Alberta Reliability Standard
Generator Relay Loadability
PRC-025-AB-2

1. Purpose

The purpose of this **reliability standard** is to set load-responsive protection relays associated with generation facilities at a level to prevent unnecessary tripping of a **generating unit** or an **aggregated generating facility** during a **disturbance** for conditions that do not pose a risk of damage to the associated equipment.

2. Applicability

2.1 Inclusions

This **reliability standard** applies to:

(a) the **legal owner** of a **generating unit**, including all electrical equipment that connects the stator windings of any **generating unit** to the **transmission system**, that is:

(i) directly connected to the **bulk electric system**, or that is part of an industrial complex that is directly connected to the **bulk electric system**, and has a **maximum authorized real power** rating greater than 18 MW;

(ii) within a power plant or industrial complex which:

(A) is not part of an **aggregated generating facility**;

(B) is directly connected to the **bulk electric system**; and

(C) has a combined **maximum authorized real power** rating greater than 67.5 MW;

(iii) a **blackstart resource**; or

(iv) material to this **reliability standard** and to the **reliability** of either the **interconnected electric system** or the City of Medicine Hat electric system as the **ISO** determines and publishes on the AESO website and may amend from time to time on notice to **market participants** in accordance with the process set out in Appendix 1;

(b) the **legal owner** of an **aggregated generating facility** that is:

(i) directly connected to the **bulk electric system** and has a **maximum authorized real power** rating greater than 67.5 MW;

(ii) within a power plant or industrial complex which:

(A) is directly connected to the **bulk electric system**; and

(B) has a combined **maximum authorized real power** rating greater than 67.5 MW;

(iii) a **blackstart resource**; or

(iv) material to this **reliability standard** and to the **reliability** of either the **interconnected electric system** or the City of Medicine Hat electric system as the **ISO** determines and publishes on the AESO website and may amend from time to time on notice to **market participants** in accordance with the process set out in Appendix 1;

(c) the **legal owner** of a **transmission facility** that is:

(i) part of the **bulk electric system**; or

(ii) which the **ISO** determines is necessary for the reliable operation of either the **interconnected electric system** or the City of Medicine Hat electric system and publishes on the AESO

website and may amend from time to time on notice to **market participants** in accordance with the process set out in Appendix 1.

3. Requirements

R1 Each **legal owner** of a **generating unit**, **legal owner** of an **aggregated generating facility**, and **legal owner** of a **transmission facility**, must apply settings that are in accordance with Appendix 3 - *Relay Loadability Evaluation Criteria* to **protection systems**, excluding those listed in Appendix 2 – *Excluded Protection Systems*, on each load-response protection relay while maintaining reliable **fault** protection.

4. Measures

The following measures correspond to the requirements identified in section 3 of this **reliability standard**. For example, MR1 is the measure for requirement R1.

MR1 Evidence of applying protection relay settings in accordance with requirement R1 exists. Evidence may include summaries of coordination studies, calculations, setting sheets, and protection relay test reports or records of installation of settings in protection relays including references to how the requirements of Table 1 and maintaining reliable **fault** protection have been met, or other equivalent evidence.

It is only necessary to provide evidence that the protection relays settings do not limit loadability. PRC-025-AB-2 does not require evidence to be provided that the protection relays reliably detect all **fault** conditions and protect the applicable **system elements** from these **faults**.

5. Appendices

Appendix 1 – *Amending Process for List of Facilities*

Appendix 2 – *Excluded Protection Systems*

Appendix 3 - *Relay Loadability Evaluation Criteria*

Revision History

Date	Description
xxxx-xx-xx	Initial release.

Appendix 1

Amending Process for List of Facilities

In order to amend any list referenced in subsections 2.1(a)(iv), 2.1(b)(iv) and 2.1(c)(ii) of section 2.1, Inclusions, the **ISO** must:

(a) upon determining that a **generating unit**, an **aggregated generating facility**, or a **transmission facility** is to be added, notify the **legal owner** in writing and determine an effective date, which must be no less than 4 full calendar quarters after the date of notice, for the **legal owner** to meet the applicable requirements;

(b) upon determining that a **generating unit**, an **aggregated generating facility**, or a **transmission facility** is to be deleted, notify the **legal owner** in writing and determine an effective date for the **legal owner** to no longer be required to meet the applicable requirements; and

(c) publish the amended list with effective dates on the AESO website.

