



**Énergie NB Power**

# New Brunswick Power Transmission Guide for Electrical Facility Ratings



	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: i of v
		Effective date: 2015/07/17	Rev.: 13

## PREFACE

The Transmission Guide for Electrical Facility Ratings has been prepared to describe the current methodology used for developing and communicating facility ratings of its transmission equipment. The document has also been prepared to comply with the North American Electric Reliability Corporation (NERC) facilities ratings methodology requirements of reliability standards FAC-008, FAC-009 and PRC-023.

## APPROVAL

This document was produced and reviewed by the Transmission Planning Department.

**Planning Engineer**

**APPROVED**

\_\_\_\_\_

Signature

\_\_\_\_\_

Date

**Director, Technical Services**

**APPROVED**

\_\_\_\_\_

Signature

\_\_\_\_\_

Date


 Title: <b>Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: ii of v
	Effective date: 2015/07/17	Rev.: 13

**This page has been left blank intentionally.**

## TABLE OF CONTENTS

### TERMS AND ACRONYMS

	<b>Page</b>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
1.1 Purpose.....	1
1.2 North American Electric Reliability Corporation (NERC) Criteria.....	1
<b>2.0 TYPES OF RATINGS .....</b>	<b>2</b>
2.1 Summer Warning .....	2
2.2 Summer Operate.....	2
2.3 Winter Warning .....	2
2.4 Winter Operate.....	2
2.5 Assumptions.....	3
<b>3.0 TRANSMISSION LINE RATINGS.....</b>	<b>4</b>
3.1 Overhead Conductor .....	4
3.2 Cables .....	5
3.3 Disconnect Switches .....	5
3.4 Current Transformers .....	5
3.5 Circuit Breakers.....	5
3.6 Wavetraps .....	6
3.7 Metering Units .....	6
3.8 Relay Tripping .....	6
3.9 Shunt Reactive Devices (Capacitors and Inductors) .....	7
3.10 Series Reactive Devices (Capacitors and Inductors) .....	7
<b>4.0 TRANSFORMER RATINGS .....</b>	<b>8</b>
<b>5.0 VOLTAGE LIMITS .....</b>	<b>9</b>
5.1 Operational Term/Planning Term .....	9
<b>6.0 COMMUNICATION OF FACILITY RATINGS .....</b>	<b>10</b>
<b>7.0 SOL and IROL Determination .....</b>	<b>11</b>
<b>8.0 REVISION HISTORY .....</b>	<b>12</b>
<b>9.0 REFERENCES.....</b>	<b>13</b>

	Title: <b>Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: iv of v
		Effective date: 2015/07/17	Rev.: 13

## TERMS AND ACRONYMS

A glossary of terms used in reliability standards has been compiled by NERC and is available at [www.nerc.com](http://www.nerc.com) under “Standards”. Key terms and acronyms used in this Manual have been listed below for reference.

**Bulk Electric System (BES)** is the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are generally not included in this definition.

**Bulk Power System (BPS)** is the New Brunswick portion of the NBSO controlled grid that includes electrical generation resources, transmission lines, interconnections with neighboring systems and associated equipment as designated by the NBSO through the application of NPCC Criteria A-10 Classification of Bulk Power System Elements.

**Element** is any electrical device with terminals that may be connected to other electrical devices such as a generator, transformer, circuit breaker, bus section, or transmission line. An element may be comprised of one or more components.

**Facility** is a set of electrical equipment that operates as a single bulk electric system element (e.g. a line, a generator, a shunt compensator, transformer, etc.).

**Facility Rating** is the maximum or minimum voltage, current, frequency, or real or reactive power flow through a facility that does not violate the applicable equipment rating of any equipment comprising the facility

**North American Electric Reliability Corporation (NERC)** is an international, independent, self-regulatory, not-for-profit organization, whose mission is to improve the reliability and security of the bulk power system in the United States, Canada and part of Mexico.


**Northeast Power Coordinating Council (NPCC)** is a not-for-profit corporation in the state of New York responsible for promoting and improving the reliability of the international, interconnected bulk power system in Northeastern North America. NPCC carries out its mission through (i) the development of regional reliability standards and compliance assessment and enforcement of continent-wide and regional reliability standards, coordination of system planning, design and operations, and assessment of reliability

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: v of v
		Effective date: 2015/07/17	Rev.: 13

**System Operating Limit (SOL):** The value (such as MW, Mvar, Amperes, Frequency, or Volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria. *System Operating Limits* are based upon certain operating criteria. These include, but are not limited to:

- Facility Ratings (Applicable pre- and post-Contingency equipment or facility ratings).
- Transient Stability Limits (Applicable pre- and post- Contingency Stability Limits).
- Voltage Stability Limits (Applicable pre- and post- Contingency Voltage Stability).
- System Voltage Limits (Applicable pre- and post- Contingency Voltage Limits).

