ISO Rules
Part 500 Facilities
Division 502 Technical Requirements
Section 502.1 Aggregated Generating Facilities Technical Requirements

Applicability

1(1) Section 502.1 applies to:

(a) the **legal owner** of an **aggregated generating facility** directly connected to the **transmission system** or to a **transmission facility** within the service area of the City of Medicine Hat, including an **aggregated generating facility** situated within an industrial complex that is directly connected to the **transmission system** or to a **transmission facility** within the service area of the City of Medicine Hat, except as described in subsection 1(2);

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

(c) the **ISO**.

(2) Subject to subsection 1(3), the provisions of this Ssection 502.1 do not apply to the **legal owner** of an **aggregated generating facility** that was energized and commissioned prior to April 7, 2017 in accordance with a previous technical requirement, technical standard, **ISO rule** or functional specification, but the **legal owner** of such an existing **aggregated generating facility** must remain compliant with all the standards and requirements set out in that previous technical requirement, technical standard, **ISO rule** or functional specification, and must also meet the applicable requirements set out in Ssection 304.9 of the ISO rules*, Wind and Solar Aggregated Generating Facility Forecasting* and Ssection 502.16 of the ISO rules, *Aggregated Generating Facilities Operating Requirements*.

(3) Where an **aggregated generating facility** directly connected to the **transmission system** or a **transmission facility** within the service area of the City of Medicine Hat described in subsection 1(2) undergoes one or more:

(a) facility additions after April 7, 2017 resulting in an increase in the cumulative **gross real power** capability of the **aggregated generating facility** by an amount equal to or greater than 5 MW; or

(b) equipment replacements after April 7, 2017 where the equipment replaced has a **gross real power** capability equal to or greater than 5 MW irrespective of whether the cumulative **gross real power** capability of the **aggregated generating facility** is increased,

this Ssection 502.1 applies in respect of the facility addition(s) or equipment replacement(s) as if the addition(s) or replacement(s) is a new **aggregated generating facility**;

(4) Notwithstanding subsection 1(2) and (3), the **ISO** may require the **legal owner** of an **aggregated generating facility** or a **transmission facility** to comply with any specific provision or all of the provisions of this Ssection 502.1, if the **ISO** determines that such compliance is necessary for the safe and reliable operation of the **interconnected electric system**.

Requirements

Functional Specification

2~~(1)~~ The **ISO** must~~ay~~, in accordance and generally consistent with this Ssection 502.1, ~~issue~~ approve a written functional specification containing details, work requirements, and specifications for the design, construction, and operation of an **aggregated generating facility** and associated **transmission facility** connection facilities.

~~**(2)** The functional specification referred to in subsection 2(1) must be generally consistent with the provisions of this section 502.1, but may contain material variances approved of by the **ISO** based upon its discrete analysis of any one or more of the technical, economic, safety, operational and **reliability** requirements of the **interconnected electric system** related to the specific facility project.~~

Maximum Authorized Real Power

3(1) The **legal owner** of an **aggregated generating facility** must, upon receiving a request from the **ISO**, determine the **maximum authorized real power** for the **aggregated generating facility** and provide this value to the **ISO**.

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

Reactive Power Requirements

4(1) For the purposes of determining the dynamic **reactive power** requirements of this Ss~~s~~ection 502.1, the **legal owner** of an **aggregated generating facility** must determine the root mean square phase-to-phase voltage value at the **collector bus** of the **aggregated generating facility**, to be used as the 1.00 per unit voltage value.

(2) An **aggregated generating facility** and any external dynamic **reactive power** resources approved under subsection 4(6) must have the capability to operate by both:

(a) manual control of the set point of the **voltage regulating system** of the **aggregated generating facility**; and

(b) automated action of the **voltage regulating system** of the **aggregated generating facility**.

(3) Subject to subsection 4(5), the dynamic **reactive power** capability of the **aggregated generating facility** must be in compliance with the following minimum requirements:

(a) 0.90 **power factor**, supplying dynamic **reactive power**; and

(b) 0.95 **power factor**, absorbing dynamic **reactive power**;

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

(4) Subject to subsection 4(5), an **aggregated generating facility** must not have limiters set to reduce the dynamic **reactive power** capability set out in subsection 4(3).

(5) The **legal owner** of an **aggregated generating facility** that has the capability to meet the dynamic **reactive power** requirements of this subsection 4 but that has stability concerns must submit in writing to the **ISO**:

(a) a request for a variance allowing for the reduction in the dynamic **reactive power** capability requirement set out in subsection 4(3)(b) due to **aggregated generating facility** stability concerns; and

(b) a detailed study in support of the request, which is specific to the **aggregated generating facility** at its location and completed by a qualified professional engineer, demonstrating that the dynamic **reactive power** capability set out in subsection 4(3)(b) should be reduced by a limiter because that dynamic **reactive power** capability will cause the **aggregated generating facility** to become unstable.