Appendix 2

Excluded Protection Systems

This **reliability standard** does not apply to the following **protection systems**:

(a) any protection relay elements that are in-service only during startup of a **generating unit**;

(b) load-responsive components of a **protection system** that are armed only when the **generating unit** is disconnected from the **interconnected electric system**;

(c) phase **fault** detector protection relay elements employed to supervise other load-responsive phase protection distance relays, provided the phase distance relay is set in accordance with the criteria outlined in this **reliability standard**;

(d) protection relay elements that are only enabled when other protection elements fail;

(e) protection relay elements used only for **remedial action schemes**;

(f) **protection systems** that detect **generating unit** overloads that are designed to coordinate with the **generating unit** short time capability by using an extremely inverse characteristic set to operate no faster than 7 seconds at 218% of full-load current, and prevent operation below 115% of full-load current; and

(g) **protection systems** that detect transformer overloads and are designed only to respond in time periods which allow real time operating personnel 10 minutes or greater to respond to overload conditions.

Appendix 3 -

Relay Loadability Evaluation Criteria

Table 1 - Summary

Technology Type	**Applicability of options**
Synchronous **generating units**, and **aggregating generating facilities** comprised of synchronous **generating units**	1a, 1b, 1c, 2a, 2b, 2c, 3, 7a, 7b, 7c, 8a, 8b, 8c, 9a, 9b, 9c, 13a, 13b, 14a, 14b, 15a, 15b, 16a, 16b
Asynchronous **generating units**, and **aggregating generating facilities** comprised of asynchronous **generating units** including inverter-based installations	4, 5a, 5b, 6, 10, 11, 12, 13a, 13b, 17, 18, 19

Table 2 - Relay Loadability Evaluation Criteria

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage**[1]	**Pickup Setting Criteria**
Synchronous **generating units**, or **aggregated generating facilities**	Phase distance relay (e.g. 21) – directional toward the **transmission system**	1a	The voltage of a **generating unit** stator winding terminal, **collector bus**, corresponding to 0.95 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the **maximum authorized real power**, and (2) **Reactive power** output – 150% of the **real power** value, derived from the **generating unit**, or **aggregated generating facility** nameplate **apparent power** rating at rated **power factor**.
		OR		

[1] Calculations using the transmission step-up transformer turns ratio must use the actual tap that is applied (i.e. in service) for transmission step-up transformers with off-load tap changers. If on-load tap changers are used, the calculations must reflect the tap that results in the lowest **generating unit** stator winding terminal voltage. When the criterion specifies the use of the transmission step-up transformer's impedance, the nameplate impedance at the nominal transmission step-up turns ratio must be used.

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
		1b	The voltage calculated at the **generating unit** stator winding terminal, **collector bus**, corresponding to 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer (including the transformer turns ratio and impedance).	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the **maximum authorized real power**, and (2) **Reactive power** output – 150% of the **real power** value, derived from the **generating unit**, or **aggregated generating facility** nameplate **apparent power** rating at rated **power factor**.
		OR		
		1c	The simulated voltage at the **generating unit** stator winding terminal, **collector bus** coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer prior to field-forcing.	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the **maximum authorized real power**, and (2) **Reactive power** output – 100% of the maximum gross **reactive power** output during field-forcing as determined by simulation.
	The same application continues on the next page with a different relay type			

