ISO Rules
Part 500 Facilities
Division 502 Technical Requirements
Section 502.5 Generating Unit Technical Requirements

Applicability

1 Section 502.5 applies to:

(a) the **legal owner** of a **generating unit** that is:

(i) synchronous; and

(ii) directly connected to the **transmission system** or to **transmission facilities** within the City of Medicine Hat,

including a **generating unit** situated within an industrial complex that is directly connected to the **transmission system**, but not including any **aggregated generating facilities**;

(b) the **legal owner** of a **transmission facility**; and

(c) the **ISO**.

Requirements

Functional Specification

2 The **ISO** must, in accordance and generally consistent with this Section 502.5, approve a functional specification containing details, work requirements, and specifications for the design, construction, and operation of a **generating unit** connection project and any associated **transmission system** connection facilities.

Successor to Prior Requirements

3(1) Subject to subsection 4(3), this Section 502.5 succeeds and replaces sections 1.0, 2.0 and 3.0 of the *Generation and Load Interconnection Standard*, which came into effect as of September 19, 2006, as those sections relate to generation.

(2) The *Generation and Load Interconnection Standard* referred to in subsection 3(1), together with any other prior standards or drafts of standards on the subject matter, will no longer be in force and effect as they relate to generation as of November 21, 2017.

Maximum Authorized Real Power

4(1) The **legal owner** of a **generating unit** must, upon receiving a request from the **ISO**, determine the **maximum authorized real power** value for the **generating unit** and provide this value to the **ISO**.

(2) The **legal owner** of a **generating unit** must consider the **generating unit** capability and limitations under optimal conditions when determining the **maximum authorized real power** for the **generating unit**.

(3) The **ISO** must deem the **maximum authorized real power** for a **generating unit** to be the "maximum authorized MW" the **ISO** previously approved in writing or in the functional specification for the **generating unit**, but only if the **generating unit** continues to meet all conditions of that approval.

Reactive Power Requirements for a Generating Unit

5(1) For the purposes of determining the **reactive power** requirements of this Section 502.5, the **legal owner** of a **generating unit** must determine the root mean square phase-to-phase voltage value at the stator winding terminals of the **generating unit**, to be used as the 1.00 per unit voltage value.

(2) A **generating unit** and any external **reactive power** resources approved under subsection 5(7) must have the capability to operate in accordance with the requirements of this subsection 5 by both:

(a) manual control of the set point of the **automatic voltage regulator** of the **generating unit**; and

(b) automated action of the **automatic voltage regulator** of the **generating unit**.

(3) Subject to the exception in subsection 5(5), the **reactive power** capability of the **generating unit** must be in compliance with the following minimum requirements:

(a) zero point nine (0.9) **power factor**, over-excited; and

(b) zero point nine five (0.95) **power factor**, under-excited;

based on the **maximum authorized real power** of the **generating unit** over the entire **real power** operating range, down to the applicable minimum **gross real power**.

(4) Subject to the exception in subsection 5(5), a **generating unit** must not have limiters set to reduce the **reactive power** capability set out in subsection 5(3).

(5) The **legal owner** of a **generating unit** that has the capability to meet the **reactive power** requirements of this subsection 5 but that has stability concerns must submit in writing to the **ISO**:

(a) a request for approval of a proposed reduction in the **reactive power** capability requirement set out in subsection 5(3)(b) due to **generating unit** stability concerns; and

(b) a detailed study in support of the request, which is specific to the **generating unit** at its location and completed by a qualified professional engineer, demonstrating that the **reactive power** capability set out in subsection 5(3)(b) should be reduced by a limiter because that **reactive power** capability will cause the **generating unit** to become unstable.

(6) The **ISO** must make a decision on its approval and notify the **legal owner** in writing of the decision no later than ninety (90) **days** after the date of receiving the submission set out in subsection 5(5).

(7) The **legal owner** of a **generating unit** without the capability to meet the **reactive power** capability set out in subsection 5(3) must submit to the **ISO** a request in writing for approval of the use of an external dynamic **reactive power** resource to compensate for the lack of capability, such that the combined capability of the **generating unit** and the external dynamic **reactive power** resource meets the requirements of subsection 5(3).

