ISO Rules
Part 500 Facilities
Division 502 Technical Requirements
Section 502.13 Battery Energy Storage Facility Technical Requirements

Applicability

1 Section 502.13 applies to:

(a) the **legal owner** of a battery **energy storage facility** that is directly connected to the **transmission system** or to **transmission facilities** within the City of Medicine Hat, including a battery **energy storage facility** situated within an industrial complex or generating facility that is directly connected to the **transmission system**;

(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 the provisions of this Section 502.13, approve a written functional specification containing details, work requirements, and specifications for the design, construction, and operation of a battery **energy storage facility** connection project and any associated **transmission system** connection facilities.

Maximum Authorized Charging Power and Maximum Authorized Discharging Power

3(1) The **legal owner** of a battery **energy storage facility** must, upon receiving a request from the **ISO**, determine and provide the **maximum authorized charging power** and **maximum authorized discharging power** for the battery **energy storage facility** to the **ISO** within the time period set out in the request.

(2) The **legal owner** of a **battery energy storage facility** must exclude any auxiliary power used in the operation of the facility in determining the **maximum authorized charging power** and **maximum authorized discharging power** in accordance with subsection 3(1).

Reactive Power Requirements

4(1) For the purposes of determining the **reactive power** requirements for a battery **energy storage facility** in accordance with this rule, the **legal owner** of a battery **energy storage facility** must determine the root mean square phase-to-phase voltage value at the low side of the **transmission system** step up transformer, to be used as the one point zero zero (1.00) per unit voltage value.

(2) A battery **energy storage facility**, and any associated external **reactive power** resources, must

have the capability to operate in accordance with the requirements of this subsection 4 by both:

(a) manual control of the set point of the **voltage regulating system** of the battery **energy storage facility**; and

(b) automated action of the **voltage regulating system** of the battery **energy storage facility**.

(3) Subject to the exception in subsection 4(4), the **reactive power** capability of the battery **energy storage facility** 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 charging power** and **maximum authorized discharging power** of the battery **energy storage facility** over the entire **real power** operating range, as illustrated in Appendix 1.

(4) Notwithstanding subsection 4(3), if a battery **energy storage facility** has a common **point of connection** with a generating asset, the **reactive power** resources required to meet the **reactive power** capability set out in subsection 4(3) may be shared if:

(a) the **reactive power** resources are designed to be in service at all times for any operating combination of the battery **energy storage facility** and the generating asset; and

(b) the **reactive power** resources are sufficient to meet the requirements of subsection 4(3) based on the greater of:

(i) the **maximum authorized real power** of the generating asset;

(ii) the **maximum authorized charging power** of the battery **energy storage facility**;

(iii) the **maximum authorized discharging power** of the battery **energy storage facility**; or

(iv) the sum of the **maximum authorized real power** of the generating asset and the **maximum authorized charging power** for facilities designed to be operated concurrently.

(5) A battery **energy storage facility** must not be designed with limiters set to reduce the **reactive power** capability set out in subsections 4(3) and 4(4).

Voltage Ride-Through Requirements

5(1) This subsection 5 applies to the **legal owner** of a battery **energy storage facility** that has a range greater than 5 MW between its **maximum authorized charging power** and its **maximum authorized discharging power**.

(2) For the purposes of determining the voltage ride-through requirements of this rule, the **legal owner** of a battery **energy storage facility** 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 one point zero zero (1.00) per unit voltage value.

(3) The **legal owner** of a battery **energy storage facility** must ensure that the battery **energy storage facility** is designed to meet all of the following voltage ride-through requirements:

(a) continuous operation between zero point nine zero (0.90) and one point one zero (1.10) per

unit of the voltage value determined under subsection 5(2);

(b) not tripping or going off-line during, or 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 battery **energy storage facility** remains at zero point zero (0.0) per unit must be at least the **normal clearing** time for a three (3) phase fault at the specific location where the battery **energy storage facility** is connected to the **transmission system**.