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Synchronous **generating units**, or **aggregated generating facilities**	Phase overcurrent relay (e.g. 50,51) or (51V-R) – voltage-restrained	2a	**Generating unit** stator winding terminal or **collector bus** voltage corresponding to 0.95 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the **maximum authorized real power**, and (2) **Reactive power** output – 150% of the **real power** value, derived from the **generating unit** nameplate **apparent power** rating at rated **power factor**.
		OR		
		2b	Calculated **generating unit** stator winding terminal or **collector bus** voltage corresponding to 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer (including the transformer turns ratio and impedance).	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the **maximum authorized real power**, and (2) **Reactive power** output – 150% of the **real power** value, derived from the **generating unit** nameplate **apparent power** rating at rated **power factor**.
		OR		
		2c	Simulated **generating unit** stator winding terminal or **collector bus** voltage coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer prior to field-forcing.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of **maximum authorized real power** or, and (2) **Reactive power** output –100% of the maximum gross **reactive power** output during field-forcing as determined by simulation.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
	Phase time overcurrent relay (e.g. 51V-C) – voltage controlled (Enabled to operate as a function of voltage)	3	**Generating unit** stator winding terminal or **collector bus** voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	Voltage control setting must be set less than 75% of the calculated **generating unit** stator winding terminal or **collector bus** voltage.
A different application starts on the next page				

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Asynchronous **generating units** or **aggregated generating facilities** (including inverter-based installations)	Phase distance relay (e.g. 21) – directional toward the **transmission system**	4	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The impedance element must be set less than the calculated impedance derived from 130% of the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
	Phase overcurrent relay (e.g. 50, 51 or 51V-R) – voltage-restrained	5a	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The overcurrent element must be set greater than 130% of the calculated current derived from the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
		OR		
		5b	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The lower tolerance of the overcurrent element tripping characteristic must not infringe upon the resource capability (including the MVAr output of the resource and any static or dynamic **reactive power** devices) See Figure A.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage**[1]	**Pickup Setting Criteria**
	Phase time overcurrent relay (e.g. 51V-C) – voltage controlled (enabled to operate as a function of voltage)	6	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	Voltage control setting must be set less than 75% of the calculated **generating unit** bus voltage or **collector bus** voltage.
A different application starts on the next page				

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on generator–side[2] / **collector bus** side of the transmission step-up transformers connected to synchronous **generating units** or **aggregated generating facilities**	Phase distance relay (e.g. 21) – directional toward the **transmission system**	7a	**Generating unit** stator winding terminal or **collector bus** voltage corresponding to 0.95 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 150% of the aggregate generation **real power** value, derived from the generator nameplate **apparent power** rating at rated **power factor**.
		OR		
		7b	Calculated **generating unit** stator or **collector bus** winding terminal voltage corresponding to 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer (including the transformer turns ratio and impedance).	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 150% of the aggregate generation **real power** value, derived from the **generating unit** nameplate **apparent power** rating at rated **power factor**.
		OR		

[2] If the relay is installed on the high-side of the transmission step-up transformer, use Option 14.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
		7c	Simulated **generating unit** stator winding or **collector bus** terminal voltage coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer prior to field-forcing.	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output –100% of the aggregate generation maximum gross **reactive power** output during field-forcing as determined by simulation.
	The same application continues on the next page with a different relay type			

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
Relays installed on generator–side[3] / **collector bus** side of the transmission step-up transformers connected to synchronous **generating units** or **aggregated generating facilities**	Phase overcurrent relay (e.g. 50 or 51)	8a	**Generating unit** stator winding terminal or **collector bus** voltage corresponding to 0.95 per nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 150% of the aggregate generation real power value, derived from the **generating unit** nameplate **apparent power** rating at rated **power factor**.
		OR		
		8b	Calculated **generating unit** stator winding or **collector bus** terminal voltage corresponding to 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer (including the transformer turns ratio and impedance).	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 150% of the aggregate generation **real power** value, derived from the **generating unit** nameplate **apparent power** rating at rated **power factor**.
		OR		

[3] If the relay is installed on the high-side of the transmission step-up transformer, use Option 15.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
		8c	Simulated **generating unit** stator winding terminal or **collector bus** voltage coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer prior to field-forcing.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output –100% of the aggregate generation maximum gross **reactive power** output during field-forcing as determined by simulation.
	The same application continues on the next page with a different relay type			