(6) The **legal owner** of an **aggregated generating facility** without the capability to meet the dynamic **reactive power** capability set out in subsection 4(3) must submit to the **ISO** in writing a request for a variance allowing for the use of an external dynamic **reactive power** resource to compensate for the lack of capability, such that the combined capability of the **aggregated generating facility** and the external dynamic **reactive power** resource meets the requirements of subsection 4(3).

Voltage Ride-Through Requirements

5(1) For the purposes of determining the voltage ride-through requirements of this Ss~~s~~ection 502.1, the **legal owner** of an **aggregated generating facility** 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 **aggregated generating facility**, to be used as the 1.00 per unit voltage value.

(2) The **legal owner** of an **aggregated generating facility** must ensure the **aggregated generating facility** is designed to meet all of the following voltage ride-through requirements:

(a) continuous operation greater than or equal to 0.90 and less than or equal to 1.10 per unit of the voltage value determined under subsection 5(1);

(b) not tripping or going off-line, as a result of a voltage dip or a post-transient voltage deviation resulting from a **disturbance** on **transmission facilities**, 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 **aggregated generating facility** 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 **aggregated generating facility** is connected to the **transmission system** or to a **transmission facility** within the service area of the City of Medicine Hat.

(3) Notwithstanding any other provision of this subsection 5, an **aggregated generating facility** is not required to ride-through a fault on **transmission facilities** that:

(a) causes a forced outage of a radial transmission line connecting the **aggregated generating facility** to the **transmission system** or a **transmission facility** within the service area of the City of Medicine Hat;

(b) occurs on the **aggregated generating facility** 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 **aggregated generating facility** which causes the **aggregated generating facility** to be disconnected from the **transmission system** or a **transmission facility** within the service area of the City of Medicine Hat.

Voltage Regulation

6(1) An **aggregated generating facility** must be able to regulate voltage at the **voltage regulation system** or **automatic voltage regulator** point of control, under both non-disturbance and disturbance conditions.

(2) An **aggregated generating facility** must be designed so that the point of control for the **voltage regulation system** or **automatic voltage regulator** is not at the high voltage side of the **transmission facility** step-up transformer.

(3) The **aggregated generating facility** must have at least one (1) continuously variable, continuously acting, closed loop, centralized control **voltage regulating system** or **automatic voltage regulator** that measures voltage compared to a set point, and will control reactive devices including **generating units**, dynamic **reactive power** resources, capacitor and reactor banks.

(4) The **voltage regulating system** or **automatic voltage regulator** set point must be adjustable by the **operator** of the **aggregated generating facility** to a percentage between 95% and 105% of nominal voltage at the point of control for the **voltage regulating system** or **automatic voltage regulator**.

(5) The **voltage regulating system** or **automatic voltage regulator** must operate in a voltage set point control mode to the exclusion of any other modes.

(6) The **voltage regulating system** or **automatic voltage regulator** must measure voltage that represents the overall voltage response of the **aggregated generating facility**.

(7) The **voltage regulating system** or **automatic voltage regulator** must be capable of:

(a) adjustable gain, or reactive droop compensation adjustable from 0% to 10%; and

(b) reactive current compensation to compensate for any step-up transformers connected to the **transmission system** or a **transmission facility** within the service area of the City of Medicine Hat.

(8) The combined settings of the **voltage regulating system** or **automatic voltage regulator** must be able to achieve a steady state voltage regulation of +/- 0.5% of the voltage controlled by the **voltage regulating system** or **automatic voltage regulator**.

(9) The **ISO** must specify in the functional specification for the **aggregated generating facility** whether the reactive current compensation in the **voltage regulating system** or **automatic voltage regulator** must be implemented.

(10) The **voltage regulating system** or **automatic voltage regulator** must be calibrated such that a change in **reactive power** will achieve 95% of its final value, no sooner than zero point one (0.1) seconds and no later than one (1) second following a step change in voltage.

(11) When the **voltage regulation system** or **automatic voltage regulator** requires the switching of a shunt reactive device, the switching operation must be delayed by ten (10) seconds.

