Market Rules

Chapter 4
Grid Connection Requirements - Appendices

Connecting Today.
Powering Tomorrow.

Library Record No.	MDP_RUL_0002_04A
Document Name	Market Rules for the Ontario Electricity Market
Issue	Issue 16.0
Reason for Issue	Baseline 53.0
Effective Date	March 5, 2025

Document Change History

Issue/Draft	Reason for Issue	Date
Issue 1.0	Baseline 8.0	September 25, 2002
Issue 2.0	Baseline 10.0	September 10, 2003
Issue 3.0	Baseline 12.1	December 8, 2004
Issue 4.0	Baseline 14.0	September 14, 2005
Issue 5.0	Baseline 16.0	September 13, 2006
Issue 6.0	Effective date for MR-00359	March 6, 2010
Issue 7.0	Baseline 23.1	June 2, 2010
Issue 8.0	Baseline 27.1	June 6, 2012
Issue 9.0	Baseline 29.0	March 6, 2013
Issue 10.0	Baseline 29.1	June 5, 2013
Issue 11.0	Baseline 33.1	June 3, 2015
Issue 12.0	Baseline 34.0	September 9, 2015
Issue 13.0	Baseline 44.1	December 2, 2020
Issue 14.0	Baseline 45.0	February 26, 2021
Issue 15.0	Baseline 46.1	December 1, 2021
Issue 16.0	Baseline 53.0	March 5, 2025

Related Documents

Library Record No.	Document Title	Version
MDP_RUL_0002	Market Rules for the Ontario Electricity Market	88.0

Document Control

Authorities

Prepared by
Market Rules

Reviewed by
Technical Panel
Legal Affairs

Approved by
IESO Board

Distribution List

Name	Organization

Table of Contents

Appendix 4.1 – IESO-Controlled Grid Performance Standards

Ref	*Item*	*Requirement*
	Transmission System	
1	Frequency variations	All *equipment* shall be capable of continuously operating in the range between 59.5 Hz and 60.5 Hz.
2	Voltage variations	Under normal conditions voltages are maintained within the range below. Transmission Voltage: Nominal (kV) 500 230 115 Maximum Continuous (kV) 550 250* 127* Minimum Continuous (kV) 490 220 113 *In northern Ontario, the maximum continuous voltage for the 230 and 115 kV systems can be as high as 260 kV and 132 kV respectively
3	[Intentionally left blank]	
4	[Intentionally left blank]	
5	[Intentionally left blank]	
6	[Intentionally left blank]	
7	[Intentionally left blank]	
8	[Intentionally left blank]	

Appendix 4.2 – Requirements for Generation and Electricity Storage Facilities Connected to the IESO-Controlled Grid

The performance requirements set out below shall apply to *generation facilities* subject to a *connection assessment* finalized after September 21, 2020. Performance of alternative technologies shall be comparable with that of conforming conventional synchronous generation with an equal apparent power rating.

These performance requirements shall also apply to *electricity storage units* at all times while connected to the *IESO-controlled grid*, unless the *IESO* identifies specific performance requirements that are not applicable to an *electricity storage unit* for those with a *connection assessment* finalized after January 18, 2021. Due consideration will be given to inherent limitations.

Each *facility* that was authorized to *connect* to the *IESO-controlled grid* prior to September 21, 2020 shall remain subject to the performance requirements in effect for each associated system at the time its authorization to *connect* to the *IESO-controlled grid* was granted or agreed to by the *market participant* and the *IESO* (i.e. the "original performance requirements"). These original performance requirements shall prevail until the main elements of an associated system (e.g. governor control mechanism, main exciter, power inverter) are replaced or substantially modified. At that time, the associated system that is replaced or substantially modified shall meet the applicable performance requirements detailed below. All other systems, not affected by replacement or substantial modification, shall remain subject to the original performance requirements.

