** is negotiated between VT TRANSCO and the organization proposing the change. This agreement will address the following and contain an agreed upon schedule and cost reimbursements for;

- a) VT TRANSCO review of studies
- b) Financial security/bonding
- c) Drawings to be provided to VT Transco for review
- d) Reimbursements and tax responsibilities
- e) Future land ownership and facility ownership
- f) Oversight and review of Engineering and Design by VT Transco
- g) Planned Oversight of construction by VT Transco
- h) VT Transco review and approval of testing, cutovers, cycle times, relay settings, and commissioning in accordance with requirements set forth below
- i) Telecommunications for control purposes
- j) Environmental Permitting considerations and commitments
- k) Impacts on VT Transco Planning, Engineering and Project Management resources
- l) Procurement, receipt and disposal of materials

## **II B.2 Final Operations and Maintenance Agreement**

Prior to commissioning of new facilities, an **Operation and Maintenance Agreement** will be prepared and signed by VT TRANSCO and the organization proposing the change. That Agreement will contain the following information as specified in this document;

- a) Ownership and Cost responsibility( e.g. Substation Participation Agreement)
- b) Property tax and other tax liabilities
- c) Operational Control and Responsibility
- d) Daily Facilities Operations
- e) Equipment Maintenance Responsibility
- f) Outage Coordination
- g) Prearranged maintenance
- h) Interruption of service
- i) Power Quality
- j) Switching
- k) Facility infrastructure responsibilities including; access, utility systems, parking, access roads, drainage and grounds maintenance

## **II. C. Site Access and inspection requirements**

There are situations where some equipment that is owned by VT TRANSCO is located within the Customer's facility. This is often required for data acquisition or metering. In these cases, installed equipment owned by VT TRANSCO will be clearly identified as such on the appropriate station drawings, on the reference documents and at the site. Site access is to be

provided to VT TRANSCO employees where VT TRANSCO equipment is located within the Customer's existing or new facility for installation, maintenance and inspections. Also, industry standard inspection rights provisions are typically negotiated into VT TRANSCO's connection agreements.

#### **II. D. Safety**

Safety is of utmost importance. Strict adherence to established switching, tagging 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), National Electric Safety Code (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 National Electric Safety Code. Also see LIGA and SGIA.

#### **II. E. Operations**

Operational procedures are established in accordance with NESC, OSHA, and NERC requirements. Each party shall designate operating representatives to address: lines of communications, maintenance coordination, actions to be taken after deenergization of interconnected facilities, and other required operating policies. All parties are to be provided with current station operating diagrams. Common, agreed upon nomenclature is to be used for naming stations, lines and switches. Updated diagrams are to be provided when changes occur to interconnected facilities.

The operator of facilities interconnecting to the VT TRANSCO transmission system must not perform any switching that energizes or deenergizes portions of the VT TRANSCO transmission system or that may adversely affect the VT TRANSCO transmission system without prior approval of the VT TRANSCO System Operator. Operators of facilities interconnecting to the VT TRANSCO transmission system must notify the VT TRANSCO System Operator before performing any switching that would significantly affect voltages, power flows, frequency, or reliability in the VT TRANSCO transmission system.

#### **II. F. Control Areas**

Facilities owners shall follow good utility practice to avoid creating oversupply imbalances or undersupply imbalances. The facility owner shall contract for or have available to it resources within its control area that are capable of supplying in real time any deviations between power schedules and the actual power interchange with the VT TRANSCO Transmission System by the facility. See LGIA.

#### **II. G. Responsibilities during Emergency Conditions**

All control areas within the NPCC region are responsible for maintaining voltage and frequencies within agreed upon limits. All operators of facilities interconnected to the

transmission systems in the NPCC Region are required to communicate and coordinate with their control area operator. During emergency conditions, the facility operator shall raise or lower generation, adjust reactive power, switch facilities in or out, or reduce end user load as directed by the control area operator. Within the New England Region, the ISO-NE Security Coordinator has overall responsibility for the secure operation of the interconnected transmission systems. All control area operators must communicate and coordinate with and follow the directions of the ISO-NE Security Coordinator. All facility owners are expected to follow the procedures and guides contained in the NPCC website. The NPCC documents are posted electronically at <http://www.npcc.org/regStandards/Overview.aspx>

## **II. H. Maintenance of Facilities**

The maintenance of facilities is the responsibility of the owner of those facilities. Adjoining facilities on the interconnected power system are to be maintained in accordance with accepted industry practices and procedures. Each party is to have a documented maintenance program ensuring the proper operation of equipment. VT TRANSCO will have the right to review maintenance reports and calibration records of equipment that could impact the VT TRANSCO system if not properly maintained. VT TRANSCO is to be notified as soon as practicable about any out of service equipment that might affect the protection, monitoring, or operation of interconnected facilities.

Maintenance of facilities interconnected to the VT TRANSCO transmission system shall be done in a manner that does not place the reliability and capability of the VT TRANSCO transmission system at risk. Planned maintenance must be coordinated and scheduled with the VT TRANSCO System Operator. See LGIA.

## **II. I. Point of Interconnection**

The point of interconnection is to be clearly described. Usually the change of facility ownership and the point of interconnection are the same point.

An interconnection junction box may be required to connect control circuits and signals between the parties at a point of demarcation. Fiber optics is the preferred means of interconnection of control circuits. Metallic control cables will present problems if the distances are great, ground potential rise during faults can cause failures when these signals are needed the most. Long cable voltage drops can make control systems unreliable or produce inaccurate signal levels and therefore are to be avoided.

Metering equipment should be provided as close to the interconnection point as practicable. The interconnecting facility must be connected to the VT TRANSCO system through a primary interrupting device.

Facilities interconnecting to the VT TRANSCO transmission system that are not solely operated and controlled by the VT TRANSCO System Operator must have an isolating device installed at the point of interconnection. This isolating device, typically a disconnect switch, must be capable of physically and visibly isolating the facilities from the VT TRANSCO

transmission system. This isolating device must be lockable in the open position by VT TRANSCO and must be under the ultimate control of the VT TRANSCO System Operator.

## **II. J. Transmission Line Configurations**

Three terminal line interconnection configurations are to be avoided within the VT TRANSCO transmission system. This is due to problems associated with protective relay coverage from infeed, sequential fault clearing, outfeed or weak source conditions, reduced load flow, and automatic reclosing complications.

Some new connections to the VT TRANSCO transmission system may require one or more VT TRANSCO transmission circuits to be looped through the new facility. The design and ratings of the new facilities and the transmission loop into them shall not restrict the capability of the transmission circuits or impair VT TRANSCO's contractual transmission service obligations.

Long taps to feed connected load directly tied to a transmission line are to be avoided. This presents coverage problems to the protective relay system due to infeed. Power line carrier signals can also be lost due to odd quarter wavelength sections.

Any interconnection configuration should not restrain VT TRANSCO from taking a VT TRANSCO transmission line out of service for just cause. VT TRANSCO shall not be forced to open a transmission line for an adjacent interconnected generator or transmission line to obtain an outage. Manual switching or clearing electrical faults within the non-VT TRANSCO facility shall not curtail the ability of VT TRANSCO to transmit power or serve its customers.

Reliable station and breaker arrangements will be used when there are new or substantial modifications to existing VT TRANSCO switching stations affecting transmission lines rated at or above 69kV. In general, VT TRANSCO transmission switching stations are configured such that line and transformer, bus and circuit breaker maintenance can be performed without degrading transmission connectivity. This generally implies a breaker and a half or double breaker, double bus configuration. A ring bus may be used when a limited number of transmission lines are involved.

## **II. K. Grounding**

Each interconnection substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid and grounding system shall be designed to meet the requirements of ANSI/IEEE 80, IEEE Guide for Safety in AC Substation Grounding and ANSI/IEEE C2, National Electrical Safety Code. The transmission line overhead ground wire (OHGW) shall be connected to the substation ground grid.

If the interconnection substation is close to another substation, the two grids may be isolated or connected. Connected grids are preferred, since they are easier to connect than to isolate. If the ground grids are to be isolated, there may be no metallic ground connections between the two substation ground grids. There must also be sufficient physical separation to limit soil

conduction. If the ground grids are to be interconnected, the interconnecting cables must have sufficient capacity to handle the fault currents, duration, and duty. VT TRANSCO must approve any connection to a VT TRANSCO substation ground grid.

All transmission line structures must be adequately bonded and grounded to control step and touch potential in compliance with the NESC, and to provide adequate lightning performance. All transmission lines should have a continuous ground wire, not relying on earth as the primary conductor, to transfer fault current between structures and to substations and plant switchyards. Any exceptions to a continuous ground wire shall be verified with a system study. All ground wires and bond wires must be adequately sized to handle anticipated maximum fault currents and duty without damage.