Frequency and Speed Governing Requirements

7(1) An **aggregated generating facility** 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 **aggregated generating facility** is connected to the **transmission system** or a **transmission facility** within the service area of the City of Medicine Hat and is producing any **real power** as measured at the **collector bus**;

(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;

(d) not to have an intentional time delay added to the control system;

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

(f) to continuously monitor the frequency of the electric system or the speed of a synchronous **generating unit** at a sample rate of at least twenty (20) samples per second; and

(g) with a resolution of at least 0.004 Hz.

(2) The **governor system** must override any power limits in effect at the time of the frequency excursion but only while the frequency remains outside of the deadband.

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

(4) Notwithstanding subsection 7(3), an **aggregated generating facility** that trips off in a shorter period than the minimum time set forth in Appendix 2 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.

WECC Stability Control Requirements for an Aggregated Generating Facility Consisting of Directly Coupled Asynchronous Generating Units or Decoupled Generating Units

8 If any **WECC** standards or policies specify the use of a power system stabilizer or similar functionality for an **aggregated generating facility** consisting of directly coupled asynchronous **generating units** or decoupled **generating units**, then based on those standards or policies the **ISO** may, by written notice to the **legal owner**, require an **aggregated generating facility** consisting of directly coupled asynchronous **generating units** or decoupled **generating units** to use such a power system stabilizer.

WECC Stability Control Requirements for an Aggregated Generating Facility Consisting of Directly Coupled Synchronous Generating Units

9(1) The **legal owner** of an **aggregated generating facility** consisting of directly coupled synchronous **generating units** and with a **maximum authorized real power** greater than 67.5 MW must install power system stabilizers.

(2) Notwithstanding subsection 9(1), a power system stabilizer is not required to be installed on an **aggregated generating facility** consisting of directly coupled synchronous **generating units** if the closed loop phase lag between the **aggregated generating facility** voltage at the **collector bus** and the **automatic voltage regulator** reference input is greater than 135 degrees.

(3) Any pumped storage **aggregated generating facility** consisting of directly coupled synchronous **generating units** must be equipped with a power system stabilizer and be capable of operating in the pump mode while connected to the **transmission system** or a **transmission facility** in the service area of the City of Medicine Hat, and if 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.

(4) A power system stabilizer must:

(a) be designed to be in continuous operation while the **aggregated generating facility** consisting of directly coupled synchronous **generating units** is on-line, except for when the **aggregated generating facility** consisting of directly coupled synchronous **generating units** 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 **aggregated generating facility** consisting of directly coupled synchronous **generating units** 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 the **aggregated generating facility** consisting of directly coupled synchronous **generating units** 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 4(1);

(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.

(5) A power system stabilizer of the **real power** type is prohibited for an **aggregated generating facility** consisting of directly coupled synchronous **generating units**.

(6) The use of a single power system stabilizer for an **aggregated generating facility** consisting of directly coupled synchronous **generating units** must be approved by the **ISO** and detailed in the functional specification for the **aggregated generating facility**.

Transmission Facility Step-Up Transformer

10(1) The voltage ratio, tap changer type, range and step size specifications for the transmission step-up transformer of an **aggregated generating facility** must be such that the **maximum authorized real power** and **reactive power** requirements specified in subsections 3 and 4 are fully available throughout the operating voltage range documented in the functional specification for the **aggregated generating facility**.

(2) The connection of a **generating unit** step-up transformer, **transmission facility** step-up transformer or any combination of the two (2) transformers for an **aggregated generating facility** must be designed to provide:

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

(b) isolation of **transmission facilities** and **generating unit** side ground fault current contributions.

(3) An **aggregated generating facility** must utilize an effectively grounded wye connection on the high side of the **transmission facility** step up transformer.

Fault Interrupting Devices

11(1) An **aggregated generating facility** must be designed to:

(a) account for the fault contributions from both the **transmission facilities** and the **aggregated generating facility**; and

(b) have fault interrupting and momentary withstand ratings that are adequate to meet the maximum expected fault levels, with a margin for future anticipated fault levels as approved by the **ISO** in the functional specification for the **aggregated generating facility**.

(2) An **aggregated generating facility** must not use high voltage fuses at 60 kV or higher.

Aggregated Generating Facility Disconnection

12(1) An **aggregated generating facility** must have systems, controls and related procedures to electrically disconnect the **aggregated generating facility** from the **transmission system** or a **transmission facility** within the service area of the City of Medicine Hat either at:

(a) the **point of connection**;

(b) the **collector bus** feeder breakers; or

(c) both;

as documented in the functional specification, after consultation between the **legal owner** of the **aggregated generating facility** and the **legal owner** of the applicable **transmission facility**.

(2) An **aggregated generating facility** connecting to a **transmission facility** must provide the functionality and remote control capabilities to enable the **operator** of the **transmission facility** to open or trip any connecting breaker either at the **point of connection** or any **collector bus** feeder breakers, as applicable.