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on generator–side[4] / **collector bus** side of the transmission step-up transformers connected to synchronous **generating units** or **aggregated generating facilities**	Phase directional overcurrent relay (e.g. 67) – directional toward the **transmission system**	9a	**Generating unit** stator winding terminal or **collector bus** voltage corresponding to 0.95 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 150% of the aggregate generation **real power value**, derived from the **generating unit** nameplate **apparent power** rating at rated **power factor**.
		OR		
		9b	Calculated **generating unit** stator winding or **collector bus** terminal voltage corresponding to 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer (including the transformer turns ratio and impedance).	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 150% of the aggregate generation **real power** value, derived from the generator nameplate **apparent power** rating at rated **power factor**.
		OR		

[4] If the relay is installed on the high-side of the transmission step-up transformer, use Option 16.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
		9c	Simulated **generating unit** stator winding terminal or **collector bus** voltage coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit nominal voltage on the high voltage side of the transmission step-up transformer prior to field-forcing.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output –100% of the aggregate generation maximum gross **reactive power** output during field-forcing as determined by simulation.
A different application starts on the next page				

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
Relays installed on generator–side[5] / **collector bus** side of the transmission step-up transformers connected to asynchronous **generating units** or **aggregated generating facilities** comprised of asynchronous **generating units**, including inverter-based installations	Phase distance relay (e.g. 21) – directional toward the **transmission system**	10	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The impedance element must be set less than the calculated impedance derived from 130% of the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
	The same application continues on the next page with a different relay type			

[5] If the relay is installed on the high-side of the transmission step-up transformer, use Option 17.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
Relays installed on generator / **collector bus** side of the transmission step-up transformers connected to asynchronous **generating units** or **aggregated generating facilities** comprised of asynchronous **generating units**, including inverter-based installations	Phase overcurrent relay (e.g. 50 or 51)[6]	11	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer for overcurrent relays installed on the low-side.	The overcurrent element must be set greater than 130% of the calculated current derived from the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
	The same application continues on the next page with a different relay type			

[6] If the relay is installed on the high-side of the transmission step-up transformer, use Option 18.

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on generator – side /**collector bus** side of the transmission step-up transformers connected to asynchronous **generating units** or **aggregated generating facilities** comprised of asynchronous **generating units**, including inverter-based installations	Phase directional overcurrent relay (e.g. 67) – directional toward the **transmission system**[7]	12	**Generating unit** bus voltage corresponding to 1.0 per unit nominal voltage of the high voltage side of the transmission step-up transformer times the turns ratio of the transmission step-up transformer.	The overcurrent element must be set greater than 130% of the calculated current derived from the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).

[7] If the relay is installed on the high-side of the transmission step-up transformer, use Option 19.

A different application starts on the next page

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage**[1]	**Pickup Setting Criteria**
Generating unit or **aggregated generating facilities** auxiliary transformers	Phase overcurrent relay (e.g. 50 or 51) applied at the high-side terminals of the **generating unit** auxiliary transformer, for which operation of the relay will cause the associated **generating unit** to trip.	13a	1.0 per unit of the winding nominal voltage of the **generating unit** auxiliary transformer.	The overcurrent element must be set greater than 150% of the calculated current derived from the **generating unit** auxiliary transformer maximum nameplate **apparent power** rating.
		OR		
		13b	**Generating unit** auxiliary transformer bus voltage corresponding to the measured current.	The overcurrent element must be set greater than 150% of the **generating unit** auxiliary transformer measured current at the **maximum authorized real power** of the **generating unit.**
A different application starts on the next page				