Category	*Generation facilities* or *electricity storage facilities* directly connected to the *IESO-controlled grid* shall have the capability to:
1. Off-Nominal Frequency Operation	Operate continuously between 59.4 Hz and 60.6 Hz and for a limited period of time in the region bounded by straight lines on a log-linear scale defined by the points (0.0 s, 57.0 Hz), (3.3 s, 57.0 Hz), and (300 s, 59.0 Hz) and the straight lines on a log-linear scale defined by the points (0.0 s, 61.8 Hz), (8 s, 61.8 Hz), and (600 s, 60.6 Hz).
2. Speed/Frequency Regulation	Regulate speed/frequency with an average droop based on maximum active power adjustable between 3% and 7% and set at 4% unless otherwise specified by the *IESO*. Regulation deadband shall not be wider than ±0.06%. Speed/frequency shall be controlled in a stable fashion in both interconnected and island operation. A sustained 9% change of applicable rated active power as defined in category 4 after 10 s in response to a step change of speed of 0.5% during interconnected operation shall be achievable. Due consideration will be given to inherent limitations such as mill points and gate limits when evaluating active power changes. Control systems that inhibit primary frequency response shall not be enabled without *IESO* approval.
3. Voltage Ride-Through	Ride through routine switching events and design criteria contingencies assuming standard fault detection, auxiliary relaying, communication, and rated breaker interrupting times unless disconnected by configuration. For Inverter-based units, momentary current cessation or reduction of output current during system disturbances is not permitted without *IESO* approval.
4. Active Power	Continuously supply all levels of active power output within a +/- 5% range of its rated terminal voltage. Rated active power is the smaller output at either rated ambient conditions (e.g. temperature, head, wind speed, solar radiation) or 90% of rated apparent power. For *electricity storage facilities*, rated active power values shall be separately specified for both injection and withdrawal operations. To satisfy steady-state reactive power requirements, active power reductions to rated active power are permitted.
5. Reactive Power	Continuously (i.e., dynamically) inject or withdraw reactive power at the high-voltage terminal of the main output transformer[1] up to 33% of the applicable rated active power at all levels of active power, and at the typical *transmission system* voltage, except where a lesser continually available capability is permitted with the *IESO's approval*. A conventional synchronous unit with a power factor range of 0.90 lagging and 0.95 leading at rated active power connected via a main output transformer impedance not greater than 13% based on *generation unit* rated apparent power is acceptable. Reactive power losses or charging between the high-voltage terminal of the main output transformer and the *connection point* shall be addressed in a manner permitted by *IESO* approval.
6. Automatic Voltage Regulator (AVR)	Regulate voltage automatically within ±0.5% of any setpoint within ±5% of rated voltage at the low-voltage terminal of the main output transformer if the transformer impedance is not more than 13% based on the rated apparent power of the *generation facility* or *electricity storage facility* or at a point approved by the *IESO*. Reactive power-voltage droop or AVR reference load current compensation shall not be enabled without *IESO* approval. The equivalent time constants shall not be longer than 20 ms for voltage sensing and 10 ms for the forward path to the exciter output.
7. Excitation System for Synchronous Machines Greater than 20 MVA or any Synchronous Machines *within Facilities* Greater than 75 MVA	Provide (a) Positive and negative ceilings not less than 200% and 140% of rated field voltage, respectively, while supplying the field winding of the *generation unit* or *electricity storage unit* operating at nominal voltage under open circuit conditions; (b) An excitation transformer impedance not greater than 10% on excitation system base; (c) A voltage response time to either ceiling not more than 50 ms for a 5% step change from rated voltage under open-circuit conditions; and (d) A linear response between ceilings.
8. Power System Stabilizer (PSS) for Synchronous Machines within Facilities Greater than 75 MVA	Provide (a) A change of power and speed input configuration; (b) Positive and negative output limits not less than ±5% of rated AVR voltage; (c) Phase compensation adjustable to limit angle error to within 30° between 0.2 Hz and 2.0 Hz under conditions specified by the *IESO*, and (d) Gain adjustable up to an amount that either increases damping ratio above 0.1 or elicits poorly damped exciter modes of oscillation at maximum active output unless otherwise specified by the *IESO*. Due consideration will be given to inherent limitations. For *electricity storage units, Power System Stabilizer shall be disabled while withdrawing*.
9. Phase Unbalance	Provide an open circuit phase voltage unbalance not more than 1% and operate continuously with a phase voltage unbalance as high as 2% at the high-voltage terminal of its main output transformer.
10. Armature and Field Limiters	Provide short-time capabilities specified in IEEE/ANSI 50.13 and continuous capability determined by either maximum field current, maximum stator current, core-end heating, or minimum field current. More restrictive limiting functions, such as steady state stability limiters, shall not be enabled without *IESO* approval.