Transmission interconnections may substantially increase fault current levels at nearby substations and transmission lines. Modifications to the ground grids of existing substations and OHGWs of existing lines may be necessary. The interconnection studies will determine if modifications are required and the scope and cost of the modifications.

## **II. L. Insulation Coordination**

Insulation coordination is the selection of insulation strength. Insulation coordination must be done properly to ensure electrical system reliability and personnel safety. Basic Surge Level (BSLs), 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.

VT TRANSCO's standard is to shield substations and transmission lines from direct lightning strokes and to provide line entrance arresters at transmission line terminals. Surge arresters are also applied at major components and systems.

Interconnection facilities to be constructed in areas with contamination shall be properly designed to meet or exceed the performance of facilities not in a contamination area with regard to contamination caused outages.

## **II. M. Structures**

Transmission and substation structures for facilities connected to the VT TRANSCO transmission system shall be designed to meet the National Electrical Safety Code (NESC). Substation bus systems shall be designed to comply with ANSI/IEEE Standard 605, IEEE Guide for the Design of Substation Rigid-Bus Structures. All VT TRANSCO structures are currently designed to meet extreme wind loading requirements from American Society of Civil Engineers (ASCE) 7-93<sup>1</sup>. Structures connected to the VT TRANSCO transmission system shall be designed to meet ASCE 7-93 when the outage of these structures would interrupt power flow through the VT TRANSCO transmission system or interrupt service to VT TRANSCO customers.

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<sup>1</sup> ASCE 7-93, Category IV, I=1, Exposure C with drag coefficients from adequately documented Industry Standard sources.

## **II. N. Ratings**

For facility and equipment ratings, reference the VT TRANSCO Facility Rating Methodology document. This document can be made available on request to VT TRANSCO. Interconnection facility ratings shall be compatible with those of connected VT TRANSCO facilities.

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 breaker duty rating shall be in accordance with ANSI/IEEE C37 standards.

## **II. O. Reliability and System Security**

VT TRANSCO designs and operates its transmission system to meet NPCC and NERC Planning and Operating Standards. The planned transmission system with its expected loads and transfers must be stable and within applicable ratings for all category A, B, and C contingency scenarios<sup>2</sup>.

System and generator stability is to be maintained for normal clearing of all three phase faults. A normally cleared 115kV and above fault is assumed to last six cycles (0.1 seconds) for circuit elements protected by three cycle breakers. This provides approximately one cycle margin for slower than expected fault clearing. For circuit elements protected by two cycle breakers, a normally cleared fault is assumed to last five cycles.

The power system must be stable for single line to ground faults with the failure of a protection system component to operate. This includes clearing of a system fault with the simultaneous failure of a current transformer, protective relay, breaker, or communication channel. Three phase faults with the failure of a protection system component to operate are to be considered in all design alternatives with adverse consequences to system stability minimized.

VT TRANSCO transmission circuits are protected with primary system relays that provide no intentional time delay when clearing faults for 100% of a line. A second high-speed relay system with communications and no intentional time delay is required if a failure of the primary system can result in instability when a fault is cleared by time delay backup protection. This can be the case for an end of line fault on a short line combined with a failed relay. Likewise, two independent high-speed protection systems may be required for bus protection if backup clearing results in instability.

## **II. P. Protective Relaying**

Utility grade, transmission level protective relays and fault clearing systems are to be provided on the interconnected power system. All protective relays should meet or exceed ANSI/IEEE Standard C37.90. Adjoining power systems may share a common zone of protection between two parties. Compatible relaying equipment must be used on each side of

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<sup>2</sup> NERC Reliability Standards, TPL-001-0 Table 1

the point of ownership within a given zone of protection. The design must provide coordination for speed and sensitivity in order to maintain power system security and reliability.

All bulk transmission power systems are to have primary protective relaying that operates with no intentional time delay for 100% of the specified zone of coverage. On transmission circuits, this is accomplished through the use of a communication channel. A second high-speed protection system may be required on a line or bus.

Backup protective systems should provide additional coverage for breaker and relay failure outside the primary zone. Specific breaker failure protection schemes must always be applied at the bulk transmission level. Specific relay failure backup must also be provided. Backup systems should operate for failures on either side of an interconnection point. Time and sensitivity coordination must be maintained to prevent misoperations.

A power source for tripping and control must be provided at substations 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. 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 between interconnected facilities to ensure safe and reliable operation. These include, but are not limited to, breaker and switch auxiliary contacts, undervoltage and synch-check relays, and physical locking devices.

A transfer trip is required for many installations. It is used for backup protection and islanding schemes. Fiber optics is the preferred means of communication. Power line carrier is also used. Audio tone over phone line is the least preferred method because it may not meet requirements for speed and reliability.

Entities connecting to the VT TRANSCO transmission system shall investigate and keep a log of all protective relay actions and misoperations as required by NPCC in compliance with NERC Reliability Standards. The most current requirements for analysis and reporting of protection misoperations are available from the NPCC Task Force on System Protection staff.

Entities connecting to the VT TRANSCO transmission system must have a maintenance program for their protection systems. Documentation of the protection maintenance program shall be supplied to VT TRANSCO, NPCC, and NERC on request. Test reports as outlined in the maintenance program are to be made available for review by VT TRANSCO and the NPCC. At intervals described in the documented maintenance program and following any apparent malfunction of the protection equipment, the entity shall perform both calibration and functional trip tests of its protection equipment.

## **II. Q. Transmission Reclosing and synchronizing of facilities**

It is VT TRANSCO's practice to automatically and manually test its transmission lines following breaker operations for system faults. This is required to minimize customer outage time and maintain system stability. On 345 kV transmission lines and below, automatic reclosing occurs at approximately 3-15 seconds after fault clearing. For 34 kV and 46kV, a second automatic reclose may be initiated at some locations within a designated period after fault clearing. Manual reclosing and sectionalizing may also occur. Interconnected facilities must not interfere with VT TRANSCO's ability to quickly restore transmission lines following temporary or permanent system faults.

Any party wishing to interconnect with VT TRANSCO must consider the implications of automatic reclosing in their design.

## **II. R. Metering**

Each installation needs to be evaluated separately for metering requirements because of the many possible contractual agreements and interconnection configurations. In general, however, the following quantities are to be provided for each supply point. Megawatt-hours received, Megawatt-hours delivered, MegaVar-hours received, MegaVar-hours delivered, Three Phase Voltage, Three Phase Current, +/- Megawatts, and +/- Megavars. These quantities may need to be provided to various parties through various information/communication systems. Specific designs will be developed to meet those requirements. All metering devices are to be pre-approved by VT TRANSCO prior to installation and will meet ISO-NE OP19 requirements. Revenue meters are to have an accuracy class of 0.25% or better. Transducers are to be accurate to +/- 0.2% of full scale. Three element meters are to be used on all effectively grounded power systems. Backup current transformers (CTs) and potential transformers (PT's) are not required.

Instrument transformers are to have an accuracy class of 0.3% or better with 0.15% being preferred. Metering accuracy CTs and PTs are to be installed as close to the delivery point as practical. CT ratios are to be selected just above the expected full load. Auxiliary CT's are not to be used in metering circuits. When more than one point is to be monitored, individual metering is to be used. The impedance of the CT and PT cable leads is to be kept low and not impose burdens above that of the instrument transformer rating.

At locations where ferroresonance can be a problem, metering accuracy capacitor coupled voltage transformers (CCVT) may be used if an alternate design configuration cannot be used. Designs that use ferroresonance dampening resistors connected to metering PT secondary circuits are not allowed. At 345 kV and above, metering accuracy CCVT's may be used. Whenever metering accuracy CCVT's are installed, a testing program must be provided to ensure the devices maintain accuracy over time. VELCO prefers the use of wire wound PTs over CCVTs.

When the metering location is different from the delivery point, compensation for losses is required for transformer losses and transmission line losses. Compensation should be

performed internally by the installed metering equipment rather than by after-the-fact calculations.

Revenue meters are to remain sealed during operation and following maintenance or calibration testing. All parties are to be notified prior to removing seals. Calibration testing is to be performed annually and is to include all associated parties. Test equipment must be certified and traceable to the National Bureau of Standards.

