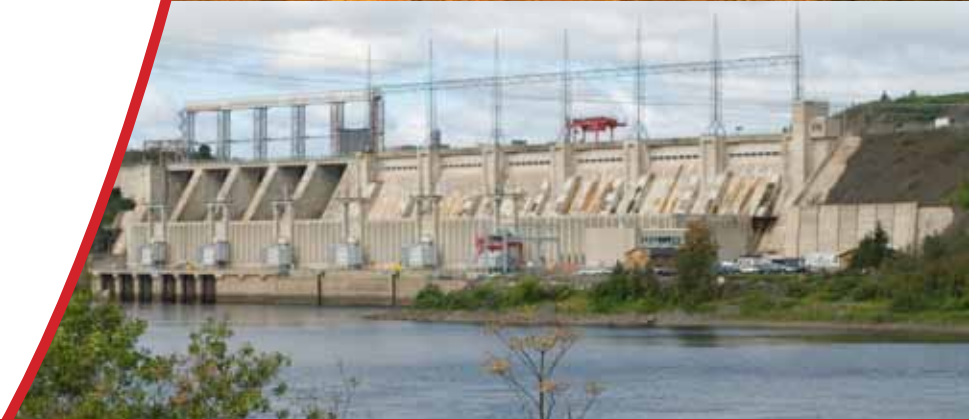
Énergie NB Power

New Brunswick Power Transmission Corporation Facility Connection Guide



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PREFACE

The Facility Connection Guide has been developed to identify the processes and general technical requirements for connecting to the New Brunswick Power transmission system.

All facilities involved in the generation, transmission and use of electricity will be properly connected to the interconnected power systems to maintain the reliability of the electric systems to which they are connected.

APPROVAL

This document was produced and reviewed by the Transmission Operations Engineering Department.

Senior Power System Engineer	APPROVED Signature	May 2011 Date
Executive Director, Transmission	APPROVED Signature	May 2011 Date

TABLE OF CONTENTS

DEFINITIONS

Generation Connection Agreement is the Connection Agreement between a Transmitter and a Generation Customer, including all schedules attached.

Connection Agreement is the Agreement between NB Power Transmission and a Load Customer, a Generator Customer or another Transmitter. Generation Connection Agreements and Network Operating Agreements are examples of Connection Agreements.

SO-Controlled Grid is the transmission systems with respect to which, pursuant to Operating Agreements, the System Operator (SO) has authority to direct operations.

Network Operating Agreement is an executed agreement that contains the terms and conditions under which the Network Customer shall operate its facilities and the technical and operational matters associated with the implementation of Network Integration Transmission Service under Part III of the Open Access Transmission Tariff.

New Brunswick Power Transmission is the entity that owns and operates NB Power transmission facilities.

North American Electric Reliability Corporation (NERC)

Northeast Power Coordinating Council (NPCC)

Open Access Transmission Tariff (OATT)

Reliability is the degree of performance of a zone, a transmission system, the SO-controlled grid or the integrated electricity system that results in electricity being delivered within accepted standards in an adequate and secure manner and in the amount desired

Transmitter is an entity (or its designated agent) that owns or operates transmission facilities that are a part of the transmission system.

1.0 INTRODUCTION

The intent of this document is to generally explain the connection requirements and processes for a customer to connect to, or significantly modify its existing connection to, NB Power's transmission system. A customer may be a load, a generator or an interconnected transmission utility and may be an existing customer or a prospective customer looking to make a new connection. This document also references the existing documents and processes that are expected to be used in the connection review and final implementation process.

1.1 Purpose

The purpose of facility connection requirements is to ensure that any changes made to the transmission system are done so in a safe, reliable and cost effective manner. Any customer connecting to NB Power's transmission system will do so in such a way that transmission reliability is maintained both initially as well as throughout the duration of the customer's connection.

1.2 Application of this Guide

This document is a guide and as such, is not intended to be used as the sole basis for the specific design of and connection with the transmission system. Because each connection is unique, these requirements may be changed or additional requirements may be added as required based upon the results of engineering facility and system impact studies. Final design will be subject to a review and approval by New Brunswick Power Transmission Corporation (NB Power Transmission) on a case-by-case basis.

NB Power Transmission can assist the customer through the review and connection process, once a customer has expressed a desire to connect or modify a facility connection to the electrical system.

This guide also explains the general process a reliability impact assessment of the customer connection as well as the process of developing a connection agreement with the specific requirements. The general facility connection requirements are listed based upon the connection type:

Generation	Section 3.0
Transmission	Section 4.0
End-user (load) Facility	Section 5.0

2.0 PLANNING PROCESSES

The process for connection assessments for new and modified facilities is described in the New Brunswick System Operator (NBSO) Market Rules, Chapter 8 “Connection of New and Modified Facilities”, and associated draft Market Procedure MP-21, “Connection Assessments”. This connection assessment process is used for generation, end-user and interconnected transmission facilities.