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on the high side of the transmission step-up transformer[8] including relays installed on the remote end of the line for **system elements** that connect any transmission step-up transformers to the **transmission system** that are used to export energy from a **generating unit, aggregated generating facility,** or generating plant – connected to synchronous generators.	Phase distance relay (e.g. 21) – directional toward the **transmission system**	14a	0.85 per unit of the line nominal voltage at the relay location.	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 120% of the aggregate generation **real power** value, derived from the generator nameplate **apparent power** rating at rated **power factor**.
		OR		
		14b	Simulated line voltage at the relay location coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit of the line nominal voltage at the remote end of the line prior to field-forcing.	The impedance element must be set less than the calculated impedance derived from 115% of: (1) **Real power output** – 100% of the aggregated **maximum authorized real power**, and (2) **Reactive power** output –100% of the aggregate generation maximum gross **reactive power** output during field-forcing as determined by simulation.
	The same application continues on the next page with a different relay type			

[8] If the relay is installed on the generator-side of the transmission step-up transformer, use Option 7.

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on the high-side of the transmission step-up transformer[9], including relays installed at the remote end of the line, for **system elements** that connect the transmission step-up transformers to the **transmission system** that are used to export energy directly from a **generating unit**, generating plant or **aggregating generating facilities** – connected to synchronous generators.	Phase Instantaneous overcurrent supervisory element (e.g. 50) – associated with current-based, communication-assisted schemes where the scheme is capable of tripping for loss of communications and/or phase time overcurrent relay (e.g. 51)	15a	0.85 per unit of the line nominal voltage at the relay location	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power output** – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 120% of the aggregate generation **real power** value, derived from the generator nameplate **apparent power** rating at rated **power factor**.
		OR		
		15b	Simulated line voltage at the relay location coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit of the line nominal voltage at the remote end of the line prior to field-forcing.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output –100% of the aggregate generation maximum gross **reactive power** output during field-forcing as determined by simulation.

[9] If the relay is installed on the generator-side of the transmission step-up transformer use Option 8

	The same application continues on the next page with a different relay type

Table 1. Relay Loadability Evaluation Criteria

Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on the high-side of the transmission step-up transformer[10] including relays installed at the remote end of the line for **system elements** that connect the transmission step-up transformers to the **transmission system** that are used	Phase directional instantaneous overcurrent supervisory element (e.g. 67) – associated with current-based, communication-assisted schemes where the scheme is capable of tripping for loss of communications	16a	0.85 per unit of the line nominal voltage at the relay location	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output – 120% of the aggregate generation **real power** value, derived from the generator nameplate **apparent power** rating at rated **power factor**.
		OR		

[10] If the relay is installed on the generator-side of the transmission step-up transformer, use Option 9.

to export energy from a power plant, **generating unit** or a**ggregated generating facility – connected to synchronous generators**.	directional toward the **transmission system** and/or phase directional time overcurrent relay (e.g. 67) – directional toward the **transmission system**	16b	Simulated line voltage at the relay location coincident with the highest **reactive power** output achieved during field-forcing in response to a 0.85 per unit of the line nominal voltage at the remote end of the line prior to field-forcing.	The overcurrent element must be set greater than 115% of the calculated current derived from: (1) **Real power** output – 100% of the aggregate **maximum authorized real power**, and (2) **Reactive power** output –100% of the aggregate generation maximum gross **reactive power** output during field-forcing as determined by simulation.
A different application starts on the next page				

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
Relays installed on the high-side of the transmission step up transformer[11] including relays installed at the remote end of the line for **system elements** that connect the transmission step-up transformers to the **transmission system** that are used to export energy from a power plant, asynchronous **generating units** or **aggregated generating facility** comprised of asynchronous **generating units** including inverter-based installations.	Phase distance relay (e.g. 21) – directional toward the **transmission system**	17	1.0 per unit of the line nominal voltage at the relay location	The impedance element must be set less than the calculated impedance derived from 130% of the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
	The same application continues on the next page with a different relay type			

[11] If the relay is installed on the generator-side of the transmission step-up transformer, use Option 10.