(4) Notwithstanding any other provision of this subsection 5, a battery **energy storage facility** is not required to ride-through a **transmission system** fault that:

(a) causes a forced outage of a radial transmission line connecting the battery **energy storage facility** to the **transmission system**;

(b) occurs on the battery **energy storage 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 battery **energy storage facility** which causes the battery **energy storage facility** to be disconnected from the **transmission system**.

Voltage regulating system

6(1) A battery **energy storage facility** must have a continuously variable, continuously acting, closed loop, centralized **voltage regulating system** that:

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

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

(c) is designed to be continuously in service and controlling while the battery **energy storage facility** is 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 value between zero point nine five (0.95) per unit and one point zero five (1.05) per unit of the operating voltage value determined under subsection 4(1);

(f) 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 is at the low side of the **transmission system** step up transformer of the battery **energy storage facility**; and

(g) is calibrated such that a change in **reactive power** will achieve 95% of its final value within,

(i) no sooner than zero point one (0.1) seconds; and

(ii) no later than one (1) second

following a step change in voltage.

(2) A battery **energy storage facility** must be designed so that when the **voltage regulating system** requires the switching of a shunt reactive device, the switching operation must be delayed by ten (10) seconds.

(3) A battery **energy storage facility** must be designed so that the point of control for the **voltage regulating system** is not at the high voltage side of the **transmission system** step-up transformer.

(4) A battery **energy storage facility** must be designed so that, if the **voltage regulating system** of two (2) or more battery **energy storage facilities** have a common measurement point, then there must be reactive current compensation in each **voltage regulating system**.

Governor System Requirements

7(1) A battery **energy storage 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 battery **energy storage facility** is connected to the **transmission system**;

(b) with a droop setting equal to or greater than 3% but less than or equal to 5%, which droop-setting must be based on the difference between the **maximum authorized charging power** and **maximum authorized discharging power**;

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

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

(e) at a rate of 5.0% of the difference between the **maximum authorized charging power** and the **maximum authorized discharging power** per second.

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

Ramp Rate Limitations

8(1) Not withstanding subsection 7(1)(e), a battery **energy storage facility** must be equipped with **ramp rate** limiting controls that are capable of limiting the ramp up or down of the **real power** of the battery **energy storage facility** for the purpose of responding to dispatches or directives.

(2) A battery **energy storage facility** must be designed such that the default settings for the **ramp rate** limiting controls referred to in subsection 8(1) are set at 10% of the difference between the **maximum authorized charging power** and **maximum authorized discharging power**.

(3) Notwithstanding subsection 8(2), a battery **energy storage facility** may participate in an **ancillary service** at the **ramp rate** defined by the technical requirements for that **ancillary service**.

Power System Stabilizer

9(1) The **ISO** may, by written notice, require the **legal owner** of a battery **energy storage facility** to use a power system stabilizer for the battery **energy storage facility** that is specified by **WECC**.

(2) Upon receipt of the written notice described in subsection 9(1), the legal owner of a battery **energy storage facility** must install and enable a power system stabilizer, as specified by **WECC**.

Transmission System Step-Up Transformer

10(1) The **legal owner** of a battery **energy storage facility** must ensure that the capability of the **transmission system** step-up transformer for the battery **energy storage facility** is such that the **real power** and **reactive power** requirements specified in this rule are fully available throughout the continuous operating voltage range for the battery **energy storage facility**.

(2) The legal owner of a battery **energy storage facility** must, in determining the capability of the **transmission system** step-up transformer under subsection 10(1), consider the following:

(a) the thermal capability of:

(i) bushings;

(ii) windings; and

(iii) the tap changer;

(b) the voltage ratio;

(c) the tap changer type;

(d) the 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 10(1), the **legal owner** of a battery **energy storage facility** may subtract the amount of auxiliary load in **apparent power** from the **apparent power** capability of the battery **energy storage facility** at the greater of the **maximum authorized charging power** or the **maximum authorized discharging power**, but only if any of that auxiliary system load is connected between the battery **energy storage facility** converter and the low side of the **transmission system** step-up transformer.