Voltage Ride-Through Requirements for Existing Generating Units

6(1) This subsection 6 applies to the **legal owner** of a **generating unit** without a functional specification referencing this Section 502.5 and which such **generating unit**:

(a) has a **maximum authorized real power** greater than 9.0 MW; or:

(b) is a part of a complex with other **generating units** with an aggregate **maximum authorized real power** amount greater than 9.0 MW.

(2) For the purposes of determining the voltage ride-through requirements of this Section 502.5, the **legal owner** of a **generating unit** must determine the root mean square phase-to-phase voltage value at the high voltage side of the **transmission system** step-up transformer, to be used as the 1.0 per unit voltage value.

(3) The **legal owner** of a **generating unit** must ensure that the **generating unit** is designed to meet

all of the following voltage ride-through requirements:

(a) continuous operation between 0.90 and 1.10 per unit of the voltage value determined under subsection 6(2);

(b) not tripping or going off-line during, as a result of, a voltage dip or post-transient voltage deviation resulting from a **disturbance** on the **transmission system**, on any phase or combination of phases at or beyond the **point of connection**, in accordance with the timing requirements of Appendix 1; and

(c) the amount of time that the voltage of the **generating unit** remains at 0.15 per unit must be at least the **normal clearing** time for a three (3) phase fault at the specific location where the **generating unit** is connected to the **transmission system**.

(4) Notwithstanding any other provision of this subsection 6, a **generating unit** is not required to ride-through a **transmission system** fault that:

(a) causes a forced outage of a radial transmission line connecting the **generating unit** to the **transmission system**;

(b) occurs on the **generating unit** side of the **point of connection**, including the low voltage network and the substation; or

(c) results in the activation of a transfer trip or anti-islanding protection scheme at the **generating unit** which will cause the **generating unit** to be disconnected from the **transmission system**.

Voltage Ride-Through Requirements for New Generating Units

7(1) This subsection 7 applies to the **legal owner** of a **generating unit** with a functional specification referencing this Section 502.5 and which such **generating unit**:

(a) has a **maximum authorized real power** greater than 9.0 MW; or

(b) is a part of a complex with other **generating units** with an aggregate **maximum authorized real power** amount greater than 9.0 MW;

(2) For the purposes of determining the voltage ride-through requirements of this Section 502.5, the **legal owner** of a **generating unit** must determine the root mean square phase-to-phase voltage value at the high voltage side of the **transmission system** step-up transformer of the **generating unit**, to be used as the 1.0 per unit voltage value.

(3) The **legal owner** of a new **generating unit** must ensure the **generating unit** is designed to meet all of the following voltage ride-through requirements:

(a) continuous operation between 0.90 and 1.10 per unit of the voltage value determined under subsection 7(2); and

(b) not tripping or going off-line, as a result of a voltage dip or post-transient voltage deviation resulting from a **disturbance** on the **transmission system**, on any phase or combination of phases at or beyond the **point of connection**, in accordance with the timing requirements of Appendix 2; and

(c) the amount of time that the voltage of the **generating unit** remains at 0.0 per unit must be at least the **normal clearing** time for a three (3) phase fault at the specific location where the **generating unit** is electrically connected to the **transmission system**.

(4) Notwithstanding any other provision of this subsection 7, a **generating unit** is not required to ride-through a **transmission system** fault that:

(a) causes a forced outage of a radial transmission line connecting the **generating unit** to the **transmission system**;

(b) occurs on the **generating unit** side of the **point of connection**, including the low voltage network and the substation; or

(c) results in the activation of a transfer trip or anti-islanding protection scheme at the **generating unit** which causes the **generating unit** to be disconnected from the **transmission system.**

Automatic Voltage Regulator

8(1) A **generating unit** must have a continuously variable, continuously acting, closed loop, centralized **automatic voltage regulator** that:

(a) compares a measured voltage to a set point;

(b) controls any dynamic **reactive power** resources needed to meet the requirements of this Section 502.5;

(c) is designed to be continuously in service and controlling while the **generating unit** is electrically connected to the **transmission system**;

(d) is capable of operating in a voltage set point control mode, to the exclusion of any other modes;

(e) is capable of manual set point adjustments to a percentage between 0.95 per unit and 1.05 per unit of the operating voltage value determined under subsection 5(1); and

(f) in combination with the **generating unit** facilities, is able to achieve, under non-**disturbance** conditions, a steady state voltage regulation of plus or minus 0.5% of the voltage set point at the point of control which, subject to subsections 8(3) through 8(6), is at the stator winding terminals of the **generating unit**.