Isolating Devices

13(1) An **aggregated generating facility** must be designed with manually operable isolation switches at all points of isolation, as documented in the functional specification, after consultation between the **legal owner** of the **aggregated generating facility** and the **legal owner** of the applicable **transmission facility**.

(2) The isolation switches must permit visual verification of electrical isolation and have the capability of being locked open with multiple locks.

Aggregated Generating Facility Power Quality

14(1) An **aggregated generating facility** must be designed to meet the following power quality requirements at the **point of connection**:

(a) the 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 is in effect as of the date the **ISO** first approves the functional specification for the **aggregated generating facility** connection project; and

(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
Pst	0.8
Plt	0.6

where:

P_{st} is the magnitude of the resulting short term flicker level for the considered aggregation of flicker sources (probabilistic value); and

P_{lt} 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 P_{st}; and

(B) 95% probability weekly value for P_{lt}

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

(b) the **aggregated generating facility** 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 – Section 11* that is in effect as of the date the **ISO** first approves the functional specification for the **aggregated generating facility** connection project; and

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

Grounding

15 An **aggregated generating facility** must be designed to operate within a **transmission system** that operates as an effectively grounded system.

Lightning and Other Surge Protection

16(1) An **aggregated generating facility** must be equipped with surge protection for any associated substation equipment.

(2) The surge protection referred to in this subsection 16(1) must operate under the following conditions:

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

(b) switching surges;

(c) neutral shifts;

(d) **electrical islands**; and

(e) temporary over-voltages.

(3) The surge protection referred to in subsection 16(1) must be compatible with the **transmission facility** connected to the **aggregated generating facility** to ensure coordination of insulation levels.

Aggregated Generating Facility Synchrophasor Measurement

17(1) The **legal owner** of an **aggregated generating facility** must install a synchrophasor measurement system on the **aggregated generating facility** in accordance with this subsection 17.

(2) Synchrophasor measurements must take place at the following points:

(a) all three (3) phase-to-ground voltages at each **collector bus** of the **aggregated generating facility**;

(b) all three (3) phase currents for each **transmission facility** step-up transformer on the low voltage side of the **aggregated generating facility**; and

(c) all three (3) phase-to-ground voltages and currents at each **point of connection** of the **aggregated generating facility**.

(3) The **legal owner** of an **aggregated generating facility** must design a synchrophasor measurement system that is capable of downloading and retaining a record of the measurements set out in subsection 17(2) for a period of not less than one (1) calendar year from the date of the initial recording ~~unless the **ISO** indicates otherwise in the functional specification for the **aggregated generating facility**~~.

Appendices

Appendix 1 – *Voltage Ride-Through Requirements for Aggregated Generating Facilities*