**Interconnected Reliability Operating Limit (IROL):** The value established by the *Reliability Coordinator* (such as MW, Mvar, Amperes, Frequency, or Volts) derived from, or a subset of, the *System Operating Limits*, which if exceeded, could expose a widespread area of the *Bulk Power System* to instability, uncontrolled separation(s) or cascading outages.

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 1 of 13
		Effective date: 2015/07/17	Rev.: 13

## 1.0 INTRODUCTION


### 1.1 Purpose

The following document outlines the methodology used by New Brunswick Power Transmission Corporation (NB Power Transmission) when calculating the facility ratings of transmission equipment for both planning and operational purposes. Such ratings determine the acceptable electrical loading and voltage on equipment before, during, and after system contingencies. These ratings are utilized to calculate power transmission limits when planning and operating the transmission system.

### 1.2 North American Electric Reliability Corporation

The NB Power Transmission Planning Group will ensure compliance with NERC reliability standards pertaining to facility ratings. These standards are titled *FAC-008 Facility Ratings Methodology*, *FAC-009 Establish and Communicate Facility Ratings* and *PRC-023 Transmission Relay Loadability* and are applicable to all power system elements which are considered to be part of the Bulk Electrical System (BES) as defined by NERC. At the present time, the BES elements in New Brunswick to which the NERC standards apply are those elements which are identified as BPS through the application of the NPCC Criteria A-10, "Classification of Bulk Power System Elements".

Information pertaining to these standards is available on the NERC website at [www.nerc.com](http://www.nerc.com).

 Title: <b>Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 2 of 13
	Effective date: 2015/07/17	Rev.: 13

## 2.0 TYPES OF RATINGS

Four (4) facility ratings are calculated for all NB Power transmission equipment rated at 345 kV, 230 kV, 138 kV and 69 kV. These ratings are defined as:

### 2.1 Summer Warning

- MVA loading up to this limit can be carried continuously by the transmission equipment under summer conditions.
- For planning purposes, this limit is referred to as the “Pre-Contingency Summer Limit”, and cannot be exceeded under all elements in service conditions.
- For operational purposes, loading above this limit (but below the Summer Operate level) may be considered acceptable for short periods of time depending on ambient conditions. If this occurs, the situation is monitored and action is taken if necessary.

### 2.2 Summer Operate

- MVA loading above this limit cannot be carried continuously by the transmission equipment under summer conditions without the possibility of damaging the transmission equipment.
- For planning purposes, this limit is referred to as the “Post-Contingency Summer Limit”, and cannot be exceeded under post-contingency conditions (for all applicable design contingencies).
- For operational purposes, action is taken immediately if this limit is exceeded.

### 2.3 Winter Warning

- MVA loading up to this limit can be carried continuously by the transmission equipment under winter conditions.
- For planning purposes, this limit is referred to as the “Pre-Contingency Winter Limit”, and cannot be exceeded under all elements in service conditions.
- For operational purposes, loading above this limit (but below the Winter Operate level) may be considered acceptable for short periods of time depending on ambient conditions. If this occurs, the situation is monitored and action is taken if necessary.

### 2.4 Winter Operate

- MVA loading above this limit cannot be carried continuously by the transmission equipment under winter conditions without the possibility of damaging the transmission equipment.
- For planning purposes, this limit is referred to as the “Post-Contingency Winter Limit”, and cannot be exceeded under post-contingency conditions (for all applicable design contingencies).
- For operational purposes, action is taken immediately if this limit is exceeded.




 Title: <b>Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 3 of 13
	Effective date: 2015/07/17	Rev.: 13

## 2.5 Assumptions

All seasonal equipment ratings are based on the following assumptions:

- Summer Conditions – Temperature of 25° C with a wind speed of 2 ft/sec.
- Winter Conditions – Temperature of 0° C with a wind speed of 2 ft/sec.