(2) The **legal owner** of a **generating unit** may submit a request in writing to the **ISO** for approval to use a reactive current compensation feature in the **automatic voltage regulator** to adjust the point of control to be other than the stator winding terminals of the **generating unit**.

(3) The **ISO** must make a decision on its approval and notify the **legal owner** in writing of the decision no later than ninety (90) **days** after the date of receiving the submission set out in subsection 8(2).

(4) A **generating unit** must be designed so that the point of control for the **automatic voltage regulator** is not at the high voltage side of the **transmission system** step-up transformer.

(5) A **generating unit** must be designed so that, if the stator winding terminals of two (2) or more **generating units** are connected to a common bus with no significant impedance between the stator winding terminals, then the **automatic voltage regulator** of each **generating unit** must be capable of reactive current compensation, the point of control is within the impedance of the **generating units**.

(6) A **generating unit** must be designed so that, if the **automatic voltage regulators** of two (2) or more **generating units** have a common measurement point, then there is reactive current compensation in each **automatic voltage regulator**.

(7) Stator current limiters are prohibited for a **generating unit**.

Frequency and Speed Governing Requirements

9(1) A **generating unit** with a **maximum authorized real power** equal to or greater than 10 MW must have a continuously acting **governor system**, which must be designed:

(a) to be continuously in service, free to respond to frequency changes and controlling the response to frequency changes while the **generating unit** is electrically connected to the **transmission system** and is producing any **real power** as measured at the generator stator winding terminals;

(b) with a droop setting equal to or greater than 3% but less than or equal to 5%;

(c) with a deadband, intentional plus unintentional, not exceeding plus or minus 0.036 Hz; and

(d) with the capability of manual setpoint adjustments within a range of 59.4 Hz and 60.6 Hz.

(2) A **generating unit** must be designed not to trip for under-frequency and over-frequency deviations for the minimum time frames as set out in Appendix 3.

(3) Notwithstanding subsection 9(2), a **generating unit** that trips off in a shorter period than the minimum time set forth in Appendix 3 must have binding and firm arrangements to automatically and simultaneously trip off an amount of load in MW on the **interconnected electric system** equal to the anticipated generation loss in MW, at comparable frequency levels.

Power System Stabilizer

10(1) If a **generating unit**:

(a) has a **maximum authorized real power** greater than 27 MW; or

(b) is a part of a complex with other **generating units** with an aggregate **maximum authorized real power** amount greater than 67.5 MW;

then a power system stabilizer must be installed on each **generating unit**.

(2) If the **legal owner** of a **generating unit** replaces the exciter or **automatic voltage regulator** on a planned basis at any time after November 18, 1993, and the **generating unit**:

(a) has a **maximum authorized real power** greater than 27 MW; or

(b) is a part of a complex with other **generating units** with an aggregate **maximum authorized real power** amount greater than 67.5 MW;

then a power system stabilizer must be installed on each **generating unit**.

(3) Notwithstanding subsection 10(1) and 10(2), a power system stabilizer is not required to be installed on a **generating unit** if the closed loop phase lag between the **generating unit** voltage at the stator winding terminals and the **automatic voltage regulator** reference input is greater than 135 degrees.

(4) If a pump storage **generating unit** is equipped with a power system stabilizer and is capable of operating in the pump mode while electrically connected to the **transmission system** such that the power system stabilizer does not produce negative damping, then the power system stabilizer must be designed to be in service in the pump mode.