From Chapter 8 “Connection of New and Modified Facilities”, any person requesting to connect any new or modified facility to NB Power’s transmission system must have NBSO approval and must have a connection agreement with NB Power Transmission.

The processes around the review and development of the connection agreement with NB Power Transmission requires involvement from transmission personnel throughout the engineering review and assessment stages as well as initial testing and continued operations.

In addition to the NBSO Market Rules, the New Brunswick Open Access Transmission Tariff (OATT) requires NB Power Transmission to perform engineering studies and approval of the generation customer design.

2.1 Reliability Assessment of New or Modified Facilities

With any change in the transmission system, a reliability review is required. This review is expected to be a joint study between the NBSO and NB Power Transmission. As the Independent System Operator and Planning Coordinator, NBSO is responsible for ensuring reliability of the interconnected transmission system. NB Power Transmission, as the Transmission Planner and Transmission Owner/Operator, will ensure the well being of its transmission equipment and reliable customer service. The following provides a summary of the review requirements (taken in part from draft Market Procedure MP-21, “Connection Assessments”):

- **Feasibility Review**
  The feasibility review is a high level review and provides an opportunity for early identification of:

  ⇒ Any problems with the customer proposed facility design;
  ⇒ All grid-related information needed by the connection applicant to design the facility connection;
  ⇒ All information required to complete the system impact study, and
  ⇒ Any likely non-standard design requirements for the new or modified facility.

- **System Impact Study, Part 1 - Local Impact Assessment**
  Local impact assessment comprises the assessment of the connection proposal’s impact on local load flows, fault levels etc, in order to determine if the new or modified facility connection is designed to the necessary standards and if its implementation would require modification of other local connections.

- **System Impact Study, Part 2- Network Impact Assessment**
  Network impact assessment comprises the assessment of the SO-controlled grid to determine:
  ⇒ if the connection proposal could be accommodated without reducing bulk transfer limits on the grid, and
  ⇒ if consequential load flows would add to grid congestion, and if so, what operating constraints or grid enhancement would mitigate this impact. This may result in a number of options.

- **Facilities Study**
  Facilities study comprises the design and estimation of cost and time requirements of those measures necessary to mitigate negative impacts identified in local impact assessment or network impact assessment in order to accommodate the facility connection. Facilities study includes estimated costs and their allocation.

2.2 Transmitter Review and Approval

As per the Open Access Transmission Tariff (OATT), the process of initiating and developing a Generation Connection Agreement includes an engineering review and approval of the new generation facility as well as the conditions for continued operation. NB Power Transmission also applies this process to interconnected transmitter and end-use facilities to ensure the well being of its transmission equipment and reliable customer service. It is also anticipated that these NB Power Transmission engineering studies would be incorporated into NBSO's reliability assessment.

The following provides the engineering review requirements as well as the overall process associated with the Connection Agreement (taken in part from OATT Attachment J "Generation Connection Agreements"). The following will be applied to generation, transmission and end-use customer facility connections.

To facilitate the connection process, the customer should contact NB Power Transmission early on in the design stages of the proposed installation. NB Power Transmission will review system parameters in relation to the proposed point of connection to determine if any necessary changes to the system are required in order to accept the connection. NB Power Transmission will verify that the facility's design meets its connection requirements and will conduct a functional test of the facility's system before the facility will be allowed to commence interconnected operation. NB Power Transmission will provide the customer written approval through the connection agreement for interconnected operation with the transmission system. The following summarizes this process.

1. **Engineering Study**
   Upon connection request of a proposed new or modified facility, NB Power Transmission will initiate an engineering study to determine the actual requirements for facility connection.

   The customer will provide NB Power Transmission complete, accurate, and applicable data to enable the proper modeling of the customer's facility in load flow, transient stability, and fault studies. This will include, as required, line, transformer, load and machine data as well as parameters for exciter systems, governor systems, and power system stabilizers.

The facility connection requirements as included in this document and the basis connection agreement may be amended to include additional site-specific requirements based upon needs identified in engineering studies.

2. **Connection Costs**
   The connection costs are provided in Attachment K, Transmission Expansion Policy, of the OATT.

3. **Design Approval**
   Transmitter will review and provide written approval for the portion of the facility's design that is required to meet its specified facility connection requirements. This review and approval will only cover the required connection equipment and is not intended to provide overall customer facility design review.

4. **Initial Inspection and Testing**
   Prior to the initial synchronization to the transmission system, the connection equipment will be inspected, calibrated, and functionally tested. The Transmitter will inspect as required the connection equipment and will either perform or observe the necessary functional testing as determined by the Transmitter.