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 4 of 13
		Effective date: 2015/07/17	Rev.: 13

### 3.0 TRANSMISSION LINE RATINGS

Operational “Summer Warning”, “Summer Operate”, “Winter Warning” and “Winter Operate” limits for transmission line will be equal to the most restrictive rating of all equipment associated with the transmission line from one terminal end to the other, including the breaker(s) and associated disconnect switches connecting the line to a bus. Due to different equipment types having different multipliers applied to their base rating to calculate “Summer Operate”, “Winter Warning” and “Winter Operate” ratings, the most limiting element for each rating may be different.

If power system (planning or operational) studies indicate that due to Transient Stability, Voltage Stability or System Voltage Limits, more restrictive line ratings are required then these more restrictive ratings will be used in the operation of the power system.

Equipment ratings are calculated in the following manner for individual transmission equipment:

#### 3.1 Overhead Conductor

The typical design for transmission lines is to use ACSR conductor tensioned to have acceptable clearances with conductor temperatures of up to 100 C. When ACSR conductors are operated at temperatures in excess of 100 C, the aluminum starts to anneal. The annealing results in permanent weakening of the conductor. To safeguard against annealing, warning limits for conductor on typical designed transmission lines are set at the current in amps that corresponds to a conductor temperature of 75 C, and operate limits are set to current in amps that corresponds to a conductor temperature of 100 C.

Some new high temperature conductors are designed to withstand temperatures in excess of 100 C without annealing. For instances where transmission lines utilizing high temperature conductors are designed for a conductor temperature in excess of 100 C, the operate limit for the conductor is set to the current in amps that results in the conductor temperature equaling the design temperature and the warning limit is set to the current in amps that results in the conductor temperature equaling the manufacturer recommended temperature for long term loading.

For instances where transmission lines are designed (sagged) for a conductor temperature in the range of 80 C to 100 C, the operate limit for the conductor is set to the current in amps that results in the conductor temperature equaling the design temperature and the warning limit is set to the current in amps that results in the conductor temperature of 75 C.

For instances where transmission lines are designed for a conductor temperature of less than 80 C, the operate limit for the conductor is set to the current in amps that results in the conductor temperature equaling the design temperature and the warning

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 5 of 13
		Effective date: 2015/07/17	Rev.: 13

limit is set to the current in amps that results in the conductor temperature equaling the design temperature minus 5 C.

Ratings are calculated according to the IEEE Standard 738 titled “IEEE Standard for Calculation of Bare Overhead Conductor Temperature and Ampacity Under Steady-State Conditions”.

### 3.2 Cables

The seasonal Warning and Operate limits for cables will be set according to the manufacturer’s ratings.

### 3.3 Disconnect Switches

The “Summer Warning” limit corresponds to 125% of the manufacturer’s nameplate rating.

The remaining limits are calculated as follows:

$$\begin{aligned} \text{Summer Operate} &= 1.2 * \text{Summer Warning} \\ \text{Winter Warning} &= 1.2 * \text{Summer Warning} \\ \text{Winter Operate} &= 1.44 * \text{Summer Warning} \end{aligned}$$

### 3.4 Current Transformers

The “Summer Warning” limit corresponds to 125% of the manufacturer’s nameplate rating.

The remaining limits are calculated as follows:

$$\begin{aligned} \text{Summer Operate} &= 1.2 * \text{Summer Warning} \\ \text{Winter Warning} &= 1.2 * \text{Summer Warning} \\ \text{Winter Operate} &= 1.44 * \text{Summer Warning} \end{aligned}$$

### 3.5 Circuit Breakers

The “Summer Warning” limit corresponds to the manufacturer’s nameplate rating.

The remaining limits are calculated as follows:

$$\begin{aligned} \text{Summer Operate} &= 1.2 * \text{Summer Warning} \\ \text{Winter Warning} &= 1.2 * \text{Summer Warning} \\ \text{Winter Operate} &= 1.44 * \text{Summer Warning} \end{aligned}$$

 <b>Énergie NB Power</b>	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 6 of 13
		Effective date: 2015/07/17	Rev.: 13

### 3.6 Wavetraps

The “Summer Warning” limit corresponds the manufacturer’s nameplate rating.