## **II. S. Supervisory Control and Data Acquisition (SCADA)**

Each installation needs to be evaluated separately for SCADA requirements because of the many possible contractual agreements and interconnection configurations. Generally, the following quantities are to be provided. Megawatt-hours received, Megawatt-hours delivered, Voltage, Current, +/- Megawatts, and +/- Megavars, breaker and switch positions, and equipment trouble alarms. These quantities may need to be provided to various parties through various information/communication systems. Specific designs will be developed to meet those requirements. Two RTU's may be required in order for a participant to receive RTU data. Equipment control of breakers, switches and other devices via SCADA is to be provided to only one responsible party.

Power for SCADA or metering communication equipment, if needed, is to be provided by the station batteries. Office power systems and switching networks are not acceptable.

## **II. T. Ferroresonance**

Ferroresonance occurs on the power system under certain system configurations that may damage high voltage equipment. This phenomenon is usually caused when PT's are tied to a bus or line stub that may be energized through breakers having capacitors in parallel with the main contacts. Since interconnection facilities may contain shared equipment, such as metering PT's and high voltage breakers, care should be used to avoid configurations that could cause ferroresonance.

## **II. U. Future Modifications**

Those entities seeking to integrate facilities shall notify the transmission provider as soon as feasible and the transmission provider shall review and respond as soon as feasible. Any changes that affect an interconnection of generation, transmission, or delivery point (end-user) facilities must be reviewed in advance. These include modifications to the metering or protection scheme as well as associated settings after the interconnection project has been completed. Information about expected increased load flows or higher fault currents levels due to system changes must be provided in a timely manner.

The procedure for notification of new or modified facilities to others (those responsible for the reliability of the interconnected transmission systems) is as follows:

- 1) Either transmission customers or the transmission provider may undertake modifications to its facilities. If a party plans to undertake a modification that reasonably may be expected to affect the other party's facilities, that party shall provide to the other party sufficient information regarding such modification so that the other party may evaluate the potential impact of such modification prior to commencement of the work. Such information shall be deemed to be confidential hereunder and shall include information concerning the timing of such modifications and whether such modifications are expected to interrupt the flow of electricity from the facility.
- 2) The party desiring to perform such work shall provide the relevant drawings, plans, and specifications to the other party at least ninety (90) Calendar Days in advance of the commencement of the work or such shorter period upon which the parties may agree, which agreement shall not unreasonably be withheld, conditioned or delayed. Any additions, modifications, or replacements made to a party's facilities shall be designed, constructed and operated in accordance with Good Utility Practice.
- 3) **Notification of New and Modified Facilities:** Notification of new and modified facilities is effected through the ISO-NE Regional Transmission Expansion Plan and VT TRANSCO's Attachment B for System Impact Study contained within the VT TRANSCO OATT which is available on the VT TRANSCO public website.

## **II. V. Normal or Emergency Conditions**

Normal or Emergency Operating Conditions will be handled through VELCO Operating Procedure #19 (Transmission Operations), or VELCO Operating Procedure #7 (Actions in an emergency). Either of these procedures may be supplied upon request to VELCO.

## **III. W. Inspection Requirements for Existing or New Facilities**

- 1) Acceptance Testing, Inspection and Commissioning

VT TRANSCO requires all Interconnection Parties proposing to interconnect to the VT TRANSCO Transmission System be in compliance with the applicable testing and/or performance requirements.

- 2) General

Prior to energizing the interconnection equipment with the VT TRANSCO Transmission System, the Interconnection Party and VT TRANSCO will work together to insure that all pertinent contracts are signed and that all equipment modifications have been completed. The Interconnection Party is required to demonstrate the correct operation of all interface protective and control devices to VT TRANSCO. VT TRANSCO shall define and witness, but is not responsible for performing this demonstration.

The Interconnection Party must provide detailed information on the protective relaying, metering, and control (including sync-check) equipment that will interface with the VT TRANSCO Transmission System. This is usually provided on a relaying and metering one-line or three-line diagram. Basic proposed AC and DC schematics or specification of

logic may also be required at this time. This information is required along with a listing of the specific relays, etc., including information on the manufacturer, model number, relay ranges, etc.

VT TRANSCO requires at least two sets of any design documentation packages. If any subsequent changes are made, the Interconnection Party shall provide VT TRANSCO two sets of revised one-lines, schematics, construction drawings, etc. A coordination meeting shall be held with VT TRANSCO and the Interconnection Party to clarify any questions that may exist before testing begins.

Scheduling of demonstration testing should be coordinated through VT TRANSCO with a minimum of fifteen business days notice. All testing shall be completed at least seven business days prior to the planned In-Service Date to provide time to resolve problems identified during testing. If no problems are identified then the equipment can be placed in service without delay. Based on the location and type of interconnection, VT TRANSCO may, at VT TRANSCO's sole discretion, require only a design and relay settings review and not require a site visit. The Interconnection Party shall be responsible for determining their own relay settings. At least sixty days before startup testing, the Interconnection Party must supply the proposed settings for the relays, including support documentation (e.g. calculations, fault studies, time over-current relay coordination curves, etc.) for approval by VT TRANSCO.

The Interconnection Party shall supply certified test reports for VT TRANSCO's required protective relaying, interlocks, and any equipment directly connected to the VT TRANSCO Transmission System (Interconnection Party's transformers and/or breakers). Certified test reports shall be sealed by a registered Professional Engineer (P.E.). VT TRANSCO's personnel may require witnessing some or all of the tests, calibrations, and the relay setting applications. The final "as-built" documentation for the Interconnection Facilities, including all drawings and final "as left" relay settings, must be provided by the Interconnection Party to VT TRANSCO no later than thirty days after commercial operation commences.

VT TRANSCO requires that the Interconnection Party's facilities that are an integral part of the VT TRANSCO Transmission System, or may disrupt the VT TRANSCO Transmission System due to miss-operation or failure, must undergo a similar level of testing and checkout. The demonstration testing indicated above is employed to ensure that the Interconnection Party has completed the appropriate testing and checkout. Specific NERC regional requirements may apply and may be obtained from the Regional Entity by request.

The Interconnection Party must assign one qualified and proficient relay and controls person to be the main point of contact throughout the commissioning phase of the project. This person should have adequate field experience in relaying and control of high-voltage equipment as appropriate to the system they are working on. This person's experience should include polarity checks, phase-outs, relay calibration, and trip testing for multiple large projects. This person will also insure adherence to this Guide. The Interconnection Party must also provide qualified electricians, technicians, and operators to perform the demonstration testing. The Interconnection Party must supply all personal protective equipment and

designate any procedures necessary to assure that safety precautions are taken while working near energized equipment.

Inspection and approval by VT TRANSCO does not constitute a warranty or relieve the Interconnection Party of responsibility for the operating condition or installation of the equipment, and may not be relied upon by the Interconnection Party for that purpose. Once interconnected, VT TRANSCO will retain the right to inspect the Interconnection Facilities at VT TRANSCO's discretion.

### 3) Demonstration

The Interconnection Party and VT TRANSCO shall follow the following steps in assuring that the Interconnection Facilities have been adequately tested prior to energization and interconnection to the VT TRANSCO Transmission System.

#### 1. CONSTRUCTION TESTING DOCUMENTATION REVIEW

The Interconnection Party must complete field-testing of all their electrical equipment prior to energization. This includes physical testing of equipment such as transformers and circuit breakers in accordance with the manufacturers' recommendations. This testing also includes setting and testing of relays and control systems per the manufacturers' recommendations, as well as verifying VT TRANSCO approved relay settings. The extent of testing shall be consistent with the level of testing specified in the International Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET). These tests shall be completed prior to demonstration testing as outlined in the following paragraph. VT TRANSCO may witness some or all of these testing activities. VT TRANSCO will notify the Interconnection Party prior to the start of testing if witness testing is required. In some cases, review of test reports shall constitute sufficient demonstration that proper testing has been completed.

The Interconnection Party must submit reports for all tests performed for approval by VT TRANSCO. All revisions and changes found on field drawings shall be shown on the Interconnection Party drawing and copies provided to VT TRANSCO for approval by VT TRANSCO. A written record must be kept of all tests showing date, personnel performing test, signature or initial of person completing tests, equipment or material tested, results, and type of testing equipment used by manufacturer, model type, last certified calibration date, next certified calibration date and model serial number. The test sheets must show all equipment nameplate data (including for all bushings and surge arresters).

The Interconnection Party must download settings and programs from each relay and programmable logic controller after testing to retrieve all as-left-in-service settings, and shall copy these files onto a CD-ROM and provide to VT TRANSCO, or e-mail the files to VT TRANSCO. For non-microprocessor-based relays, test sheets or reports for each device are to be completely filled out. All relay setting sheets are to be checked against as-left settings on the corresponding relay device and signed as being complete by the responsible technical person. The CDs, test sheets, reports, and settings are to be labeled with equipment

identification numbers, relay type numbers, and relay device numbers and returned with the test reports to the VT TRANSCO commissioning engineer.