   Prior to the physical connection/synchronization of the customer equipment the Connection Agreement between the Customer and NB Power Transmission will be complete.

5. **Ongoing Testing and Maintenance**
   After the initial synchronization, the customer is required to perform periodic testing and maintenance of the connection equipment to ensure this equipment will operate properly.

2.2.1 NERC and NPCC Requirements

All facilities that are connected to the transmission system will also comply with applicable North American Electric Reliability Council (NERC), and Northeast Power Coordinating Council (NPCC) criteria, guides, requirements, and standards.

3.0 GENERATION FACILITY CONNECTION REQUIREMENTS

The new or modified connection of a generation facility to the electrical transmission system requires a Connection Agreement with NB Power transmission. This Connection Agreement defines the technical connection requirements.

Chapter 4 of the New Brunswick Market Rules states that:

4.3.1 Each Generator that is directly connected to the SO-controlled Grid must be the subject of a Connection Agreement with the applicable Transmitter substantially the form of the agreement set forth in Attachment J to the Transmission Tariff,…

Chapter 8, Connection of New and Modified Facilities states that:

8.1.1 No person shall connect any new or modified Facility to the SO-controlled Grid…
b) other than in accordance with the provisions of a Connection Agreement with the applicable Transmitter with respect to the design and construction of any associated connection facilities….

3.1 Purpose and Application of Attachment J of the OATT:

The purpose of Attachment J, Schedule B “Generator Technical Requirements” is to establish the technical requirements for generation facilities to connect to the NB Power Transmission's (Transmitter) electrical system. Attachment J reflects, in part, the Transmitter view of Good Utility Practices with respect to the installation of generation connection equipment. The requirements in Attachment J are written to establish a basis for maintaining power quality and a safe environment for the general public, power consumers, maintenance personnel, and equipment. Attachment J describes the general protection requirements for parallel operation and includes typical one-line diagrams. Attachment J also includes equipment maintenance requirements and details the information that will be provided to the Transmitter during all stages of a project. Attachment J is a guide and as such, is not intended to be used as the sole basis for the specific design of the generator's protection systems and connection with the transmission system. Final design will be subject to review and approval on a case-by-case basis. Because each generation connection is unique the requirements are considered as the basis, and additional requirements may be added as required based upon the results of facility and system impact studies.

3.2 FAC-001 Facility Connection Requirements

The NERC reliability standard FAC-001 requires Transmission Owners to specifically address the following categories:

3.2.1 Voltage Level and MW and MVAR Capacity Demand at Point of Connection

The customer is required to submit the ratings and generator characteristics which include Voltage, MW and MVAR capability as listed in the "Electrical Equipment Data Sheets" in the OATT. This information will be applied in the engineering review and study stages prior to facility connection. The ratings and generator characteristics will then be confirmed through commissioning and pre-synchronizing activities as described in the OATT.

For normal operation, steady state voltages at all transmission levels will be kept in the range of .95 to 1.05 per unit. For contingency operation, steady state voltages at all transmission levels will be kept in the range of .90 to 1.07.

3.2.2 Breaker Duty and Surge Protection

Generation integration may substantially increase fault current levels at nearby substations. Increased fault currents may exceed existing equipment ratings, interrupting ratings and/or through fault ratings.

The transmission engineering study will verify the maximum available fault current and its impact on existing breaker interrupting capability as well as the requirements of additional breakers.

Breaker BIL levels, shielding and surge protective device application must meet requirements as determined by lightning and switching surge analysis, the latest IEEE C62 and CSA standards.

3.2.3 System Protection and Coordination

Each customer will design, install, maintain and operate appropriate protection systems. The customer must obtain Transmitter approval of specific relays and connection equipment before parallel operation can begin. Attachment J, Schedule B, Section III "System Protection" of the OATT covers Transmitter requirements for the protection systems.

3.2.4 Metering and telecommunications

Any location where a facility is connected in parallel with the transmission system will be metered to measure energy flow in two directions at the point of connection. All metering arrangement will require approval of and design by NB Power Transmission. In accordance with Attachment J, Schedule B, Section IV "Metering" of the OATT.

Supervisory control and data acquisition requirements are based upon the size of the generator and the requirements of the generator to provide AGC (area generation controls) as described in Attachment J, Schedule B, Section V "Supervisory Control and Data Acquisition" of the OATT.

3.2.5 Grounding and Safety Issues

Generation integration may increase fault current levels at nearby substations and require modifications to existing stations grounding. The interconnection substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment in, or immediately adjacent to, the station under normal and fault conditions. The facility's station ground will be designed and installed in accordance with IEEE 80 standard and NB Power Transmission grounding practices. Prior to synchronizing generation or station service loads the Customer shall verify station grounding systems to the satisfaction of NB Power Transmission as per transmission commissioning requirements.