The remaining limits are calculated as follows (in accordance with ANSI C93.3-1995 – Guide for Emergency Overload Current Capability of Line Traps):

$$\begin{aligned} \text{Summer Operate} &= 1.2 * \text{Summer Warning} \\ \text{Winter Warning} &= 1.0 * \text{Summer Warning} \\ \text{Winter Operate} &= 1.3 * \text{Summer Warning} \end{aligned}$$

### 3.7 Metering Units

The “Summer Warning” limit corresponds to 150% of the manufacturer’s nameplate rating.

The remaining limits are calculated as follows:

$$\begin{aligned} \text{Summer Operate} &= 1.2 * \text{Summer Warning} \\ \text{Winter Warning} &= 1.2 * \text{Summer Warning} \\ \text{Winter Operate} &= 1.44 * \text{Summer Warning} \end{aligned}$$

### 3.8 Relay Tripping

NERC Standard PRC-023 defines how protective relay settings for transmission lines must be set considered when calculating transmission line limits. PRC-023 also sets out criteria for which transmission lines it is applicable to. For PRC-023 applicable transmission lines, where the protective relays affect transmission line limits, these relays and associated transmission line limits will be set in accordance to the criteria in standard PRC-023.

For all other transmission lines not applicable to PRC-023, the limits due to protective relays will be set as follows:

Since relay trip setting does not vary with temperature the Warning and Operate limits are not seasonal.

Distance Relays:

- The operate limit is set equal to 85 % of the trip setting of the relay at an angle of 30 degrees from the resistive axis.
- The warning limit is operate limit divided by 1.2

Overcurrent Relays:

- The operate limit is set to be equal to 85% of the trip setting of the relay.
- The warning limit is the operating limit divided by 1.2.

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 7 of 13
		Effective date: 2015/07/17	Rev.: 13

### 3.9 Shunt Reactive Devices

Shunt reactive devices (capacitors and inductors) used for voltage control of the bulk electric system are specified, designed and applied for the full range of system voltage conditions and ranges to which they will be subjected (see section 5.0). The Summer and Winter Operate and Warning limits of these reactive devices are rated per the manufacturer's nameplate. Shunt reactive loading is controlled by the voltage applied to the terminals. Overloading under emergency conditions is not applicable because they are shunt devices.

### 3.10 Series Reactive Devices

NB Power Transmission does not have any series reactive devices (capacitors or inductors) installed on its transmission system.

 <b>Énergie NB Power</b>	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 8 of 13
		Effective date: 2015/07/17	Rev.: 13

#### 4.0 TRANSFORMER RATINGS

Transformer ratings will be as outlined below, unless system studies indicate that due to Transient Stability, Voltage Stability or System Voltage Limits, more restrictive transformer ratings are required.

The “Summer Warning” limit corresponds to the maximum manufacturer’s nameplate rating at a 65° C Temperature Rise.

The remaining limits are calculated as follows:

Summer Operate = 1.3 \* Summer Warning  
 Winter Warning = 1.2 \* Summer Warning  
 Winter Operate = 1.56 \* Summer Warning

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 9 of 13
		Effective date: 2015/07/17	Rev.: 13

## 5.0 VOLTAGE LIMITS

Voltage limits for equipment on the NB Power Transmission system are the same for both the summer and winter timeframes. Voltage limits for planning and operational purposes will be as follows, unless system studies indicate that due to Transient Stability, Voltage Stability or special equipment requirements, more restrictive limits are required:

### 5.1 Operational Term/Planning Term


Warning/Pre-Contingency Limit:  
= 95% to 105% of nominal at all busses

Operate/Post-Contingency Limit:  
= 90% to 110% of nominal at all busses (no tapping simulated)  
= 90% to 110% of nominal at non-load busses and 95% to 105% of nominal at load busses (after tapping simulated)  
= 95% to 105% of nominal at all busses (after tapping and operational intervention simulated)

Also, no planning or operational contingency can cause a voltage change of more than 10% on any equipment on the NB Power Transmission system.

For the purpose of planning studies, all system voltages should be within the “Pre-Contingency Limit” with all equipment in service and within the “Post-Contingency Limit” for all design contingencies.

For operational purposes, all system voltages should be within the “Warning Limit” for normal operations and within the “Operate Limit” for any operational contingencies.

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 10 of 13
		Effective date: 2015/07/17	Rev.: 13

## 6.0 COMMUNICATION OF FACILITY RATINGS

NB Power Transmission will communicate facility ratings information to its Regional Reliability Organization (NPCC) upon request.