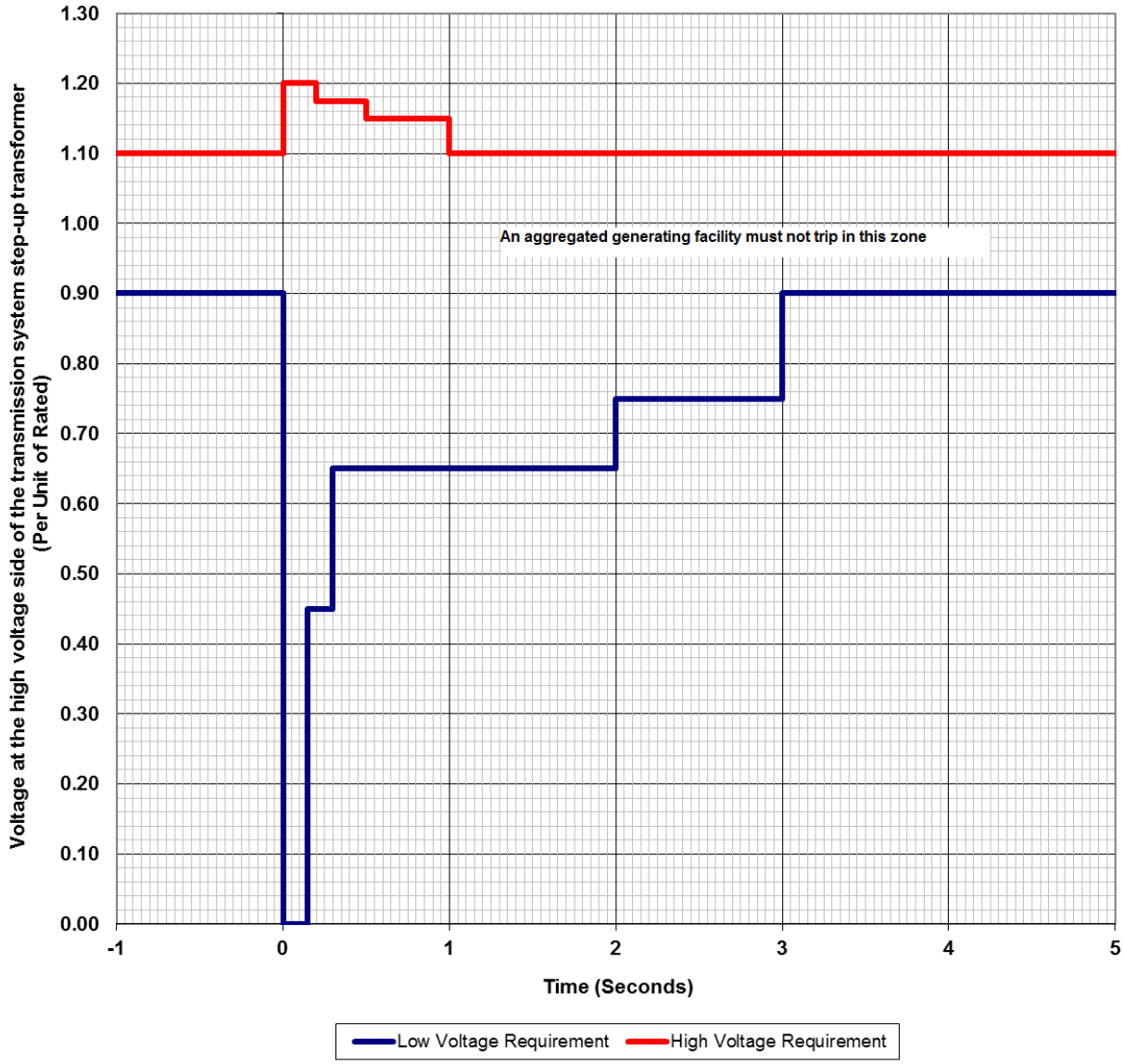
Appendix 2 – *Trip Settings of Off-Nominal Frequency Protective Relays*

Revision History

Date	Description
2019-xx-xx	Removed duplication with new Section 103.14, Waivers and Variances; standardized functional specifications language; capitalized references to "Section".
2018-09-01	Revised references to "wind aggregated generating facility" to "aggregated generating facility"; revised Applicability section; removed operating requirements, including testing post connection, modelling information, data and record requirements and operator availability; removed real power and ramp rate limitations and meteorological collection tower measurement devices and availability requirements; added frequency and speed governing and record retention period for synchrophasor measurement data requirements; revised reactive power, voltage ride through, voltage regulation, WECC stability control, disconnection, power quality and lightning surge protection requirements; clarified subsection 5(2)(a); revised Appendix 1 to apply to both wind and solar aggregated generating facilities and clarified voltage ride-through requirements for 1.10 per unit of the voltage value; removed Appendix 2, *Reactive Power Capability;* and revised Appendix 3, *Trip Settings of Off-Nominal Frequency Protective Relays* and moved to Appendix 2.
2015-04-01	Subsections 25(4) and (5) were added to increase the accuracy of the wind power forecast by requiring the current and planned available capability.
2015-03-27	Replaced "effective date" with the initial release date in sections 1(1)(b), 3 and 13; and replaced the word "Effective" in the Revision History to "Date".
2014-07-02	In subsection 7(11) deleted reference to "aggregated generation facilities" and replaced it with "aggregated generating facilities"; in subsection 25(2)(a)(ii) deleted the period at the end and replaced it with a semicolon and the word "and"; in subsection 29(3) deleted the words "two (2) year" and replaced it with "two-year"; and deleted references to "forced outage" and replaced it with "automatic forced outage".
2013-09-24	Updated to remove bolding on the term "power system stabilizer".
2011-12-01	Initial Release.

Appendix 1 – Voltage Ride-Through Requirements for Aggregated Generating Facilities

High Voltage Ride Through Duration		Low Voltage Ride Through Duration	
Voltage (per unit)	**Time (seconds)**	**Voltage (per unit)**	**Time (seconds)**
≥ 1.200	Instantaneous trip	< 0.45	0.15
≥ 1.175	0.20	< 0.65	0.30
≥ 1.15	0.50	< 0.75	2.00
> 1.10	1.00	< 0.90	3.00
≤ 1.10	Continuous operation	≥ 0.90	Continuous operation



Appendix 2 – Trip Settings of Off-Nominal Frequency Protective Relays

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