(5) A power system stabilizer must:

(a) be designed to be in continuous operation while the **generating unit** is on-line, except for when the **generating unit** is producing less **real power** than its design limit for effective power system stabilizer operation;

(b) be reviewed and retuned if any **automatic voltage regulator** response parameters for the **generating unit** are modified;

(c) be either:

(i) a dual input integral of accelerating **real power** type; or

(ii) a single input speed or frequency type;

(d) provide a compensated frequency response of the excitation system and **generating unit** such that, through the frequency range from 0.1 Hz to 1.0 Hz, the phase shift will not exceed plus or minus 30 degrees;

(e) be capable of output limits between plus or minus 5% of the operating voltage value submitted under subsection 5(1) and be approved by the **ISO** under subsection 5(6);

(f) have the gain set to provide a gain margin of no less than 6 dB and no more than 10 dB; and

(g) have the washout time constant set as low as possible while maintaining the compensated phase criteria.

(6) A power system stabilizer of the **real power** type is prohibited for a **generating unit**.

Transmission System Step-Up Transformer

11(1) The **legal owner** of a **generating unit** must ensure that the capability of the **transmission system** step-up transformer for the **generating unit** is such that the **real power** and **reactive power** requirements specified in this Section 502.5 are fully available throughout the continuous operating voltage range for the **generating unit**.

(2) The **legal owner** of a **generating unit** must, in determining the capability of the **transmission system** step-up transformer under subsection 11(1), consider the following:

(a) thermal capability of:

(i) bushings;

(ii) windings; and

(iii) tap changer;

(b) voltage ratio;

(c) tap changer type;

(d) tap changer range; and

(e) any other components that may limit the thermal capability of the **transmission system** step-up transformer.

(3) To meet the requirements of subsection 11(1), the **legal owner** of a **generating unit** may subtract the amount of auxiliary and excitation system load in **apparent power** from the **apparent power** capability of the **generating unit** at the **maximum authorized real power**, but only if any of that auxiliary and excitation system load is connected between the **generating unit** stator winding terminals and the

transmission system step-up transformer.

(4) Subject to subsection 11(5), the **legal owner** of a **generating unit** must ensure that the **transmission system** step-up transformer winding connections for the **generating unit** provide for:

(a) a favourable circuit to block the transmission of harmonic currents;

(b) isolation of **transmission system** and low voltage side ground fault current contributions;

(c) an effectively grounded wye connection on the high voltage side of the transformer; and

(d) on-load or off-load tap changers with a minimum capability of plus or minus 5% voltage range in 2.5% increments.

(5) Notwithstanding subsection 11(4) the **legal owner** of a **generating unit**:

(a) without a functional specification referencing this Section 502.5; and

(b) with a **transmission system** step-up transformer that does not comply with the requirements of subsection 11(3);

is exempt from complying with subsection 11(4), but if at any time after November 21, 2017, the **transmission system** step-up transformer is replaced on a planned basis, then the **legal owner** must ensure the replacement equipment meets the requirements of subsection 11(4).

Auxiliary Systems

12(1) When multiple **generating units** are at a common location, the auxiliary systems of each **generating unit** must be designed such that:

(a) the failure of a single component will not result in the simultaneous tripping or shutdown of two (2) or more **generating units**;

(b) staggered shutdowns of each **generating unit** must be separated in time by more than ten (10) minutes; and

(c) for combined cycle plants, the loss of the combustion turbine that results in the tripping of the steam turbine is acceptable.

(2) The auxiliary systems of each **generating unit** must be designed to take into account the voltage ride-through requirements as specified in subsection 6 or 7, as applicable.

(3) The **legal owner** of a **generating unit** without a functional specification referencing this Section 502.5 but with auxiliary systems that do not comply with the requirements of subsection 12(1) is exempt from complying with subsection 12(1).

Generating Unit Disconnection and Interrupting Devices

13(1) The **legal owner** of the **generating unit** and the **legal owner** of the **transmission facility** to which the **generating unit** is connected must ensure that there are circuit breakers and controls that will electrically disconnect the **generating unit** from the **transmission system** at the **point of connection**.

(2) The circuit breaker design for the **generating unit** must account for the present and future fault current contributions from both the **transmission system** and the **generating unit** facilities.