For switching and tagging procedures; each party will comply with Transmitter's Switching, Tagging, and Grounding Rules in existence on the date of the Connection Agreement and as they may be modified by Transmitter from time to time, at all utility primary and secondary systems equipment connection or demarcation points.

3.2.6 Insulation and Insulation Coordination

Equipment BIL levels, shielding and surge protective device application must meet requirements as determined by lightning and switching surge analysis as per the latest IEEE C62 and CSA standards.

3.2.7 Voltage, Reactive Power and Power Factor Control

Unless otherwise agreed to by the parties, a customer will operate its facility with automatic voltage regulators consistent with Attachment J, Schedule B of the OATT. The voltage regulators will control voltage at the points of connection when the facility is operating consistent with the range of voltage and reactive capability set forth in Attachment J, Schedule H, Generator Capability Curve, of the OATT.

Voltage: The distribution voltage to all customers is typically maintained with +/- 5% of nominal voltage as specified by the transmitter. All generators must be equipped with an automatic voltage regulator and it must remain in-service unless authorized by the NBSO.

Reactive capability/ power factor control: All synchronous generators shall be rated to operate continuously at maximum rated power and at any power factor between 90% lagging and 95% leading within +/- 5% of rated voltage.

3.2.8 Power Quality Impacts

In accordance with Attachment J, Schedule B of the OATT:

Flicker: Any sudden change in real or reactive power from the customer's equipment is reflected as sudden voltage changes that can cause problems to equipment and also cause lights to flicker. Flicker limitations may be determined at the power consumer connected nearest to the customer's facility and will be based on the flicker chart of % voltage fluctuation versus fluctuations per time period, as given in IEEE Standard 519, "IEEE recommended Practice and Requirements for Harmonic Control in Electric Power Systems." No more than a 3% instantaneous variation in voltage (flicker) is allowed when connecting or disconnecting any generator or station load to the transmission system.

Harmonic Content: The harmonic content of the voltage and current waveforms on the transmission system will be restricted to levels which will not cause any interference or equipment operating problems for customers. Minimum requirements for limitations of harmonic content on the transmission system shall comply with IEEE Standard 519.

Harmonic problems will also be addressed on a complaint basis. If the Transmitter determines that the facility is the cause of a harmonic problem, then that generation will be removed from the transmission system until the condition is resolved. In addition, all costs associated with research and corrective action, including settlements paid to other customers, will be at the customer's expense.

Load Balance: The customer agrees to take and use the three phase current supplied through the Transmitter's transmission system in such manner that in no case shall the difference between any two phases be greater than 5%. The customer, upon written instructions from the Transmitter, shall so adjust its load as to comply with this requirement.

3.2.9 Equipment Ratings

Equipment ratings will be provided in the engineering review and study stages prior to facility connection. The ratings will then be confirmed through commissioning activities as described in the OATT.

All current carrying equipment and devices shall be designed to carry the maximum loads that are predicted and used in load flow analysis. Loading levels exceeding "nameplate" or "normal" design capacities is acceptable provided sound engineering justification is applied and transmission approval is obtained.

NB Power Transmission's methodology for determining its facility ratings is discussed in its "Facility Ratings Methodology" document which is available upon request.

3.2.10 Synchronizing of Facilities

All components of the connection protection system and the synchronizing circuits will be energized and functioning correctly before the customer will be allowed to begin parallel operation with the transmission system. The customer will work with transmission on both the pre-synchronizing checks as well as the switching plan for the initial synchronizing of the facility.

3.2.11 Maintenance Coordination

After the initial synchronization, the customer is required to perform periodic testing and maintenance of the connection equipment to ensure this equipment will operate properly. Attachment J, Schedule B, Section VIII.E, “Testing and Maintenance” of the OATT provides additional details for these ongoing requirements.

As per the basis connection agreement, NB Power Transmission will, to the extent practicable, schedule any testing, shutdown or withdrawal of the customer’s transmission facilities to coincide with customer’s scheduled outages.

3.2.12 Operational Issues (abnormal frequency and voltages)

All generators will be equipped with an automatic frequency sensitive speed governing system capable of achieving a 4% droop characteristic. In addition, there are requirements for generation to remain online during low frequency events to provide system support, as well as coordinate with the regions underfrequency load shedding program.

During an emergency or otherwise a generator may be required to provide voltage support to the transmission system by operating their generator at any point within the generator’s capability curve as directed by System Operations.