Table 1. Relay Loadability Evaluation Criteria

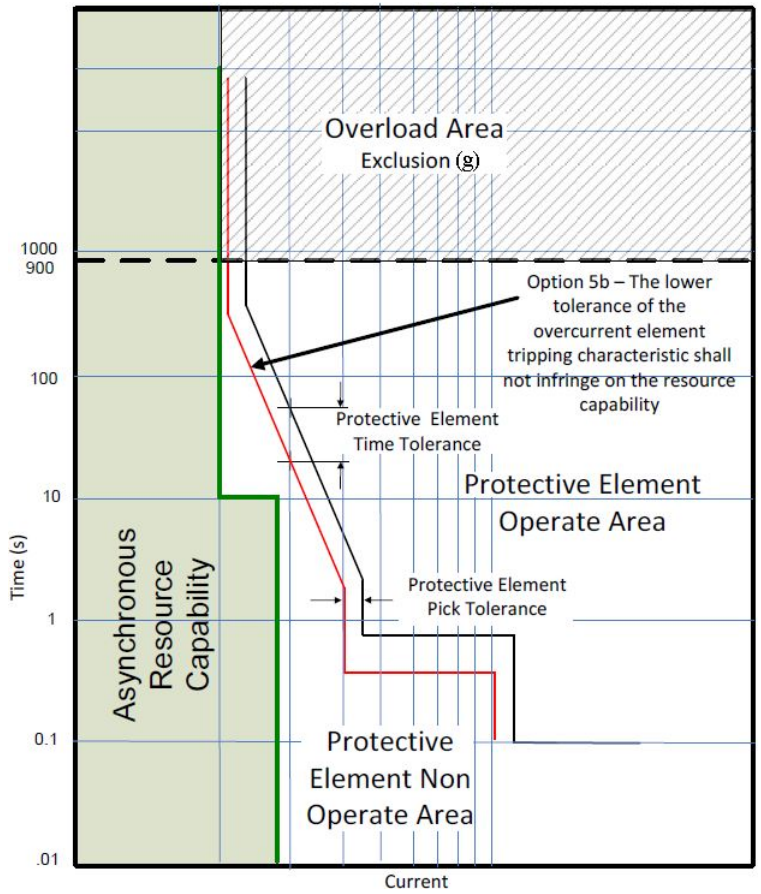
Application	Relay Type	Option	Bus Voltage[1]	Pickup Setting Criteria
Relays installed on the high side of the transmission step-up transformer[12] including relays installed at the remote end of the line for **system elements** that connect the transmission step-up transformers to the **transmission system** that are used to export energy from a power plant, asynchronous **generating unit** or **aggregated generating facility** comprised of asynchronous **generating units** including inverter-based installations.	Phase overcurrent supervisory element (e.g. 50) – associated with current-based, communication-assisted schemes where the scheme is capable of tripping for loss of communications or phase time overcurrent relay (e.g. 51)	18	1.0 per unit of the line nominal voltage at the relay location	The overcurrent element must be set greater than 130% of the calculated current derived from the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
	The same application continues on the next page with a different relay type			

[12] If the relay is installed on the generator-side of the transmission step-up transformer, use Option 11.

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage[1]**	**Pickup Setting Criteria**
Relay installed on the high-side of the transmission step-up transformer[13] including relays installed at the remote end of the line for **system elements** that connect the transmission step-up transformers to the **transmission system** that are used to export energy from a power plant, asynchronous **generating units** or **aggregated generating facility** comprised of asynchronous **generating units** including inverter-based installations.	Phase directional instantaneous overcurrent supervisory element (e.g. 67) – associated with current-based, communication-assisted schemes where the scheme is capable of tripping for loss of communications directional toward the **transmission system** and/or phase directional time overcurrent relay (e.g. 67)	19	1.0 per unit of the line nominal voltage.	The overcurrent element must be set greater than 130% of the calculated current derived from the maximum aggregate nameplate **apparent power** output at rated **power factor** (including the **reactive power** output of any static or dynamic **reactive power** devices).
End of Table 1				

[13] If the relay is installed on the generator-side of the transmission step-up transformer, use Option 12.

Figure A.



This figure is for demonstration of Option 5b and does not mandate a specific type of protective curve or device manufacturer.