11. Technical Characteristics	Exhibit, at the high-voltage terminal of its main output transformer, performance comparable to an equivalent synchronous *generation unit* with characteristic parameters within typical ranges. Inertia, unsaturated transient impedance, transient time constants, and saturation coefficients shall be within typical ranges (e.g. H > 1.2 Aero-derivative, H > 1.2 Hydroelectric units less than 20 MVA, H > 2.0 Hydroelectric units 20 MVA or larger, H > 4.0 Other synchronous units, X'd < 0.5, T'd0 > 2.0, and S1.2 < 0.5) except where permitted by *IESO* approval.
12. Reactive Power Response to Voltage Changes of Inverter-Based Units	For a constant voltage at the high-voltage terminal of the main output transformer, achieve a sustained reactive power change of 30% of *generation facility* or *electricity storage facility* rated apparent power at the low-voltage terminal of the main output transformer within 3s following a step change no larger than 4% to the AVR voltage reference. AVR response to the voltage error signal must be consistent over the entire operating range.

[1] A main output transformer steps up the voltage from the *generation unit/facility* to the transmission voltage level.

Appendix 4.3 – Requirements for Connected Wholesale Customers and Distributors Connected to the IESO-Controlled Grid

The performance requirements set out below shall apply to *connected wholesale customers* and *distributors* that are connecting equipment or *facilities* to the *IESO-controlled grid* or to their *distribution systems* after January 18, 2021.

Equipment connected within a *connected wholesale customer's* or *distributor's facilities* or *distribution systems* that was authorized to *connect* prior to January 18, 2021 shall remain subject to the performance requirements in effect at the time its authorization to *connect* was granted (i.e. the "original performance requirements"). These original performance requirements shall prevail until the main elements of an associated system are replaced or substantially modified. At that time, the associated system that is replaced or substantially modified shall meet the applicable performance requirements detailed below. All other systems not affected by replacement or substantial modification, shall remain subject to the original performance requirements.

Category	***Requirement***
1. Power Factor	*Connected wholesale customers* and *distributors* connected to the *IESO-controlled grid* shall operate at a power factor within the range of 0.9 lagging to 0.9 leading as measured at the *defined meter point*.
2. Under Frequency Load Shedding	*Connected wholesale customers* and *distributors connected* to the *IESO-controlled grid* may be required to participate in under frequency load shedding
3. Remedial Action Schemes	*Connected wholesale customers* and *distributors connected* to the *IESO-controlled grid* may be required to participate in *remedial action schemes*.
4. Voltage Reduction	*Distributors* connected to the *IESO-controlled grid* with directly *connected load facilities* of aggregated rating above 20 MVA and with the capability to regulate *distribution* voltages under load, shall install and maintain *facilities* and equipment to provide *voltage reduction capability*.
5. [Intentionally left blank]	
6. [Intentionally left blank]	
7. [Intentionally left blank]	
8. [Intentionally left blank]	
9. Testing and Compliance Monitoring	*Connected wholesale customers* and *distributors connected* to the *IESO-controlled grid* shall test and maintain their equipment in accordance with all applicable *reliability standards*.
10. Metering	*Connected wholesale customers* and *distributors connected* to the *IESO-controlled grid* shall comply with metering codes and standards set by the *IESO*.
11. Voltage Ride-Through	Equipment connected within a *connected wholesale customer's* or a *distributor's facility* or *distribution system* that is connected to the *IESO-controlled grid* shall ride through routine switching events and design criteria contingencies on the *transmission system* assuming standard fault detection, auxiliary relaying, communication, and rated breaker interrupting times unless either disconnected by configuration or a failure to do so has been assessed and confirmed by the *IESO* as having no material adverse effect on the operation of the *IESO-controlled grid*.