3.2.13 Inspection Requirements for Existing or New Facilities

The following site inspections will be coordinated between the customer and the Transmitter as contemplated in the basis connection agreement of the OATT:

1. Initial Inspection
The initial inspection includes the customer's facility acceptance testing which will be conducted before the facility will be allowed to generate in parallel with the transmission system, as described in Attachment J, Schedule B, Section III.L, “Generator Facility Acceptance,” of the OATT. This inspection will also involve a discussion and observation of standard operation and safety procedures.

2. Annual Inspection
Transmitter will determine the necessity for an annual inspection. If conducted, it will include a visual inspection of the generator and switchgear rooms (where connection equipment is located) and a review of operation and maintenance procedures, pertinent documentation, and adherence to all applicable codes and standards.

3. Biennial Test and Inspection

This test and inspection will occur every two years after the initial inspection. Items of concern for the annual inspection will be reviewed and a test of the connection system will be performed in accordance with Attachment, Schedule B “Connection Protection System” of the OATT. This test will include input verification testing, overall protection system operability, and calibration of protective relays. Input verification testing will include verification of PT and CT circuits, transformer ratios, and DC trip source availability. The overall protection system operability will entail verification of trip circuits including a trip test of each breaker tripped by the connection relaying. Calibration of relays will verify the setpoints and confirm the ability of the protective devices to respond within specified parameters. Protective connection relay calibration testing will be performed by a qualified contractor and observed by the Transmitter. At the customer's option, this testing may be performed by the Transmitter. Verification of setpoints will be in accordance with the Transmitter’s specifications.

3.2.14 Communications and procedures during normal and emergency operating conditions

As described in Attachment J, Schedule B, Section 4, “Operations” of the OATT, the Connection Agreement between NB Power Transmission and the generator customer includes the provisions for the inclusion of the necessary normal and emergency procedures. The OATT also includes communications requirements as well provide the Transmitter the right to dispatch generator or even disconnect the generator as required in an emergency.

For staffed facilities, a telephone line dedicated to voice communications with the NBSO will be provided. For unstaffed facilities, the customer must provide an alternative means of communications to meet the requirements of the NBSO.

Each party will provide, by written notice, an emergency telephone number, staffed 24 hours-a-day, to call in case of an emergency.

Consistent with Good Utility Practice, the customer will comply with all applicable standards and requirements, including, without limitation, maintenance outage coordination, voltage schedules, generator power factor, control and reporting of output and line flow data and major equipment status, and metering accuracy. The customer will also be obligated to comply with the NBSO’s directives regarding operation during emergency conditions.

4.0 TRANSMISSION FACILITY CONNECTION REQUIREMENTS

It is expected that a connection agreement will be developed between the Transmitters to institute these requirements and any additional requirements that arise as a result of the engineering assessment or other requirements that are beneficial to the transmission parties. For initial studies and review a connection agreement may be preceded with a Memorandum of Understanding (MOU) or similar agreement to describe general intent, scope and cooperation between parties.

4.1 FAC-001 Facility Connection Requirements

The NERC reliability standard FAC-001 requires Transmission Owners to specifically address the following categories:

4.1.1 Voltage Level and MW and MVAR capacity or demand at point of connection:

The MW transfer capability between transmitters will be based upon planning studies in full compliance with NERC planning requirements. The voltage levels and MVAR capability of the systems shall be adequate in normal and contingency situations.

4.1.2 Breaker duty and surge protection

Changes in transmission may increase fault current levels at nearby substations. Increased fault currents may exceed existing equipment ratings, interrupting ratings and/or through fault ratings.

The transmission engineering study will verify the maximum available fault current and its impact on existing breaker interrupting capability as well as the requirements of additional breakers.

Breaker BIL levels, shielding and surge protective device application must meet requirements as determined by lightning and switching surge analysis as per the latest IEEE C62 and CSA standards.

4.1.3 System protection and coordination

Each party will design, install, maintain and operate appropriate protection systems that meet or exceed NPCC and NERC standards. Should there be a disagreement between parties on the adequacy of the protection the most reliable solution will be used.

The Transmitter Connection Agreement will detail the specifics of each protection scheme to ensure adequate review and approval. The agreement shall consider communication, single or three phase clearing, reclosing requirements etc.

Special Protection Systems (SPS) may be employed to enhance the transfer limits on interfaces with neighbouring utilities. Whenever applicable, the SPSs are identified and their action is taken into consideration as a part of the TTC calculations.

4.1.4 Metering and telecommunications

NB Power Transmission is responsible for metering at all interconnection boundaries. The metering requirements are located in the NBSO market Rules

In addition, those interconnections that define the NBSO Balancing Area shall have additional real-time metering requirements for the use in calculating ACE.

Each transmitter will install the necessary telecommunications and associated hardware for the control, status and analog information. This information will consider the timely control and awareness of breakers and voltage control devices as well as the monitoring of Voltage, MW and MVAR quantities necessary to support operator awareness.