## 2. DEMONSTRATION TESTS

Demonstration tests must be employed to ensure that each of the required protection systems and protective devices operate correctly. These tests are used to verify that the Interconnection Party has completed testing as indicated in the preceding paragraph. These tests also verify synchronizing equipment and the proper operation of the VT TRANSCO – Interconnection Party interface protective relays. Upon performance and certification of the demonstration, the Interconnection Party will be granted approval for operation of their Transmission Facilities in parallel with the VT TRANSCO Transmission System. Unsuccessful demonstration may lead to delays in the Interconnection Party facility In-Service Date. VT TRANSCO and the Interconnection Party will develop an initial energization / interconnection procedure prior to the scheduled energization / interconnection date. If deemed necessary by VT TRANSCO, a meeting will be held on site within one week of the scheduled energization / interconnection date to discuss any particulars of the initial facility energization / interconnection.

The actual demonstration requirements will depend upon the final, approved AC/DC schematics, relay settings, etc. This demonstration is intended to be non-destructive. However, VT TRANSCO will not be liable for any equipment damage or injury resulting from the use of these guidelines. It is the responsibility of the Interconnection Party to demonstrate the operation of all protective devices in a safe manner and in a manner that does not adversely affect the Interconnection Party or any equipment on the VT TRANSCO Transmission System. VT TRANSCO recommends that similar tests be performed for the Interconnection Party's other relays to insure the adequacy of all protective relaying

## 3. POST IN-SERVICE TESTS

These tests are employed for verification of metering and relay connections under actual load conditions. This is commonly known as "load checking." These checks are completed by directly measuring actual operating quantities in differential, distance, and overcurrent relays. This also includes spot-checking of metering and SCADA systems. Post in-service tests may also include online tests of substation equipment including insulating oil tests of power transformers and infrared-thermography testing.

## 4) FUTURE CHANGES IN REQUIREMENTS

From time to time new requirements for testing, reporting, equipment and/or performance are established by NERC or Regional Entity for interconnections. The Interconnection Party should take steps so it is notified of any changes by the applicable entity. If an Interconnection Party fails to comply with these changes in requirements and VT TRANSCO is required to pay monetary penalties as a result of the Interconnection Party actions or inactions, then VT TRANSCO will bill the Interconnection Party for any monetary penalty resulting from the non-performance of the Interconnection Party.

## 5) PERFORMANCE OF TESTS

The Interconnection Party must test all wire, cable, electrical equipment, and systems installed by the Interconnection Party or connected by the Interconnection Party to assure proper installation, adjustment, setting, connection, and functioning. The Interconnection Party must inform VT TRANSCO of any equipment or system that fails testing or that is deficient in any matter. The extent of testing where modifications are made to existing circuits shall be sufficient to check the entire trip/control/CT/VT path as if it were new. VT TRANSCO will not be responsible for any damage to equipment or material due to Interconnection Party's inadequate, substandard, improper test procedures or test apparatus handling.

VT TRANSCO reserves the option to assign its personnel to assist the Interconnection Party in checking out certain control schemes where VT TRANSCO concludes such assistance is necessary to meet the project schedule. If VT TRANSCO should exercise this option, the Interconnection Party will be notified in advance of the extent of VT TRANSCO's involvement in assisting with the testing.

VT TRANSCO also reserves the right to shut down testing activities if, in VT TRANSCO's opinion or the opinion of VT TRANSCO's designated representative, the Interconnection Party is using unsafe practices or is in violation of applicable local, state, or federal safety regulations. VT TRANSCO requires compliance with the most conservative of the safety practices as provided by OSHA, NESC, or VT TRANSCO's safety practices whenever work is being performed in an energized facility.

## 6) TESTING EQUIPMENT

The Interconnection Party must provide all equipment necessary to perform the tests required by VT TRANSCO. A list of testing equipment shall be submitted to VT TRANSCO for approval prior to the beginning of the testing, including test instrument type (manufacturer, type, serial number) and associated calibration certifications. The equipment certification shall be renewed per manufacturer recommendation and shall be traceable to the National Bureau of Standards.

## 7) VT TRANSCO SUPPLIED EQUIPMENT

Any VT TRANSCO supplied equipment that is factory calibrated (transducers, pressure switches, tuners, etc.) shall be tested to verify calibration. The Interconnection Party may not modify calibration settings without authorization from VT TRANSCO. If equipment does not meet specifications, the Interconnection Party should notify VT TRANSCO of the problem immediately. VT TRANSCO will then direct the Interconnection Party on how to proceed. If the Interconnection Party modifies factory settings without authorization, VT TRANSCO will not be responsible for any costs associated with repair, replacement, or re-calibration of the Interconnection Party's Transmission Facilities.

## 8) FINAL DESIGN / AS-BUILT DOCUMENTS

The Interconnection Party must at the time of demonstration testing have a complete set of construction drawings and documentation available. These documents should represent a complete set of information showing exactly how the facility has been built and the logic behind how the control systems will operate. The documents shall include but are not limited to one-line diagrams, meter and relaying diagrams (M&R), AC and DC elementary diagrams (schematic drawings), circuit lists, Programmable Logic Controller (PLC) and relay logic, and any other appropriate or necessary information. VT TRANSCO shall be provided a duplicate copy of this documentation at least fifteen business days prior to demonstration testing. A coordination meeting with VT TRANSCO should be held to clarify any questions on documentation or testing requirements .

### **III. GENERATION**

This section addresses the technical requirements for connecting new generation to the VT TRANSCO transmission system or substantially modifying existing generating facilities connected to the VT TRANSCO transmission system. General overviews of functional requirements are described in this section. Detailed, project specific requirements will be developed as part of an Interconnection Feasibility Studies and other documents such as the NERC Planning Standards, the NERC Operating Standards, or the National Electrical Safety Code. The applicant will also require Vermont Public Service Board approval to interconnect.

The generator interconnection application needs to be made directly to the ISO-NE. ISO-NE will perform, or have performed the interconnection studies for the requesting generator.

#### **III. A. Applicability**

This section applies to all interconnections with the VT TRANSCO system made at 69 kV or greater where generation is installed behind the interconnection point and is capable of operating in continuous parallel with the VT TRANSCO transmission system. It also applies to incremental additions of generation intended to serve VT TRANSCO native load. VT TRANSCO generators, cogenerators, qualifying facilities, merchant plants, and non-utility generators are covered under this section. This section also covers utility-to-utility interconnections as specifically noted in Section III.

#### **III. B. Configuration**

Generating plants connected to the VT TRANSCO transmission system are designed to minimize the impacts of the maintenance or unplanned outages of a generator, line, transformer, circuit breaker or bus. The potential adverse effects of maintenance and equipment outages must be considered in the design of the generating plant and its connection to the VT TRANSCO transmission system.

Sudden outages of generation larger than 50 MW can cause voltage stability problems in the VT TRANSCO transmission system. Generating plants configured such that a single outage will disconnect more than 100 MW of gross generation may adversely impact the capabilities

of the VT TRANSCO system. In addition, regional and inter-regional studies would be needed to address related reliability issues. Generators larger than 1000 MW are presently considered to have substantial impact on the New England and NPCC regions and would likely require a large amount of very costly new and/or upgraded transmission infrastructure that could take five to ten years to implement in order to interconnect in a reliable manner; and, therefore, such expansion may be deemed infeasible.

### **III. C. Operations and Safety**

Operators of generating facilities must notify the VT TRANSCO System Operator and obtain approval before synchronizing the facility to or disconnecting the facility from the VT TRANSCO transmission system. Disconnection without prior approval is permitted only when necessary to prevent injury to personnel or damage to equipment. Generators must not energize a denenergized VT TRANSCO transmission circuit unless such actions are directed by the VT TRANSCO System Operator or are provided for in the interconnection agreement.

Each generating facility shall provide a point of contact to the VT TRANSCO System Operator. This contact person shall have the authority and capability to operate the facility according to the instructions of the VT TRANSCO System Operator to ensure that the reliability of the transmission system is maintained. A point of contact shall be reachable and available through telephone or other agreed upon means of communication at all times when the Facility is energized or in operation.

Generating facilities connected to the VT TRANSCO Transmission System must follow all applicable NPCC and NERC Operating Standards. A number of constrained transmission interfaces have been identified within the VT TRANSCO Transmission Systems. Power transactions may need to be curtailed when a threat to one of these interfaces is identified by the ISO-NE Security Coordinator. The maintenance of lines breakers and transformers at plant sites larger than 100 MW may require a reduction in the output level of the plant in order to maintain security of the VT TRANSCO transmission system.