(3) The **legal owner** of a **generating unit** and the **legal owner** of the **transmission facility** to which the **generating unit** is connected must not use fuses at 60 kV or higher to meet any of the requirements

of this subsection 13.

Isolating Devices

14(1) The **legal owner** of a **generating unit** and the **legal owner** of the **transmission facility** to which the **generating unit** is connected must ensure that:

(a) the **generating unit** has a minimum of one (1) isolation device with manual operation capability at a point of isolation; and

(b) the isolation device(s) referred to in subsection 14(1)(a):

(i) permit visual verification of electrical isolation and are capable of being locked open with multiple locks;

(ii) are under the control of a single control authority, as confirmed by a joint operating agreement between the **legal owner** of the **generating unit** and the **legal owner** of the **transmission facility**; and

(iii) permit the installation of temporary safety grounding so that either side of the isolation device can be safely maintained when the other side is energized.

(2) The **legal owner** of a **generating unit** without a functional specification referencing this Section 502.5 is exempt from the requirements of subsection 14(1)(b)(iii).

Power Quality

15 The **generating unit** must be designed to meet the following power quality requirements at the **point of connection**:

(a) for flicker, the induced voltage must:

(i) be in compliance with the specifications set out in the version of the *International Electrotechnical Commission 61000-3-7, Electromagnetic compatibility (EMC) – Part 3-7: Limits - Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems* that:

(A) for a **generating unit** with a functional specification referencing this Section 502.5, is in effect as of the date the **ISO** first approves the functional specification for the **generating unit** connection project; or

(B) for a **generating unit** without a functional specification referencing this Section 502.5, was in effect as of September 19, 2006;

(ii) be in compliance with the short and long term flicker limits as set out in the following Table 1:

Table 1

Short and Long Term Flicker Limits

Planning Levels	
P_{st}	P_{lt}
0.8	0.6

where:

Pst is the magnitude of the resulting short term flicker level for the considered aggregation of flicker sources (probabilistic value);

Plt is the magnitude of the resulting long term flicker level for the considered aggregation of flicker sources (probabilistic value);

and

(iii) meet the:

(A) 99% probability weekly value for Pst; and

(B) 95% probability weekly value for Plt

based on a measurement period of one (1) week of normal operation of the **generating unit**;

(b) for harmonics, the **generating unit** must be in compliance with the specifications set out in the version of the *IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems* that:

(i) for a **generating unit** with a functional specification referencing this Section 502.5, is in effect as of the date the **ISO** first approves of the functional specification for the **generating unit** connection project; or

(ii) for a **generating unit** without a functional specification referencing this Section 502.5, was in effect as of September 19, 2006;

(c) for resonance, the **generating unit** must not introduce any resonance into the **transmission system**, including self-excitation of induction machines, transformer ferroresonance, resonant effects of capacitor additions and the capacitance of the cables of the **generating unit**;

Grounding

16 A **generating unit** must be designed to operate within a **transmission system** that operates as an effectively grounded system.

Lightning and Other Surge Protection

17(1) A **generating unit** must be equipped with surge protection for any associated substation

equipment.

(2) The surge protection referred to in subsection 17(1) must operate under the following conditions:

(a) lightning, including the average ground flash density level for the **generating unit** location;

(b) switching surges;

(c) neutral shifts;

(d) **electrical islands**; and

(e) temporary over-voltages.

(3) The surge protection referred to in subsection 17(1) must be compatible with the **transmission facility** connected to the **generating unit** to ensure coordination of insulation levels.

Synchrophasor Measurement System

18(1) A new **generating unit** or an existing **generating unit** that undergoes a modification replacing the protective relays must be equipped with a synchrophasor measurement system.

(2) The synchrophasor measurement system referred to in subsection 18(1) must be designed to record at the following locations:

(a) at the stator winding terminal of the **generating unit** for all three (3) phase-to-ground voltages and currents; and

(b) at the high side of the step-up transformer of the **generating unit** for all three (3) phase-to-ground voltages and currents.

(3) The **legal owner** of the **generating unit** must design a synchrophasor measurement system that is capable of downloading and retaining the recordings set out in subsection 18(2) for a period of not less than one (1) calendar year from the date of the initial recording.