In addition, Transmitters will share data in accordance with NERC reliability standard TOP-005 “Operational Reliability Information” to ensure entities have the necessary operating data to monitor conditions in each area of responsibility.

4.1.5 Grounding and safety issues

NB Power Transmission facility’s are designed and installed in accordance with IEEE 80 standard and transmission grounding practices.

Significant transmission changes may increase fault current levels at nearby substations and require modifications to existing stations grounding. A review of fault current levels will determine if existing grounding will be reviewed.

For switching and tagging procedures; the parties will jointly develop Switching, Tagging, line energizing and Grounding Rules in the Transmitter Connection Agreement. Should there be a disagreement between parties the more limiting will be used provided safety is ensured.

4.1.6 Insulation and insulation coordination

Equipment BIL levels, shielding and surge protective device application must meet requirements as determined by lightning and switching surge analysis, the latest IEEE C62 and CSA standards.

EMTP and other studies will be carried out on an as needed basis to ensure insulation coordination is adequate and equipment is not adversely affected. EMPT studies may be triggered by possible HVDC interactions, series capacitor/sub-synchronous resonance, SVC interactions etc.

4.1.7 Voltage and Reactive Power

Voltage: The distribution voltage to all customers is typically maintained with +/- 5% of nominal voltage as specified by the transmitter.

For normal operation, voltages at all transmission levels will be kept in the range of .95 to 1.05 per unit. For contingency operation, Voltages at all transmission levels will be kept in the range of .90 to 1.07.

The coordination of reactive power between the parties will be such to support normal and contingency situations of both transmitters while keeping the system voltages at acceptable levels.

4.1.8 Power Quality Impacts

Flicker: Any sudden change in real or reactive power from the customer's equipment is reflected as sudden voltage changes that can cause problems to equipment and also cause lights to flicker. Flicker limitations may be determined at the power consumer connected nearest to the Customer's facility and will be based on the flicker chart of % voltage fluctuation versus fluctuations per time period, as given in IEEE Standard 519, "IEEE recommended Practice and Requirements for Harmonic Control in Electric Power Systems." No more than a 3% instantaneous variation in voltage (flicker) is allowed when connecting or disconnecting.

Harmonic Content: The harmonic content of the voltage and current waveforms on the transmission system will be restricted to levels which will not cause any interference or equipment operating problems for customers. Minimum requirements for limitations of harmonic content on the Transmission System shall comply with IEEE Standard 519.

Harmonic problems will also be addressed on a complaint basis. If Transmitter determines that the connected transmitter Facility is the cause of a harmonic problem, then NB Power Transmission will work with the other transmitter until the condition is resolved. In addition, all costs associated with research and corrective action, including settlements paid to other customers, will be at the Customer's expense.

4.1.9 Equipment Ratings

Equipment ratings will be considered in the engineering review and study stages prior to facility connection.

All current carrying equipment and devices shall be designed to carry the maximum loads that are predicted and used in load flow analysis. Loading levels exceeding "nameplate" or "normal" design capacities is acceptable provided sound engineering justification is applied.

NB Power Transmission's methodology for determining its facility ratings is discussed in its "Facility Ratings Methodology" document which is available upon request.

Should new or existing equipment thermal ratings be a limiting factor, the normal and emergency short term ratings for this equipment will be clearly identified in the connection agreement.

4.1.10 Synchronizing of Facilities

All components of the synchronizing circuits will be energized and functioning correctly before the customer will be allowed to begin parallel operation with the NB Power Transmission electrical system. The parties will work together on both the pre-synchronizing checks as well as the switching plan for the initial synchronizing of the facility.

4.1.11 Maintenance coordination

The connection agreement between transmitters to consider optimizing and coordination of maintenance activities to minimize market impacts through interface restrictions. The connection agreement to include as required particulars with respect to resource support during maintenance activities both during normal and emergency situations.

4.1.12 Operational issues (abnormal frequency and voltages)

It is expected that the Interconnection Agreement (IA) operational agreement between the NBSO and the external transmitter will cover operational issues. NBSO will then inform NB Power Transmission of its obligations under the IA agreement.

4.1.13 Inspection requirements for existing or new facilities

There is no requirement for NB Power Transmission to carry out an inspection on a neighboring transmitter. NB Power Transmission will work jointly and coordinate with the other transmitter with respect to initial testing prior to connected operation as well as ongoing maintenance activities as defined in the transmitter connection agreement.

4.2.14 Communications and procedures during normal and emergency operating conditions

It is expected that the Interconnection Agreement operational agreement between the NBSO and the external transmitter will cover operational issues. NBSO will then inform NB Power Transmission of its obligations under the IA agreement.