12. Generation Units **and** ***Electricity Storage Units***	Any *generation unit* or *electricity storage unit* connected within a *connected wholesale customer's* or a *distributor's facility* or *distribution system* that is connected to the *IESO-controlled grid* shall meet, at a minimum, the performance requirements for Off-Nominal Frequency Operation (category 1), Speed/Frequency Regulation (category 2), and Voltage Ride-Through (category 3) specified in Appendix 4.2. If a *connected wholesale customer* injects active power into the *IESO-controlled grid*, all performance requirements specified in Appendix 4.2 are applicable to the *generation units* and *electricity storage units* installed within their *facility*. Note: These performance requirements shall apply to *electricity storage units* and *generation units* at all times while connected within a *connected wholesale customer's* or *distributor's facilities* or *distribution system* that is connected to the *IESO-controlled grid*, unless the *IESO* identifies specific performance requirements that are not applicable to an *electricity storage unit* or *generation unit* for those with a *connection assessment* finalized after January 18, 2021. Due consideration will be given to inherent limitations.

Appendix 4.4 – Transmitter Requirements

Ref	*Item*	*Requirement*
1	Abrupt Voltage Changes	Voltage changes shall not normally exceed 4% of steady state rms for capacitor switching operations. Voltage changes shall not normally exceed 10% of steady state rms for line switching operations
2	Frequency Variations	All equipment shall be capable of continuous operation within the range of 59.5 to 60.5 Hz and have the capability to operate for 10 minutes in the range 58 to 61.5 Hz.
3	Load Shedding Facilities	Each *transmitter* shall comply with *IESO* requirements for automatic under-frequency load shedding in accordance with its *operating agreement.* Each *transmitter* shall be able to manually drop up to 50% of its load within 10 minutes.
4	Automatic Reclosure	Transmission circuits shall be equipped with timed, single-shot automatic re-closing facilities. Reclosure shall only be initiated by protections that operate when it is highly likely that the fault is not permanent. Reclosure within 5 seconds of fault detection is allowed only in exceptional circumstances. Angle supervision shall be provided on all breakers rated at 230 kV and above. Automatic reclosure shall remain enabled only for a limited period of time, usually about 40 seconds, following initiation.
5	Thermal Ratings	• *Market participants* that own and operate transmission equipment shall provide the *IESO* with the continuous and limited time thermal ratings for their transmission circuits and transformers. • *Market participants* shall provide this information to the *IESO* via a data link with a minimum update rate of 5 minutes or as agreed to by the *IESO*. For backup and pre-dispatch purposes, *market participants* shall provide a thermal rating table in a suitable format to facilitate *IESO* applications to perform thermal rating interpolation. • Where other equipment (e.g. wavetraps) is more limiting, *market participants* shall provide the *IESO* with the thermal rating of the most restrictive element. • *Generators* and *connected wholesale customers* that own and operate transmission equipment that is part of the *IESO-controlled grid* shall provide the *IESO* with the continuous and limited time thermal ratings for their transmission circuits and transformers only if required by the *IESO* to maintain *reliable* operation of the *IESO-controlled grid*. • Limited time thermal ratings shall be 15-minute ratings, unless mutually agreed by the *IESO* and *market participant.*
6	Protective System Requirements	Protection systems shall be constructed and maintained in accordance with all applicable *reliability standards*.
7	*IESO* Information Requirements	The *transmitter* shall provide any information that the *IESO* deems necessary to direct the operation of the *IESO-controlled grid*. This Information, including, but not limited to, voltages, flows, and equipment status shall be telemetered continually to the *IESO*.
8	Voltage Reduction	*Transmitters* with the ability to regulate *distribution* voltages under load shall install and maintain facilities and equipment to provide *voltage reduction capability*.
9	Telecommunications	Communication channels shall have a level of reliability that is consistent with the required performance of the associated protection system. Telecommunications shall be designed to assure adequate signal transmission during transmission disturbances and may be provided with means to verify proper signal performance. Equipment may be monitored to assess its readiness and be powered by batteries or other sources independent of the *IESO*.
10	Testing and Compliance Monitoring	*Transmitters* shall test and maintain their equipment in accordance with all applicable *reliability standards.*
11	Metering	*Transmitters* shall comply with the metering codes and standards set by the *IESO*.