(4) As of November 21, 2017, the **legal owner** of any **generating unit** without a functional specification referencing this Section 502.5 is exempt from the requirements of this subsection 18 but, if at any time after November 21, 2017the protective relays are replaced on a planned basis, then the replacement equipment must include a synchrophasor measurement system that meets the requirements of this subsection 18.

Internal Sequence of Event Monitoring

19(1) Subject to subsection 19(4), a **generating unit** must have an internal sequence of event monitoring system that initiates an event record for every event that results in a trip of the **generating unit**, or for the status of key components, including if present:

(a) a **governor system** trip;

(b) an **automatic voltage regulator** trip, including:

(i) over-excitation limiter action; and

(ii) under-excitation limiter action;

(c) a medium and low voltage switchgear and motor control centre protection trip;

(d) the status of key auxiliary components, including:

(i) induced draft and forced draft fans;

(ii) boiler feed water pumps;

(iii) turbine inlet valves;

(iv) medium and low voltage switchgear and motor control centres; and

(e) a mechanical protection trip.

(2) The **legal owner** of the **generating unit** must design a sequence of event monitoring system that is capable of downloading and retaining the recordings set out in subsection 19(1) for a period of not less than one (1) calendar year from the date of the initial recording.

(3) The sequence of event monitoring system must be synchronized to within one (1) millisecond of the Coordinated Universal Time scale.

(4) As of November 21, 2017, the **legal owner** of a **generating unit** without a functional specification referencing this Section 502.5 with an internal sequence of event monitoring system that is incapable of monitoring and recording any specific event or component set out in subsection 19(1) is exempt from monitoring and recording of that specific event or equipment, but if at any time after November 21, 2017 the sequence of event monitoring system is replaced, then the replacement system must meet the monitoring and reporting requirements of this subsection 19.