5.0 END-USE FACILITY CONNECTION REQUIREMENTS

Network Integration Transmission Services shall not commence until the Transmitter and the Network Customer, or a third party, have completed installation of all equipment specified under the Network Operating Agreement consistent with Good Utility Practice and any additional requirements reasonably and consistently imposed to ensure the reliable operation of the Transmission System.

The new or modified connection of a end use facility to the electrical transmission system requires a Connection Agreement with NB Power Transmission. This Connection Agreement defines the technical connection requirements.

> *Chapter 4 of the New Brunswick Market Rules states that:*
>
> *4.3.3 Each Load Facility, including for greater certainty a Distribution System, that is directly connected to the SO-controlled Grid must be the subject of a Connection agreement with the applicable Transmitter substantially the form of the Network Operating Agreement set forth in the Transmission Tariff,…*
>
> *Chapter 8 Connection of New and Modified Facilities states that:*
>
> *8.1.1 No person shall connect any new or modified Facility to the SO-controlled Grid…*
> *b) other than in accordance with the provisions of a Connection Agreement with the applicable Transmitter with respect to the design and construction of any associated connection facilities….*

5.1 FAC-001 Facility Connection Requirements

The NERC reliability standard FAC-001 requires transmission owners to specifically address the following categories:

5.1.1 Voltage Level and MW and MVAR capacity or demand at point of connection:

The MW, MVAR requirements shall be provided by the customer in order for the appropriate reliability studies to be carried out. In addition, the customer should provide in advance any potential future increases in MW or MVAR so this may be considered in the facility design.

The voltage level and the point of connection to be specifically defined as per in the Network Operating Agreement.

Voltage: The distribution voltage to all customers is typically maintained with +/- 5% of nominal voltage as specified by the transmitter.

For normal operation, voltages at all transmission levels will be kept in the range of .95 to 1.05 per unit. For contingency operation, Voltages at all transmission levels will be kept in the range of .90 to 1.07.

5.1.2 Breaker duty and surge protection

Changes in transmission may increase fault current levels at nearby substations. Increased fault currents may exceed existing equipment ratings, interrupting ratings and/or through fault ratings.

The engineering studies will confirm the maximum available fault current and its impact on existing breaker interrupting capability as well as the requirements of additional breakers.

Breaker BIL levels, shielding and surge protective device application must meet requirements as determined by lightning and switching surge analysis, the latest IEEE C62 and CSA standards.

5.1.3 System protection and coordination

The customer will obtain Transmitter approval of specific relays and connection equipment before connected operation can begin.

The Network Operating Agreement may also contain the specifics of the customer's protection requirements to ensure adequate transmitter review and approval.

5.1.4 Metering and telecommunications

NB Power Transmission at its cost will provide, and maintain the metering equipment as outlined in Attachment G of the OATT and metering requirements as specified in the NBSO market rules.

If required for reliability, NB Power Transmission include additional requirements in the Network Operating Agreement for the installation of the necessary telecommunications and associated hardware for the control, status and analog information at the customer's expense.

5.1.5 Grounding and safety issues

NB Power Transmission facility's are designed and installed in accordance with the IEEE 80 standard and transmission grounding practices.

Should significant transmission changes be required, a review of possible increased fault current levels will be carried out to determine if nearby substations will require modifications to existing stations grounding.

For switching and tagging procedures; each party will comply with Transmitter's Switching, Tagging, and Grounding Rules in existence on the date of the Network Operating Agreement and as they may be modified by Transmitter from time to time, at all utility primary and secondary systems equipment connection or demarcation points.

5.1.6 Insulation and insulation coordination

Equipment BIL levels, shielding and surge protective device application must meet requirements as determined by lightning and switching surge analysis, the latest IEEE C62 and CSA standards.

5.1.7 Voltage, Reactive Power and Power factor

For normal operation, steady state voltages at all transmission levels will be kept in the range of .95 to 1.05 per unit. For contingency operation, steady state voltages at all transmission levels will be kept in the range of .90 to 1.07.

Unless otherwise agreed, the transmission customer is required to maintain a power factor within the range established by the Transmitter pursuant to Good Utility Practice. The power factor requirements are specified in the Service Agreement where applicable.

In lieu of any specific power factor requirements in the relevant service agreement, a penalty for poor power factor in any month shall be charged when 90% power factor is experienced.

5.1.8 Power Quality Impacts

Flicker: Any sudden change in real or reactive power from the customer's equipment is reflected as sudden voltage changes that can cause problems to equipment and also cause lights to flicker. Flicker limitations will be determined at the power consumer connected nearest to the customer’s facility and may be based on the flicker chart of % voltage fluctuation versus fluctuations per time period, as given in IEEE Standard 519, "IEEE recommended Practice and Requirements for Harmonic Control in Electric Power Systems." No more than a 3% instantaneous variation in voltage (flicker) is allowed when connecting or disconnecting.