Appendix 4.5 – [Intentionally left blank]

Appendix 4.5A – [Intentionally left blank]

Appendix 4.6 – [Intentionally left blank]

Appendix 4.7 – [Intentionally left blank]

Appendix 4.8 – [Intentionally left blank]

Appendix 4.9 – [Intentionally left blank]

Appendix 4.10 – [Intentionally left blank]

Appendix 4.11 – [Intentionally left blank]

Appendix 4.12 – [Intentionally left blank]

Appendix 4.13 – [Intentionally left blank]

Appendix 4.14 – [Intentionally left blank]

Appendix 4.15 – IESO Monitoring Requirements: Generators

The following information, as a minimum, shall be available on a continual basis to the *IESO* from:

(a) any *generator* (i) whose *generation facility* is connected to the *IESO-controlled grid*, or (ii) that is participating in the *IESO-administered markets*; and

(b) any *embedded generator* (i) that is not a *market participant* or whose *embedded generation facility* is not a *registered facility*; (ii) whose *embedded generation facility* includes a *generation unit* rated at greater than 20 MVA or that comprises *generation units* the ratings of which in the aggregate exceeds 20 MVA; and (iii) that is designated by the *IESO* for the purposes of section 7.3.1 of this Chapter as being required to provide such data in order to enable the *IESO* to maintain the *reliability* of the *IESO-controlled grid*.

TYPE	INFORMATION REQUIREMENTS
Major generation facility	*Monitored Quantities* *1. Active Power (MW) and Reactive Power (MX)* a) The standard requirement for active and reactive power is the provision of *net MW* and *net MX* or *gross MX*. *Gross MW* and *gross MX* or *net MX* are also to be provided, if designated by the *IESO* as required for: (i) determination of operating *security limits*; (ii) to maintain *reliable* operation of the *IESO-controlled grid*; (iii) for compliance monitoring purposes; or (iv) if provision of only the standard requirement values as defined above would have a negative impact on other *market participants* through reduced operating *security limits*. b) For *generation units* rated greater than or equal to 100 MVA, the standard requirement as defined in part a) for each *generation unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *generation unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). c) For *generation units* rated at less than 100 MVA: (i) for a group of *generation units* if those *generation units* are similar in size and operating characteristics, the standard requirement as defined in part a) shall be provided as a total for these *generation units*, and total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); or (ii) if designated by the *IESO* as required for determination of operating *security limits* or to maintain reliable operation of the *IESO-controlled grid* or for compliance monitoring purposes, the standard requirement as defined in part a) for each *generating unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *generation unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). d) For *generation facilities* that have been aggregated pursuant to Chapter 7 section 2.3:

TYPE	INFORMATION REQUIREMENTS
	(i) the standard requirement as defined in part a) shall be provided as an aggregated total, and an aggregated total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); or (ii) if so designated by the *IESO* as required for determination of operating *security limits* or to maintain *reliable* operation of the *IESO-controlled grid* or for dispatch compliance monitoring purposes, the standard requirement as defined in part a) for each *generating unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *generation unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). e) For frequency changers: (i) total MW and MX at either frequency; or (ii) if so designated by the *IESO* as required for determination of operating *security limits*, total MW and MX at both frequencies. f) For synchronous condensers: (i) total MX. *2. Voltage:* a) For each *generation unit*, unit terminal voltage, except if *generation units* are connected to a common low voltage bus section, then the bus section voltage is adequate for those *generation units*. *3. Frequency:* a) For each *generation unit* or *generation facility* providing *black start capability*, frequency of the applicable *generation unit* or *generation facility*. *4. Equipment Status* a) Unit mode (i.e. generator, condenser, pump) for each *generation unit* capable of different modes of operation. b) *AGC* status for each *generation unit* providing *regulation*. c) AVR and Stabilizer Status for each *generating unit* with a rated capacity $\geq$ 100 MVA. Stabilizer status reporting is only required if it can be switched off by *generation facility* personnel remotely or at the *facility*. d) AVR and Stabilizer status for each *generation unit* with a rated capacity $\leq$ 100 MVA if the status of this equipment is designated by the *IESO* as required for determination of operating *security limits* or to maintain *reliable* operation of the *IESO-controlled grid*. Stabilizer status reporting is only required if it can be switched on or off by *market participant* operating personnel remotely or at the *facility*. e) Synchronizing Breaker status for each *generation unit*. Where a *generation facility* is designed such that no low voltage synchronizing breaker is installed for each *generation unit*, the status of the appropriate HV breaker(s) and disconnect switch(es) normally used to isolate the *generation unit* must be provided. Where this results in access to the majority of breakers on a bus, the status of the remainder of the breakers shall be provided to complete the bus configuration. Where a *generation facility* is designed such that there are disconnect switches in parallel, or directly in series, with the synchronizing breaker, the status of those switches is also required. f) *Remedial Action Scheme* status for each applicable *generation unit*.
Significant generation facility and minor generation facility	*Monitored Quantities* *1. Active Power (MW) and Reactive Power (MX):*