Appendices

Appendix 1 –*Voltage Ride-Through Requirements for Existing Generating Units*

Appendix 2 – *Voltage Ride-Through Requirements for New Generating Units*

Appendix 3 – *Frequency Ranges*

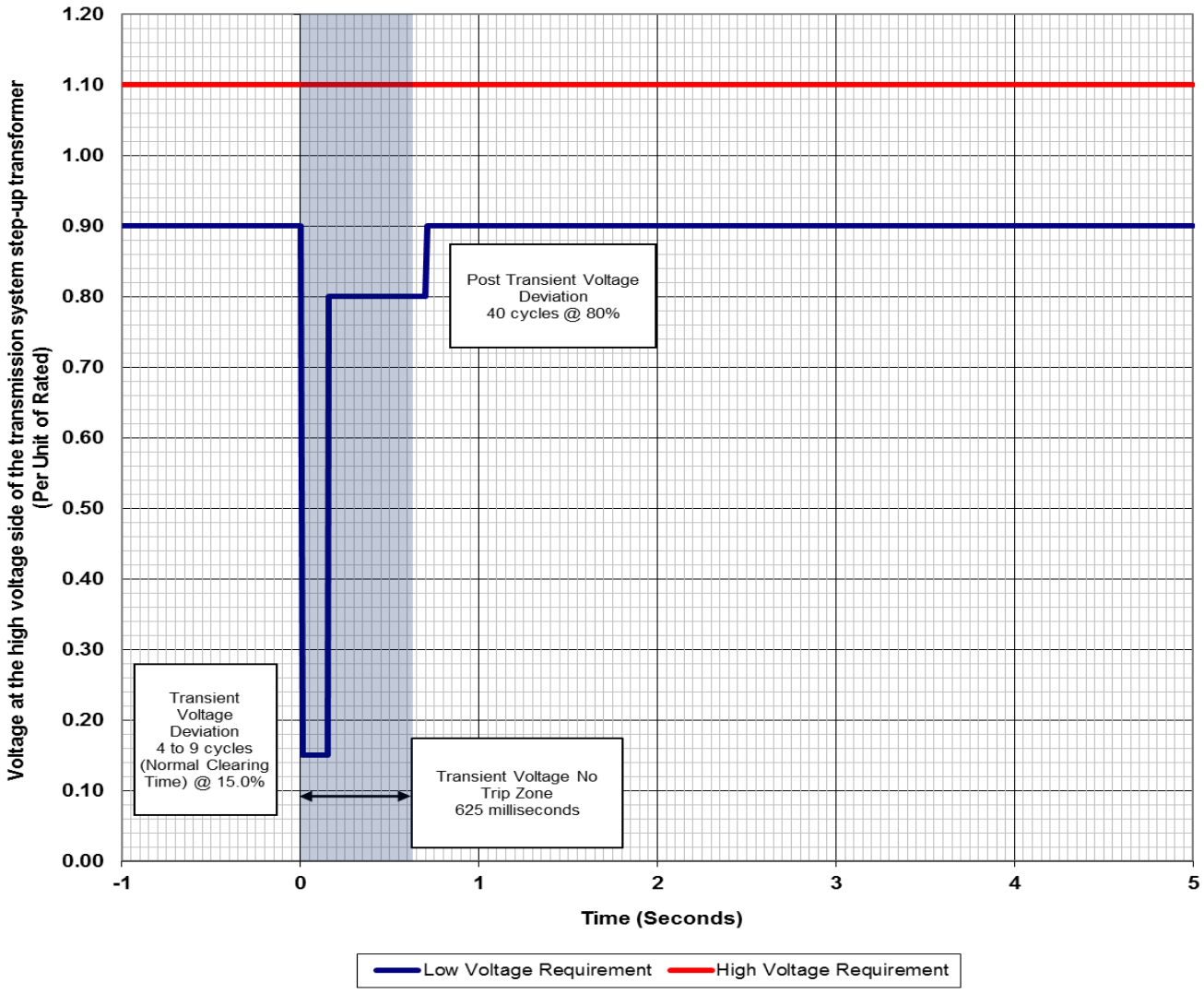
Revision History

Date	Description
2019-12-11	Removed duplication with new Section 103.14, *Waivers and Variances*; standardized functional specifications language; capitalized references to “Section”; inserted effective date of November 21, 2017, where applicable.
2017-11-21	Initial release.