Harmonic Content: Electrical harmonics shall be considered as components of current or voltage whose frequency is some multiple of the 60 hertz fundamental frequency. The harmonic content of the voltage and current waveforms on the transmission system will be restricted to levels which will not cause any interference or equipment operating problems for customers. Minimum requirements for limitations of harmonic content on the transmission system shall comply with IEEE Standard 519.

The customer shall assume the responsibility of direct loss by reason of damages to the Transmitter facilities caused by electrical harmonics produced in the customer facilities provided that such liability shall be restricted to the repair or, if necessary, the replacement or modification of such Transmitter Facilities which have been damaged or made necessary by reason of electrical harmonics produced in the customer facilities. The customer agrees to take all reasonable steps to limit the effects of any electrical harmonics which may be produced in the customer facilities to a level tolerable to the Transmitter. The Transmitter shall cooperate with the customer in the investigation of any harmonic problems and the analysis of corrective measures. The Transmitter reserves the right to discontinue the supply of power and energy where in its opinion the reliability of the Transmitter Facilities is threatened by the presence of electrical harmonics.

Load Balance: The customer agrees to take and use the three phase current supplied through the Transmitter's transmission system in such manner that in no case shall the difference between any two phases be greater than 5%. The customer, upon written instructions from the Transmitter, shall so adjust its load as to comply with this requirement.

5.1.9 Equipment Ratings

Equipment ratings will be considered in the engineering review and study stages prior to facility connection.

All current carrying equipment and devices shall be designed to carry the maximum loads that are predicted and used in load flow analysis. Loading levels exceeding "nameplate" or "normal" design capacities is acceptable provided sound engineering justification is applied and is approved by NB Power Transmission.

NB Power Transmission's methodology for determining its facility ratings is discussed in its "Facility Ratings Methodology" document which is available upon request.

5.1.10 Synchronizing of Facilities

All components of the synchronizing circuits will be energized and functioning correctly before the customer will be allowed to begin connected operation with the NB Power Transmission electrical system.

The parties will work together on both the pre-synchronizing checks as well as the switching plan for the initial synchronizing of the facility.

Should the customer's facility become disconnected from the transmission system, the customer shall not reconnect without obtaining approval from the NBSO.

5.1.11 Maintenance coordination

The general rights of the transmitter under the basis Network Operating Agreement include the interruption of supply for maintenance. The transmitter will work with the customer to ensure the interruption is scheduled in a timely manner and such interruptions are minimal.

5.1.12 Operational issues (abnormal frequency and voltages)

The General Obligation of the customer, the customer shall be responsible for installing and maintaining protective equipment to protect the customer facilities from variations in frequency and voltage.

5.1.13 Inspection requirements for existing or new facilities

As per the basis Network Operating Agreement in OATT:

> *One or more representatives of the Transmitter may at any reasonable time have access to the Customer's premises for the purposes of metering reading, inspection , operation, testing adjustment, repair, alteration, reconstruction and removal or the Transmitter Facilities, or for the purpose of inspecting the Customer Facilities.*

5.1.14 Communications and Procedures during Normal and Emergency Operating Conditions

Prior to the service commencement date, the Transmission Provider and the Network Customer shall establish load shedding and curtailment procedures pursuant to the Network Operating Agreement with the objective of responding to contingencies on the Transmission System.

6.0 REVISION HISTORY

Revision Number	Revised Section(s)	Revision Summary	Revised By	Effective Date
00	Not applicable	New document issued.	R. MacDonald	2011/05/15

7.0 REFERENCES

Institute of Electrical and Electronics Engineers (IEEE) C62, *IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits*.

Institute of Electrical and Electronics Engineers IEEE-519, *IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.*

Institute of Electrical and Electronics Engineers (IEEE) 80-2000, *IEEE Guide for Safety in AC Substation Grounding.*

New Brunswick System Operator. 2010. *New Brunswick Electricity Market Rules*, Version 4.1.

New Brunswick System Operator. 2010. *Market Procedure MP-21 Connection Assessments* (Draft) Issue: 01.

New Brunswick System Operator. *Open Access Transmission Tariff*. April 1, 2010.

Northeast Power Coordinating Council. *Document A-10 Classification of Bulk Power System Elements.* April 28, 2007.

Standard *FAC-001 Facility Connection Requirements*, North American Electric Reliability Corporation, Effective Date: April 1, 2005.

Standard *FAC-002 Coordination of Plans For New Generation, Transmission and End-User Facilities*, North American Electric Reliability Corporation, Effective Date: April 1, 2005.

Standard *TOP-005 Operational Reliability Information*, North American Electric Reliability Corporation, Effective Date: November 5, 2009.