In order to maintain the reliability of the VT TRANSCO transmission system and meet FERC requirements for posting of Available Transmission Capability (ATC), planned outages of plant and transmission equipment must be coordinated. Notification of preliminary plans for overhauls and maintenance outages of generators must be submitted to the VT TRANSCO generation coordinator by July 31<sup>st</sup> for the upcoming year's outages. The plans must specify the start date of the outage, the return to service date of the unit, and the generation capacity affected. For forced outages the length of time of the outage and the expected return to service date shall be reported as soon as the information is known. Changes in schedules either accelerating or delaying the forecasted return to service date of generation shall be reported as soon as they are known. Permission to synchronize to the interconnected system must be requested of VT TRANSCO system operator following any overhaul, unit trip or islanding.

When restoring interconnected generation facilities, it is VT TRANSCO's practice to energize in the direction from the VT TRANSCO system toward the de-energized generation facility,

except as designated for blackstart units. Synchronization of a generator to the energized VT TRANSCO system is accomplished within the generation facility using the appropriate synch breaker. The design at generation sites must consider the speed at which the VT TRANSCO transmission system is restored through auto-restoration following system faults. The generation facility owner must protect their generators from out of synch closures under such conditions. See LGIA..

### **III. D.           Islanding**

It is the responsibility of the electric power system owner to ensure safety and quality of service within its boundaries. VT TRANSCO ensures this through equipment design, operating procedures, protective relay settings and a variety of automatic and manual processes. Under an island condition, a portion of load becomes separated from the rest of the VT TRANSCO transmission systems and is served by a local area generation site. It is the responsibility of VT TRANSCO to ensure that even under an island condition, power quality is maintained to its customers. Therefore, VT TRANSCO does not allow generation to island with VT TRANSCO load where VT TRANSCO does not have control over the generator voltage, frequency, protective relays, and operating procedures. Thus, when an island situation occurs, the generation must be separated from the VT TRANSCO load except under temporary and controlled conditions. This ensures the quality of service and orderly restoration to VT TRANSCO customers. Without such provisions the resynchronization between two separated power systems becomes uncontrolled.

The tap connection of generators to the Vt Transco transmission system in which the capacitive susceptance (line charging) of the circuit is greater than the MVA rating of the generator is to be avoided. These types of connections may be subject to overvoltages and require special study.

### **III. E.           Generator Protection Requirements**

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 generators connected to the VT TRANSCO transmission system must be able to withstand certain temporary excursions in voltage, frequency, reactive and real power output without tripping. This is required to support the grid and avoid cascading events in the region.

Documentation of the generator protection and controls that could respond to these conditions by tripping the generator shall be provided to VT TRANSCO and the ISO-NE Master Local Control Center Heads Operating Committee. In the event the generating equipment owner

can not correct or mitigate these potential generator trip conditions, a request for a waiver may be made to the OC. A waiver may be justified in certain special circumstances such as low adverse reliability consequences from generator tripping.

Generating facilities must be designed to remain on line for normal clearing system faults within the close proximity to the plant switchyard. Voltage may approach zero at the switchyard bus for six cycles for some types of faults. Control systems, contactors, motors and auxiliary loads that might otherwise cause a generator trip if lost must not drop out under these conditions. Critical contactors must be provided with ride-through capability where required. Additionally, generator protection systems such as the Load Drop Anticipator, Early Valve Actuator or Power Load Unbalance should not be designed to trip a generator for normal clearing external faults or stable swings. See LGIA.

### **III. F. Support of the Grid**

1. All synchronous generators connected to the VT TRANSCO transmission system are to be equipped with automatic voltage regulators (AVR). Generators must operate with their excitation system in the automatic voltage control mode unless otherwise approved by the VT TRANSCO system operator. Generating equipment owners shall maintain a log which records the date, time, duration and reason for not being in the automatic voltage control mode when operating in parallel with the VT TRANSCO system. Generating equipment owners shall make this log available to VT TRANSCO on request. Appendix 2 has additional details for reporting of AVR status and voltage schedule deviations.
2. All synchronous generators connected to the VT TRANSCO transmission system must maintain a network voltage or reactive power output as specified by the VT TRANSCO system operator within the reactive power required in LGIA and SGIA. Generating equipment owners shall maintain a log which records the date, time, duration, and reason for not meeting the network voltage schedule or desired reactive power output when operating in parallel with the VT TRANSCO system. Generating equipment owners shall make this log available to VT TRANSCO on request.
3. The generator step-up and auxiliary transformer tap settings shall be coordinated with VT TRANSCO transmission systems voltage requirements. Generating equipment owners shall provide VT TRANSCO with generator step-up and auxiliary transformer tap settings and available ranges.
4. The AVR's control and limiting functions must coordinate with the generator's short time capabilities and protective relay settings. The generating equipment owner shall provide VT TRANSCO with the AVR's control and limiter settings as well as the protection settings which coordinate with AVR control and limiting functions.
5. Poorly damped power oscillations have occurred in the VT TRANSCO transmission systems and can be a major concern if not properly addressed. The installation of new generating plants has the potential to aggravate existing modes of oscillation or create new modes. All new synchronous generators connected to the VT TRANSCO transmission

system with a nameplate rating greater than 100 MVA shall be equipped with a power system stabilizer. Technical evaluations of oscillatory stability will be conducted for the interconnection of new generating plants. New generators that cause a decrease in the damping of an existing mode of oscillation or cause a poorly damped mode of oscillation will be required to operate with the power system stabilizer in service. The determination of the power system stabilizer's control settings will be coordinated with VT TRANSCO. Typically this coordination would be to provide VT TRANSCO with preliminary power system stabilizer settings prior to the stabilizer's field commissioning tests with the final settings provided after the field commissioning tests.

Where stabilizing equipment is installed on generating equipment for the purpose of maintaining generator or transmission system stability, the generating equipment owner is responsible for maintaining the stabilizing equipment in good working order and promptly reporting to the VT TRANSCO System Operator any problems interfering with its proper operation.

6. All new synchronous generators connected to the VT TRANSCO transmission system with a nameplate rating greater than 20 MVA shall be equipped with a speed/load governing control that has a speed droop characteristic in the 3 to 6% range. The preferred droop characteristic setting is 5% as this is the typical setting for generators in the region. Notification of changes in the status of the speed/load governing controls must be provided to the VT TRANSCO System Operator as detailed in Appendix 1. See LGIA.
7. Some generators may choose to provide reactive power control to achieve the required reactive power levels. This is not a requirement but recommended as an option.

### **III. G. Generator Testing**

1. Prior to commercial operation, the generating equipment owner shall provide VT TRANSCO with open circuit, step-in voltage test results. Recording of generator terminal voltage and field voltages shall be clearly labeled so that initial and final values can be identified in physical units.
2. Generating equipment owners shall annually test the gross and net dependable summer and winter capability of their units. These test results shall be provided to VT TRANSCO.
3. Generating equipment owners shall test the gross and net reactive capability of their units at least every five years. These test results shall be provided to VT TRANSCO.

Generating equipment owners shall test the AVR control and limit functions of their units at least every five years. An initial test result shall be provided to VT TRANSCO prior to commercial operation and every five years thereafter. The initial test results shall include documentation of the settings AVR control and limit functions. Typical AVR limit functions are; maximum and minimum excitation limiters and volts per hertz limiters. Documentation of the generator protection that coordinates with these limit functions shall also be provided. Typical generator protection of this type includes overexcitation protection, loss of field protection. See LGIA.

### **III. H. Power Factor**

See LGIA.

### **III. I. Interrupting Ratings**

AC high voltage circuit breakers are specified by operating voltage, continuous current, interrupting current, and operating time in accordance with ANSI/IEEE Standards C37 series, "Symmetrical Current Basis." These ratings are displayed on the individual Circuit Breaker nameplate. Breakers are scheduled for replacement when they exceed 100% of ANSI C37 Guidelines.

There may be cases where adding generation will increase the available fault current above the present interrupting ratings of the existing breakers at a substation or stations. When this occurs, breaker upgrades are to be considered as part of the interconnection project. Similarly, the connection of new generators to the transmission system may increase fault current to a level which exceeds the short time rating of overhead ground wires. The rating of overhead ground wires is discussed further in VT TRANSCO's Transmission Facility Rating Methodology document. If equipment ratings will be exceeded, the appropriate modifications must be performed prior to the new generation coming on line.