Appendix 1

Voltage Ride-Through Requirements – Existing Generating Units

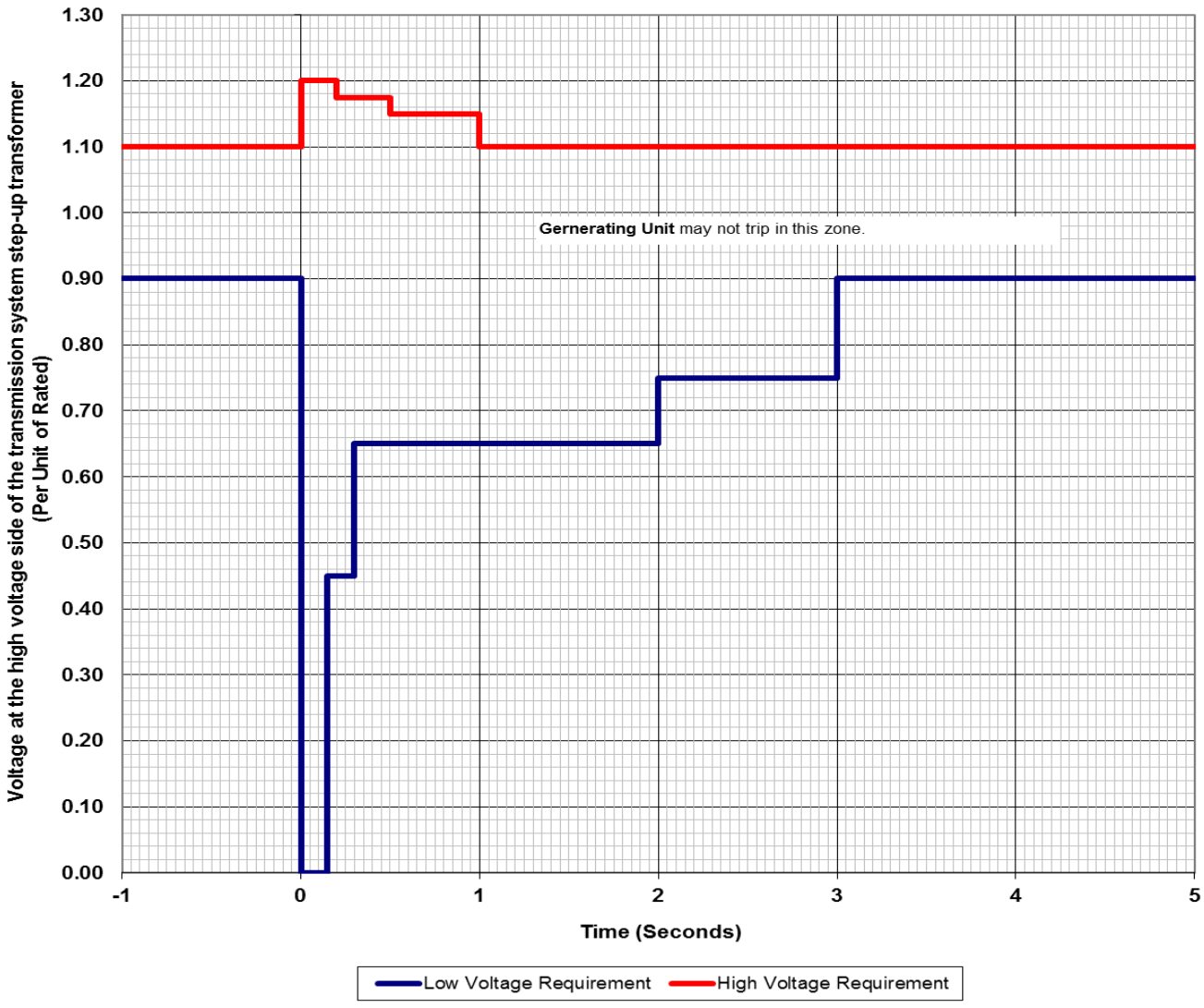
High Voltage Ride Through Duration		Low Voltage Ride Through Duration	
Voltage (per unit)	**Time**	**Voltage (per unit)**	**Time**
> 1.100	Instantaneous trip	< 0.15	4 to 9 Cycles
-	-	< 0.80	40 Cycles
≤ 1.10	Continuous operation	≥ 0.90	Continuous operation


Voltage at the high voltage side of the transmission system step-up transformer (Per Unit of Rated)
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-1
0
1
2
3
4
5
Time (Seconds)
Post Transient Voltage Deviation 40 cycles @ 80%
Transient Voltage Deviation 4 to 9 cycles (Normal Clearing Time) @ 15.0%
Transient Voltage No Trip Zone 625 milliseconds
Low Voltage Requirement
High Voltage Requirement

Appendix 2

Voltage Ride-Through Requirements – New Generating Units

High Voltage Ride Through Duration		Low Voltage Ride Through Duration	
Voltage (per unit)	**Time**	**Voltage (per unit)**	**Time**
≥ 1.200	Instantaneous trip	< 0.45	4 to 9 cycles
≥ 1.175	0.20 seconds	< 0.65	0.30 seconds
≥ 1.15	0.50 seconds	< 0.75	2.00 seconds
≥ 1.10	1.00 seconds	< 0.90	3.00 seconds
< 1.10	Continuous operation	≥ 0.90	Continuous operation


1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Voltage at the high voltage side of the transmission system step-up transformer (Per Unit of Rated)
Gernerating Unit may not trip in this zone.
-1
0
1
2
3
4
5
Time (Seconds)
Low Voltage Requirement
High Voltage Requirement

Appendix 3

Frequency Ranges

High Frequency Duration		Low Frequency Duration	
Frequency (Hz)	**Time (seconds)**	**Frequency (Hz)**	**Time (seconds)**
≥ 61.7	Instantaneous trip	≤57.0	Instantaneous trip
≥61.6	30	≤57.3	0.75
≥60.6	180	≤ 57.8	7.5
<60.6	Continuous operation	≤ 58.4	30
		≤ 59.4	180
		> 59.4	Continuous operation