(4) The **legal owner** of a battery **energy storage facility** must ensure that the **transmission system** step-up transformer winding connections for the battery **energy storage facility** 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;

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

Auxiliary Systems

11(1) When multiple battery **energy storage facilities** are at a common location, the auxiliary systems of each battery **energy storage facility** 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 battery **energy storage facilities**; and

(b) staggered shutdowns of each battery **energy storage facility** must be separated in time by more than ten (10) minutes.

(2) The auxiliary systems of each battery **energy storage facility** must be designed to take into account the voltage ride-through requirements, as specified subsection 5.

Battery Energy Storage Facility Disconnection and Interrupting Devices

12(1) The **legal owner** of a battery **energy storage facility** and the **legal owner** of the **transmission facility** to which the battery **energy storage facility** is connected must ensure that there are circuit breakers and controls that will electrically disconnect the battery **energy storage facility** from the **transmission system** at the **point of connection**.

(2) The **legal owner** of a battery **energy storage facility** and the **legal owner** of the **transmission facility** to which the battery **energy storage facility** is connected must ensure that the battery **energy storage facility** provides the functionality and remote control capabilities to enable the **operator** of the **transmission facility** to which the battery **energy storage facility** is connected to open or trip any connecting breaker.

(3) The **legal owner** of a battery **energy storage facility** and the **legal owner** of the **transmission facility** to which the battery **energy storage facility** is connected must not use fuses at 60 kV or higher to meet any of the requirements of this subsection 12.

Isolation Devices

13(1) The **legal owner** of a battery **energy storage facility** and the **legal owner** of the **transmission facility** to which the battery **energy storage facility** is connected must ensure that:

(a) the battery **energy storage facility** has a minimum of one (1) isolation device with manual operating capability at a point of isolation; and

(b) The isolation device(s) referred to in subsection 13(1)(a) must:

(i) permit visual verification of electrical isolation and must be capable of being locked open with two (2) or more locks;

(ii) be under the control of a single control authority as confirmed by a joint operating agreement between the **legal owner** of the battery **energy storage facility** 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.

Power Quality

14(1) A battery **energy storage 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 battery **energy storage 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
P_{st}	0.8
P_{lt}	0.6

where:

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

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) week of normal operation of the battery **energy storage facility**;

(b) the battery **energy storage 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 battery **energy storage facility** connection project; and

(c) the battery **energy storage facility** 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 battery **energy storage facility**.

Grounding

15 A battery **energy storage facility** must be designed to operate within a **transmission system** that operates as an effectively grounded system.

Lightning and Other Surge Protection

16 The lightning surge protection for the substation equipment within a battery **energy storage facility** must be designed to take into account the average lightning ground-flash density level for the site location of the battery **energy storage facility** and to be compatible with the connecting **transmission facility** to ensure coordination of insulation levels.

Synchrophasor Measurement System

17(1) A battery **energy storage facility** must be equipped with a synchrophasor measurement system.

(2) The synchrophasor measurement system referred to in subsection 17(1) must be designed to record at the following locations:

(a) at the low side of the **transmission system** step-up transformer of the battery **energy storage facility** for all three (3) phase-to-ground voltages and currents; and

(b) at the high side of the **transmission system** step-up transformer of the battery **energy storage facility** for all three (3) phase-to-ground voltages and currents.

(3) Where a battery **energy storage facility** has a common **point of connection** with a generating asset, the synchrophasor measurement system:

(a) must have dedicated voltage and current channels for the feeder to the battery **energy storage facility** at the low side of the **transmission system** step-up transformer; and

(b) may have common voltage and current channels at the high side of the **transmission system**

step-up transformer.

(4) The **legal owner** of a battery **energy storage facility** must design a synchrophasor measurement system that is capable of downloading and retaining the recordings set out in subsection 17(2) for a period of not less than one (1) calendar year from the date of the initial recording.