### **III. J Source System Grounding**

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 overvoltages 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  $X_0/X_1 \leq 3$  and  $R_0/X_1 \leq 1$ . Interconnected generators should provide for effective system grounding of the high side transmission equipment by means of a grounded high voltage transformer.

An alternative design only for sites with less than 10 MVA is available in some limited cases but requires a special Electromagnetic Transients Program (EMTP) system study to determine applicability. Under this non-preferred option the system is not grounded at the source. However, the transmission system equipment insulation level in the area must be rated to withstand the amplitude and duration of all overvoltages caused by neutral displacement. Also the source must be removed rapidly when any overvoltage condition occurs. This includes isolation of the ungrounded source for system faults simultaneously with other relaying systems within the protected zone. Since the source provides no ground fault current, relay protection devices must operate for zero current. Some switching operations may cause the loss of all remote ground sources by islanding a part of the system even under non-fault conditions. The protection scheme must also be able to quickly remove the generation under this situation before any adverse effects occur. Some form of communication with remote transmission stations is usually required in order to accomplish this.

### **III. K Generator Telemetry**

All generating plants connected to the VT TRANSCO transmission system must provide real time telemetered data for individual generators to the VT TRANSCO system control center. The required data includes generator MW, MVAR, terminal voltage and switchyard high side voltages. MW and MVAR data should be Net output values as measured at the low side of the generator step up transformer less any auxiliary load directly fed from the generator. These generator output quantities shall be telemetered at a two second scan rate. In addition, the status of individual generator circuit breakers and the status of the generators' automatic voltage regulator must be made available to the VT TRANSCO control center.

Individual generator output data values may be aggregated when the generator is rated less than 20 MVA. Other metering requirements are addressed in section I.O. See LGIA.

## **IV TRANSMISSION**

This section addresses the technical requirements for connecting new transmission lines to the VT TRANSCO transmission system as well as for new and existing delivery points. The VT TRANSCO planning process is designed to ensure that VT TRANSCO's transmission system will have sufficient capability for VT TRANSCO to meet the expected loads at distribution substations/delivery points, and to fulfill VT TRANSCO's contractual obligations with other entities to receive and deliver power. A utility/customer may elect to connect to VT TRANSCO through a "delivery point" connection or an "interconnection point" connection.

A "delivery point" is a point of connection between VT TRANSCO's transmission system and another entity's system or facilities which ultimately delivers the power to individual customers' loads. Two characteristics may be generally used to distinguish delivery points from interconnections: i) the protective schemes of the integrated transmission system are designed to either entirely or partially suspend service to a delivery point by disconnecting a transmission facility that serves such delivery point from the transmission system; ii) power normally flows only in one direction across the delivery point (i.e., from the transmission system to the delivery point), and thus the protective schemes at the delivery point may be designed taking into account this characteristic.

An "interconnection point", in contrast, is a point of connection between two entities' respective transmission systems. Interconnection points are normally operated in parallel with the transmission systems such that it is possible for power to flow in either direction. Protection systems for interconnection points are designed to prevent and/or minimize the possibility of an event within one of the systems affecting or cascading into the other system.

### **IV. A. Applicability**

This section applies to all interconnections with the VT TRANSCO system made at 69 kV or greater. This includes utility-to-utility (entity) type interconnections used for power interchanges as well as delivery point type connections used to deliver power to end users. Subsections C through J apply mainly to transmission interconnections. Subsections K through Q apply to delivery point connections. Detailed, project specific requirements will be

developed as part of a System Impact Study, a Facilities Study or are referenced in other documents such as the NERC Planning Standards or the National Electrical Safety Code.

#### **IV. B. Configuration**

The interconnection point between utilities is typically through a transmission line or lines. The change of ownership is usually at a transmission line structure. The neighboring utility must have an effectively grounded transmission system. Three terminal lines are to be avoided for interconnections due to problems discussed in Section I.

#### **IV. C. Operations and Safety**

Interconnections between VT TRANSCO's transmission system and other transmission systems are normally operated in parallel unless otherwise agreed. However, if any operating condition or circumstance creates an undue burden on the VT TRANSCO Transmission System, VT TRANSCO shall have the right to open the interconnection(s) to relieve its system of the burden imposed upon it. Prior notice will be given to the extent practical. Each party shall maintain its system and facilities so as to avoid or minimize the likelihood of disturbances that might impair or interrupt service to the customers of the other party.

The VT TRANSCO System Operator shall be notified prior to any maintenance work on a transmission interconnection. VT TRANSCO switching and safety procedures shall be strictly adhered to when maintenance is being performed on an interconnection.

#### **IV. D. Metering**

Metering equipment may be located at either end of the transmission line but should be installed at the station closest to the change of ownership.

If the neighboring utility is within and under the VT TRANSCO control area, VT TRANSCO is to own, operate and maintain the metering installation equipment, including the instrument transformers, secondary conductors, cables, meters and transducers. If the interconnection facilities are owned by the neighboring utility, and that utility does not own the instrument transformers or meters, a structure and a location for mounting metering transformers and recording devices is to be provided by the facility owner. The neighboring utility may not connect additional devices such as relays or meters directly to potential or current transformer secondaries used for revenue metering.

#### **IV. E. Protection**

The relay protection criteria under Section I is to be adhered to for utility-to-utility interconnections. When tap load stations are connected to the transmission line, special consideration must be applied. (See section IV.H.)

When ground distance relaying is used on short lines, the quadrilateral characteristic is to be used to provide adequate coverage for fault resistance.

Directional ground overcurrent should be avoided on lines that have considerable mutual coupling with other circuits. Directional ground overcurrent relays can also cause false operation on circuits with distribution tap load stations due to switch pole asynchronism.

#### **IV. F. Separations**

The separation from the Vt Transco systems is not desirable and the interconnecting generator may need to install special relaying or transfer trip equipment depending on the separation scenarios.

#### **IV. G. Transmission Reclosing**

Automatic reclosing on interconnected transmission lines between utilities is handled on a case- by-case basis. Transmission interconnections between utilities may be restored from either direction depending upon a reclosing practice agreed to by the utilities involved

#### **IV. H. Reactive Power Control**

Entities interconnecting their transmission system with VT TRANSCO's transmission system shall endeavor to supply the reactive power required on their own system, except as otherwise mutually agreed. VT TRANSCO shall not be obligated to supply or absorb reactive power for the other party when it interferes with operation of the VT TRANSCO transmission system, limits the use of VT TRANSCO interconnections, or requires the use of generating equipment that would not otherwise be required.

For post contingency protection, VT TRANSCO prefers to operate the VT TRANSCO transmission system at approximately 1.01 PU voltages. In order to achieve an ideal reactive power interface with the connecting transmission system they shall also regulate their voltage to approximately 1.01 PU.

The interconnecting transmission utility shall not be allowed to put any undue power factor requirements on VT TRANSCO in accordance with ISO-NE Operating Procedure #17 requirements for Load Power Factor.

#### **IV. I. Delivery Point Demand**

Transmission interconnections need to be studied at length to determine the effect on the integrated transmission network. As such, a requesting interconnecting transmission companies shall provide VT TRANSCO with the interconnecting Voltage level, the forecasted MW and MVAR demand, and forecasted generation patterns expected. This will ensure that VELCO can study the transmission interconnection adhering with all local and regional Reliability Planning standards.

#### **IV. J. Unbalance Phases**

Unbalance currents and voltage are to be controlled by each party on their respective side of the interconnection. However, it should be realized that switching devices, such as breakers and switches, are three phase devices and can fail with only one or two poles closed. It is the responsibility of the facility owner to protect their own equipment such as generators or transformers from damaging negative sequence currents or voltage.

#### **V. DELIVERY POINT (END-USER)**

##### **V. A. Delivery Point (End-User) Power Factor**

The Vt Transco transmission systems can, under some circumstances, be subject to voltage instability and collapse. An essential element in the reliability of the VT TRANSCO transmission system is the installation of power factor correction capacitor banks that compensate for the reactive power demands of customer loads. VT TRANSCO designs and operates its load connections so that the load power factor measured at the point where the load connection exits the VT TRANSCO integrated transmission system is between 95% lagging and 99% leading during summer peak load conditions. In order to avoid transmission system overvoltages, load power factor compensation is controlled so that the load power factor measured at the point where the load connection exits the VT TRANSCO integrated transmission system is unity or lagging during spring load conditions. Delivery point connections to the VT TRANSCO transmission system shall meet the power factor requirements listed above.