The NB Power Transmission Planning group will notify the NB Power System Operations group whenever there is a new facility rating, or change to an existing facility rating, and the operations group will ensure that the change is implemented for use in operations. If a facility is made up of multiple equipment, the most limiting equipment will be identified.

The NB Power System Operations group will notify the NB Power Transmission Planning group whenever there is a change to any equipment rating due to operational requirements.

When updated ratings of its facilities are applicable, NB Power Transmission will communicate those new ratings to the NPCC via appropriate mechanisms such as by submitting updated ratings to system modeling databases, by electronic mail, or, in the event of real-time system loading issues, by telephone.

NB Power shall provide Facility Ratings, including the identity of the most limiting equipment, to associated entities as scheduled if such schedules are provided by requesting entities. These entities would include Nova Scotia Power, ISO-NE and Hydro Quebec.

NB Power shall provide Facility Ratings to associated requesting entities, including the identity and thermal rating of the most limiting equipment as well as the next most limiting equipment, that limits the use of the Facilities under the requester's authority by causing any of the following: 1) An Interconnection Reliability Operating Limit, 2) A limitation of Total Transfer Capability, 3) An impediment to generator deliverability, or 4) An impediment to service to a major load center. NB Power shall provide this information within 30 calendar days of the request.

NB Power Transmission will maintain records of updated facility ratings submittals for documentation purposes in order to demonstrate compliance with the requirements of FAC-008, FAC-009 and PRC-023. Records will be retained for a period of three (3) years.



	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 11 of 13
		Effective date: 2015/07/17	Rev.: 13

## 7.0 SOL and IROL Determination

All facilities will have associated facility ratings calculated as per the above methodology. By default, for any BES facility its associated seasonal post-contingency facility ratings will be considered a SOL. Anytime facility ratings are updated, they will be communicated to the NB Power System Operator as per section 6.0 of this document.

Whenever it is identified in any planning study that a violation of a SOL could expose a widespread area of the BES to instability, uncontrolled separation(s) or cascading outages, that SOL will be considered an IROL. Anytime NB Power Transmission Planning develops a new IROL, it will be communicated to the NB Power System Operator and added to their documentation of IROL.

 <b>Énergie NB Power</b>	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 12 of 13
		Effective date: 2015/07/17	Rev.: 13

## 8.0 REVISION HISTORY

Revision Number	Revised Section(s)	Revision Summary	Prepared / Revised by	Date (yyyy/mm/dd)
04	N/A	Initial release.	A. Wilcox A. Briggs	2005/04/29
05	N/A	Document updated.	A. Wilcox	2008/09/26
06		Protection limits for non-bulk	D. Verner R. MacDonald	2010/10/08
07		Added reference to IEEE 783 and ANSI C93.3 Document reformatted.	A. Wilcox	2011/11/01
08	Sect. 4.9 and 4.10	Added sections 4.9 and 4.10	A. Wilcox	2012/05/02
09	All	Updated section 3.8 Relay tripping to satisfy PRC-023-1 R1.2 and reformatted the entire document to make it consistent with requirements of document control procedure	A. Wilcox	2012/09/30
10		Added System Operating Limit *SOL) and Interconnected Reliability Operating Limit (IROL) to Terms and Acronyms. Added new section 7.0 SOL and IROL Determination.	A. Wilcox	2013/08/27
11	Section 3.1	Updated section	A. Wilcox	2014/01/09
12	Section 6.0	Updated section	A. Wilcox	2014/05/01
13	Section 3.8	Updated section	A. Wilcox	2015/07/17

	<b>Title: Transmission Guide for Electrical Facility Ratings</b>	Document No.: CO1-T02830-0001	Page: 13 of 13
		Effective date: 2015/07/17	Rev.: 13

## 9.0 REFERENCES

ANSI C93.3-1995 – Guide for Emergency Overload Current Capability of Line Traps

Institute of Electrical and Electronics Engineers (IEEE) Standard 738, IEEE Standard for Calculation of Bare Overhead Conductor Temperature and Ampacity Under Steady-State Conditions”.

Standard *FAC-008 Facility Ratings Methodology*, North American Electric Reliability Corporation, Effective Date: August 7, 2006.

Standard *FAC-009 Establish and Communicate Facility Ratings*, North American Electric Reliability Corporation, Effective Date: October 7, 2006.

Standard *PRC-023 Transmission Relay Loadability*, North American Electric Reliability Corporation, Effective Date: Refer to standard.