Internal Sequence of Event Monitoring

18(1) A battery **energy storage facility** must have an internal sequence of event monitoring system that initiates an event record for every event that results in a trip of the battery **energy storage facility**.

(2) The **legal owner** of the battery **energy storage facility** must design a sequence of event

monitoring system that is capable of downloading and retaining the recordings set out in subsection 18(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.

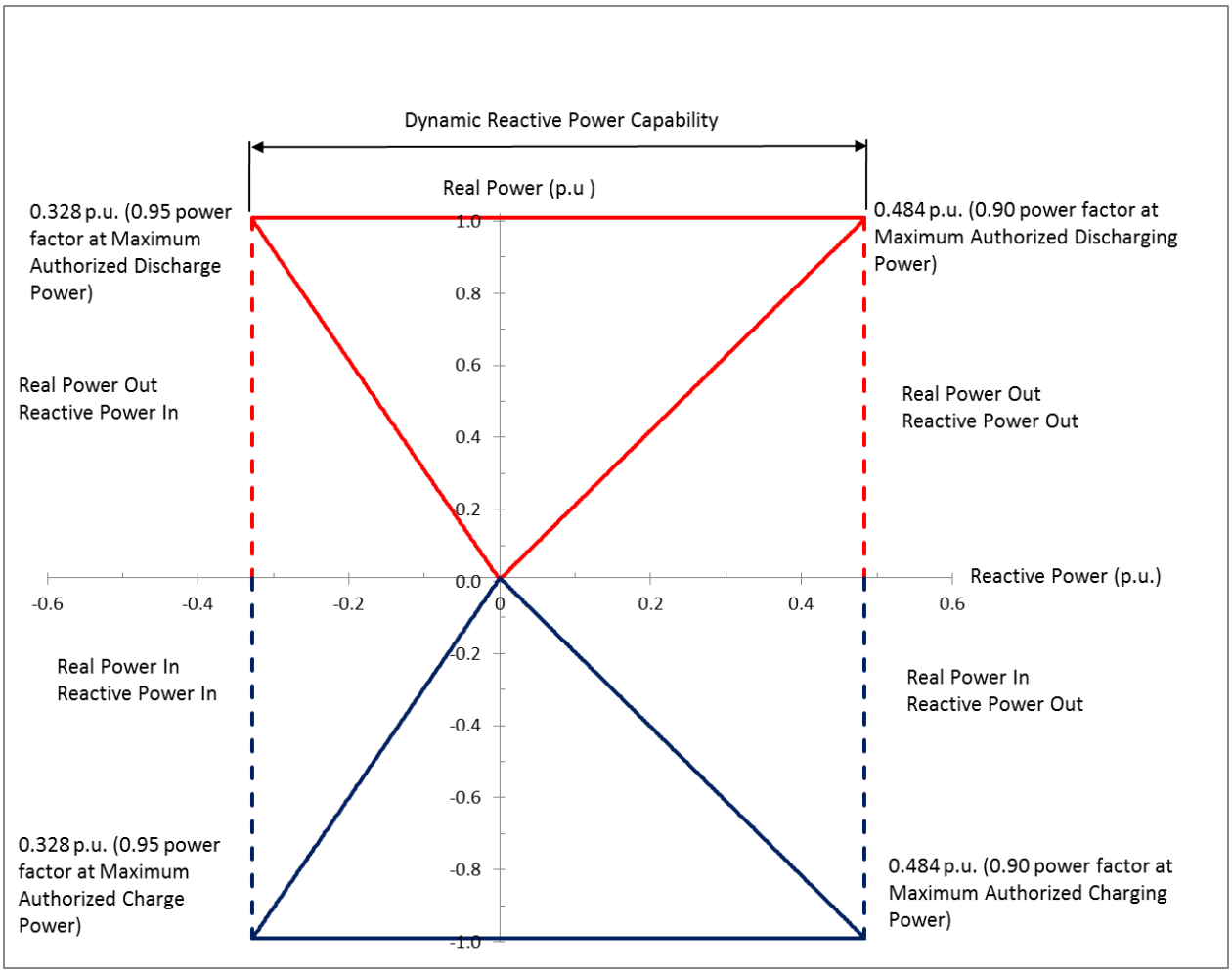
Appendices

Appendix 1 – *Reactive Power Requirements*
Appendix 2 – *Voltage Ride-Through Requirements*
Appendix 3 – *Frequency Ranges*