In order to assess power factor, the delivery point real (kW) and reactive demands (kVar) shall be recorded at the time of VT TRANSCO's transmission system summer peak load (June, July, or August) and at the minimum spring load (March, April, or May). For compliance assessment purposes, VT TRANSCO and the customer can aggregate delivery points that are in close electrical/geographical proximity (by summing kW and kVar values). ISO-NE Operating Procedure #17 (Load Power Factor Correction) will be

VT TRANSCO experiences high loads in the summer and winter periods. Load serving entities should cooperate to the extent feasible with requests from the VT TRANSCO System Operator to help support system voltage and frequency.

##### **V. B. Delivery Point (End-User) Power Quality**

Generation of harmonics should be limited to values prescribed by IEEE Standard 519 when measured at the interconnection point of ownership. Additionally, the VT TRANSCO transmission system should not be subjected to harmonic currents in excess of 5% of a transformer's rated current as stated in ANSI/IEEE Standard C57.12.00. Harmonic contents shall all be in accordance with IEEE 519 (Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems).

#### **V. C. Delivery Point (End-User) Metering**

VT TRANSCO is to own, operate and maintain the metering installation equipment, including the instrument transformers, secondary conductors, cables, meters and transducers. If the interconnection facilities are owned by the end user, and that party does not own the instrument transformers or meters, then a structure and a location for mounting metering transformers and recording devices are to be provided by the facility owner. End user devices are not to be connected directly to potential or current transformer secondaries used for revenue metering.

#### **V. D. Delivery Point (End-User) Auto-Restoration**

End user facilities are energized in the direction from VT TRANSCO to the load. Owners of interconnected load facilities are to be aware of VT TRANSCO's automatic reclosing practices as stated in Section I. VT TRANSCO's standard high speed reclosing, 0.25 seconds after fault clearing, should be taken into account by end users with sensitive control systems or large motors. Ride-through capability and heavy motor inrush currents should be assessed in the design stages of the facility.

#### **V. E. Delivery Point (End-User) Load Shedding Programs**

Entities responsible for load serving delivery points shall implement and maintain an underfrequency load shedding program designed and coordinated with VT TRANSCO and NPCC. VT TRANSCO has installed automatic emergency load shedding schemes at several locations in the VT TRANSCO transmission system to minimize the potential for instability following severe contingencies. VT TRANSCO has the right to require entities responsible for load serving delivery points to implement an emergency load shedding program to the extent that such a program is required and utilized by VT TRANSCO to assure transmission integrity under adverse conditions. The amount of load to be interrupted by emergency load shedding programs will be distributed comparably among VT TRANSCO's and other entities' customers in the applicable region.

#### **V. F. Delivery Point (End-User) Generation**

Delivery point connections usually do not have generating facilities that operate in parallel with the VT TRANSCO transmission system. Customers wishing to install generating facilities to be operated in parallel with VT TRANSCO must notify VT TRANSCO in writing prior to the commencement of any work. The technical requirement for the connection of generation outlined in Section II of this document must be followed. No generation shall be operated in parallel with the VT TRANSCO transmission system without prior written approval of VT TRANSCO.

#### **V. G. Delivery Point (End-User) Parallel Operation**

The distribution and transmission facilities behind the designated delivery point with VT TRANSCO's transmission system shall be operated as a radial system only. Operation in a

mode which would tie two or more delivery points together in a manner which would cause the system behind the delivery points to be operated as a parallel network to the VT TRANSCO transmission system is prohibited without the express written permission of VT TRANSCO. The installation of such protective equipment may be required by VT TRANSCO to ensure that parallel operation is automatically interrupted within the time frame allowed by VT TRANSCO's standard.

**V. H. Delivery Point (End-User) Protection**

When tap load Delivery Point (End-User) stations are connected to the transmission line, special consideration must be applied. Permissive overreaching transfer trip (POTT) type schemes are not to be used without communications from all distribution tap substations. This is required to ensure high-speed fault clearing when the line is open at a tap station between the transmission terminals.

**V. I. Delivery Point (End-User) Demand**

The Voltage level, MW, MVAR, and the forecasted demand expectations should be provided to VT TRANSCO to ensure adherence with the regional Reliability Planning standards.

**V. J. Delivery Point (End-User) Operational Issues**

VT TRANSCO, as the Transmission Operator for Vermont, has the overall operational authority for ensuring reliability for Vermont and its effects on the interconnected transmission grid. As such, if Operational issues warrant, VELCO may, under certain circumstances take action to ensuring reliability of the transmission grid. Such actions may include manual load shedding of firm load. ISO-NE Operating Procedure #7 can be provided upon request for determination of actions in an emergency for low voltage and frequency excursions.

Revision History

0	090406	Original Document
1	100901	Added to Section II. B, expanded inspection/Testing section II.W and updated Appendix accordingly

# **Appendix 1**

## **Procedures for Notification of Generating Plant Operational Data and Control Status**

### **Introduction**

An essential part of operating a transmission system reliably is the coordination of reactive power sources to maintain an adequate transmission voltage profile both for normal and contingency conditions. Reactive sources must be distributed throughout electric systems due to the large voltage drops associated with transmission of reactive power. Operators of transmission systems follow voltage control strategies to minimize the risk of exceeding equipment voltage limitations and the transmission grid's voltage stability limitations. Generators operating in parallel with the transmission system must operate with the automatic voltage regulator (AVR) on and follow the established voltage schedule for the voltage control strategy to be effective.

Owners of generators connected to the VT TRANSCO transmission system must coordinate with Transmission Operations to optimize generating plant transformer tap settings. By carefully selecting transformer tap ratios, it is possible to optimize generating plant voltages and reactive capabilities for the expected range of transmission voltages.

VT TRANSCO has established these information and notification procedures to facilitate the coordination of reactive power and to comply with the NERC Planning Standards.

### **Requirements**

1. Notification of AVR status - All synchronous generators with MVA ratings larger than 20.0 MVA connected to the VT TRANSCO transmission system shall operate with the generator's AVR on and in the voltage control mode to the extent practicable. The operator of the synchronous generator must contact the VT TRANSCO System Operator when it becomes necessary to operate with the AVR off for more than 30 minutes and state the reason for operating with the AVR off. In addition to verbal notification of the reason for operating with the AVR off, the AVR status should also be automatically telemetered to the VT TRANSCO control center.

Owners of generating equipment are responsible for maintaining records that a) provide a summary of the number of hours per month each generator was not in the automatic voltage control mode while operating in parallel with the VT TRANSCO transmission system and b) provide the date, duration, and reason for each period of occurrence. These records must be available for the preceding 12 months and must be provided within five business days of request.

2. Notification of Deviation from Voltage Schedule - All synchronous generators connected to the VT TRANSCO transmission system with ratings larger than 20.0 MVA shall maintain a voltage schedule at the point of interconnection as prescribed by the System

Operator to the extent allowed by the capabilities and limitations of the generating plant equipment.

Typical voltage schedules for generating plants are listed below.

Switchyard <u>Nominal Voltage</u>	10am-10pm <u>Scheduled Voltage</u>	10pm-10am <u>Scheduled Voltage</u>
115 kV	117.0 kV	115 kV
230 kV	240.0 kV	235 kV
345 kV	358.0 kV	354 kV

The VT TRANSCO System Operator or designated agents will advise generating plant operators of the current voltage schedule. This voltage schedule may change on an hourly basis depending on conditions in the power system.

The operator of the synchronous generator must contact the VT TRANSCO System Operator when the generator cannot maintain the voltage at the point of interconnection as prescribed by the VT TRANSCO System Operator for more than 30 minutes. The operator of the synchronous generator shall state the reason for deviating from the voltage schedule and provide the VT TRANSCO System Operator with the generator’s reactive limitations that exist at that time. Owners of generating equipment are responsible for maintaining records that a) provide a summary of the number of hours per month each generator was not following the voltage schedule as prescribed by the System Operator and b) provide the date, duration, and reason for each period of occurrence. These records must be available for the preceding 12 months and must be provided within five business days of a request.

3. Notification of Plant Capabilities - Prior to commercial operation, the generating equipment owner shall notify the VT TRANSCO System Operator of the expected generator capabilities as listed below.

<b>Generator</b>	<b>Summer Continuous Generator Gross Capabilities</b>		
	<b>MW</b>	<b>Lagging MVAR</b>	<b>Leading MVAR</b>
_____	_____	_____	_____
<b>Generator</b>	<b>Winter Continuous Generator Gross Capabilities</b>		
	<b>MW</b>	<b>Lagging MVAR</b>	<b>Leading MVAR</b>
_____	_____	_____	_____
<b>Total Plant Auxiliary Power Usage</b>	<b>MW</b>	<b>MVAR</b>	
	_____	_____	_____
<b>Summer</b>	_____	_____	_____
<b>Winter</b>	_____	_____	_____

Updated information based on actual test results shall be provided to the VT TRANSCO System Operator as it becomes available.

4. Notification of Turbine Governor Status - Owners of synchronous generators with ratings larger than 20.0 MVA connected to the VT TRANSCO transmission system shall notify the VT TRANSCO System Operator of changes in the status of the speed/load governing controls for the turbine. The VT TRANSCO System Operator shall be made aware of nonfunctioning, partially functioning or blocked governor controls when these conditions are expected to persist for five days or more.
5. Notification of Available Transformer Ratios and Changes in Transformer Data – Owners of synchronous generators with ratings larger than 20.0 MVA connected to the VT TRANSCO transmission system shall provide the VT TRANSCO System Operator with the transformer data. Updated information shall be provided when transformer changes are made. In the event that operating experience indicates that transformer ratio changes are desirable, VT TRANSCO will provide the generating equipment owner with a detailed study that documents the technical justification for making a transformer tap change. VT TRANSCO’s practice has been to select transformer ratios that will be acceptable for both Summer high load conditions and Spring/Fall light load conditions so that seasonal adjustments are not necessary. As required by the NERC Planning Standards, the generating equipment owners are expected to make these transformer tap changes during the next scheduled maintenance period.
6. Notification of Generator AVR Control and Protection Settings – Most synchronous generator AVRs are equipped with limiting controls that help protect the generator while also allowing the generator to support the grid during temporary excursions in transmission voltage. These limiting controls must be properly coordinated with generator protection and with the generator’s short term voltage/reactive capabilities. Two common examples of these controls are the maximum excitation limiter (coordinates with overexcitation protection) and the minimum excitation limiter (coordinates with the loss of field relay).

Prior to commercial operation, the owner of a synchronous generator with a rating larger than 20 MVA shall provide the VT TRANSCO System Operator with documentation that describes the functional operation and settings for the AVR’s control functions. This documentation shall demonstrate the AVR’s controls are coordinated with the generator protection and with the generator’s short term capabilities. In cases where the AVR has been set to regulate a voltage other than the generator’s terminal voltage or it has been set to regulate a compensated terminal voltage, sufficient data shall be provided to allow the AVR to be modeled accurately.

7. Provision of Generator Test Data – One of the standard generator commissioning tests is to introduce a step change in the AVR’s reference voltage with the generator running at synchronous speed but not connected to the transmission system. This is referred to the open circuit, step in voltage test and is used to confirm the AVR is functioning properly.

Prior to commercial operation, the owner of a synchronous generator with a rating larger than 20 MVA shall provide the VT TRANSCO System Operator with open circuit, step in voltage test results. Recordings of the generator terminal voltage and generator field voltage magnitudes must be provided together with any calibration data necessary to equate the recordings with actual voltages. In situations where it is impractical to measure the generator field voltage (e.g. brushless excitation systems) alternate quantities with equivalent response characteristics can be provided. An estimate of the generator's field winding temperature during this test must be provided.

## Appendix 2

### Matrix for Compliance with NERC standard FAC-001

NERC Standard FAC-001 after 4/6/09

<b>NERC FAC-001 Requirement</b>	<b>Generation Facilities</b>	<b>Transmission Facilities</b>	<b>End User Facilities</b>
<b>R1</b>	FCR	FCR	FCR
<b>R1.1</b>	FCR Section III	N/A	N/A
<b>R1.2</b>	N/A	FCR Section IV	N/A
<b>R1.3</b>	N/A	N/A	FCR Section V
<b>R2.1.1</b>	FCR II.B Process and flowchart	FCR II.B Process and flowchart	FCR II.B Process and flowchart
<b>R2.1.2</b>	FCR Process flowchart	FCR Process flowchart	FCR Process flowchart
<b>R2.1.3</b>	FCR Appendix 1 Sec 3	FCR Section IV.I	FCR Section V.I
<b>R2.1.4</b>	FCR Section II.N	FCR Section II.N	FCR Section II.N
<b>R2.1.5</b>	FCR Section II.P	FCR Section II.P	FCR Section II.P
<b>R2.1.6</b>	FCR Section II.R	FCR Section II.R	FCR Section II.R
<b>R2.1.7</b>	FCR Section II.D and II.K	FCR Section II.D and II.K	FCR Section II.D and II.K
<b>R2.1.8</b>	FCR Section II.L	FCR Section II.L	FCR Section II.L
<b>R2.1.9</b>	FCR Section III.F.1, .2, .7	FCR Section IV.H	FCR Section V.A
<b>R2.1.10</b>	FCR Section III.D	FCR Intro	FCR Section V.B
<b>R2.1.11</b>	FCR Section II.N	FCR Section II.N	FCR Section II.N
<b>R2.1.12</b>	FCR Section II.Q and Section III.C	FCR Section II.Q	FCR Section II.Q
<b>R2.1.13</b>	FCR Section II.H	FCR Section II.H	FCR Section II.H
<b>R2.1.14</b>	FCR Section III.C	FCR Section IV.C	FCR Section V.J
<b>R2.1.15</b>	FCR Section II.C and W	FCR Section II.C and W	FCR Section II.C and W
<b>R2.1.16</b>	FCR Section II.V	FCR Section II.V	FCR Section II.V
<b>R3</b>			

NERC Standard FAC-001 before 4/6/09

<b>NERC FAC-001 Requirement</b>	<b>Generation Facilities</b>	<b>Transmission Facilities</b>	<b>End User Facilities</b>
<b>R1</b>	Substation Design Criteria Section 2	Substation Design Criteria Section 2	Substation Design Criteria Section 2
<b>R1.1</b>	ISO-NE PP5-3, Attachment 2 and Section 3.1.2	N/A	N/A
<b>R1.2</b>	N/A	ISO-NE PP5-3, Attachment 2	N/A
<b>R1.3</b>	N/A	N/A	ISO-NE PP5-3, Attachment 2
<b>R2.1.1</b>	ISO-NE PP5-3, Attachment 2 and Section 3.1.2	ISO-NE PP5-3, Attachment 2 and Section 3.1.2	ISO-NE PP5-3, Attachment 2 and Section 3.1.2
<b>R2.1.2</b>	ISO-NE PP5-3,3.3.2	ISO-NE PP5-3,3.3.2	ISO-NE PP5-3,3.3.2
<b>R2.1.3</b>	Substation design criteria table 2.2/1-1	N/A	Substation design criteria table 2.2/1-1
<b>R2.1.4</b>	Substation design criteria 2.2.2 Section A.2	Substation design criteria 2.2.2 Section A.2	Substation design criteria 2.2.2 Section A.2
<b>R2.1.5</b>	Substation design criteria 4.3, 4.5, 4.6, 4.7, 4.8	Substation design criteria 4.4	Substation design criteria 4.3, 4.5, 4.6, 4.7, 4.8
<b>R2.1.6</b>	Substation design criteria Section 4.22 & 4.6	Substation design criteria Section 4.22 & 4.6	Substation design criteria Section 4.22 & 4.6

<b>R2.1.7</b>	Substation design criteria Section 2.2.8 A,B,C	Substation design criteria Section 2.2.8 A,B,C	Substation design criteria Section 2.2.8 A,B,C
<b>R2.1.8</b>	Substation design criteria Section 2.2.8 C	Substation design criteria Section 2.2.8 C	Substation design criteria Section 2.2.8 C
<b>R2.1.9</b>	ISO OP 17 Section 2, & Substation design criteria Section 2.2.1	ISO OP 17 Section 2, & Substation design criteria Section 2.2.1	ISO OP 17 Section 2, & Substation design criteria Section 2.2.1
<b>R2.1.10</b>			
<b>R2.1.11</b>	Substation design criteria 2.2.2 Section A, A.1, & D	Substation design criteria 2.2.2 Section A, A.1, & D	Substation design criteria 2.2.2 Section A, A.1, & D
<b>R2.1.12</b>	Substation design criteria 4.17	Substation design criteria 4.17	Substation design criteria 4.17
<b>R2.1.13</b>	VELCO OP3 Section 1	VELCO OP3 Section 1	VELCO OP3 Section 1
<b>R2.1.14</b>	VELCO OP7 Section II & IV	VELCO OP7 Section II & IV	VELCO OP7 Section II & IV
<b>R2.1.15</b>	ISO OP 3 Appendix B Section V	ISO OP 3 Appendix B Section V	ISO OP 3 Appendix B Section V
<b>R2.1.16</b>	VELCO OP 7 and 19	VELCO OP 7 and 19	VELCO OP 7 and 19
<b>R3</b>			