Revision History

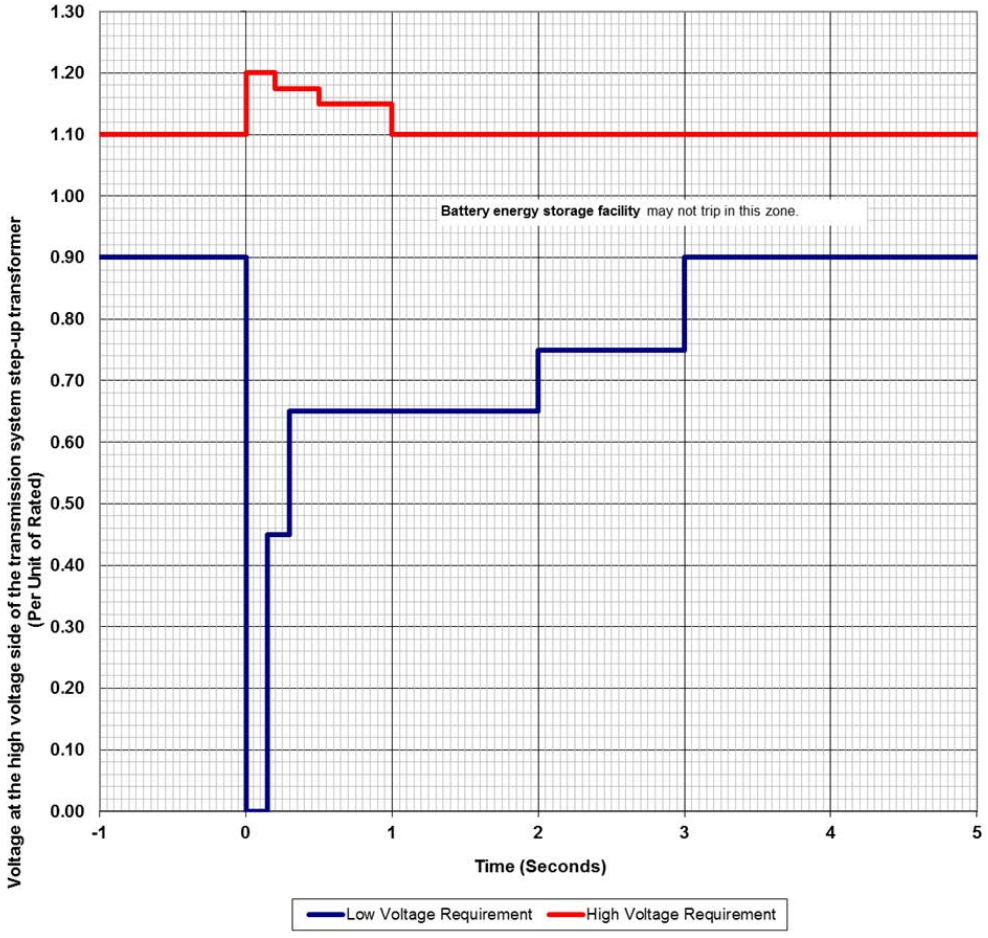
Date	Description
2019-xx-xx	Removed duplication with new Section 103.14, Waivers and Variances; standardized functional specifications language; capitalized references to “Section”
2016-04-25	Initial release.

Appendix 1
Reactive Power Requirements



Appendix 2
Voltage Ride-Through Requirements

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



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