TYPE	INFORMATION REQUIREMENTS
connected to IESO-controlled grid	a) The standard requirement for active and reactive power is the provision of *net MW* and *net MX* or *gross MX*. *Gross MW* and *gross MX* or *net MX* are also to be provided, if designated by the *IESO* as required for: (i) determination of operating *security limits*; (ii) to maintain *reliable* operation of the *IESO-controlled grid*; (iii) for compliance monitoring purposes; or (iv) if provision of only the standard requirement values as defined above would have a negative impact on other *market participants* through reduced operating *security limits*. b) For *generation facilities* that have not been aggregated pursuant to Chapter 7 section 2.3: (i) for a group of *generation units* if those *generation units* are similar in size and operating characteristics, the standard requirement as defined in part a) shall be provided as a total for these *generation units*, and total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); (ii) if designated by the *IESO* as required for determination of operating *security limits* or to maintain *reliable* operation of the *IESO-controlled grid* or for compliance monitoring purposes, the standard requirement as defined in part a) for each *generating unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *generation unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). c) For *generation facilities* that have been aggregated pursuant to Chapter 7 section 2.3: (i) the standard requirement as defined in part a) shall be provided as an aggregated total, and an aggregated total *gross MW and gross MX* or *net MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); or (ii) if so designated by the *IESO* as required for determination of operating *security limits* or to maintain *reliable* operation of the *IESO-controlled grid* or for dispatch compliance monitoring purposes, the standard requirement as defined in part a) for each *generating unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *generation unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). d) For frequency changers: (i) total MW and MX at either frequency; or (ii) if so designated by the *IESO* as required for determination of operating *security limits*, total MW and MX at both frequencies. e) For Synchronous Condensers: (i) Total MX. *2. Voltage:* a) For *generation units* that are VAR *dispatchable*, unit terminal voltage, except if the *generation units* are connected to a common low voltage bus section, then the bus section voltage is adequate for those *generation units*. *3. Frequency:*

TYPE	INFORMATION REQUIREMENTS
	a) For each *generation unit* or *generation facility* providing *black start capability*, frequency of the applicable *generation unit* or *facility.* *4. Equipment Status* a) Unit mode (i.e. generator, condenser, pump) for each *generation unit* capable of different modes of operation. b) AVR and Stabilizer Status for each *generation unit* if the status of this equipment is designated by the *IESO* as required for determination of operating *security limits* or to maintain *reliable* operation of the *IESO-controlled grid*. Stabilizer status reporting is only required if it can be switched on or off by *market participan*t operating personnel remotely or at the *facility*. c) Synchronizing Breaker Status for each *generation unit*. Where a *generation facility* is designed such that no low voltage synchronizing breaker is installed for each *generation unit*, the status of the appropriate HV breaker(s) and disconnect switch(es) normally used to isolate the *generation unit* must be provided. Where this results in access to the majority of breakers on a bus, the status of the remainder of the breakers shall be provided to complete the bus configuration. Where a *generation facility* is designed such that there are disconnect switches in parallel, or directly in series, with the synchronizing breaker, the status of those switches is also required. d) *Remedial Action Scheme* status for each applicable *generation unit*.
Self-scheduling generation facility with a name-plate rating of less than 10 MW	*None*
Intermittent and transitional scheduling generator	• *if a major generation facility, as described above for a major generation facility* • *if a significant generation facility, as described above for a significant generation facility* • *if a minor generation facility, as described above for a minor generation facility if designated by the IESO at the time of registration as affecting the reliability of the IESO-controlled grid* • *if a small generation facility, none*
Small generation facility	*None*
Minor generation facility that is embedded in a distribution system and registered as a dispatchable generator	• *Total active power (MW) output of the individual generation unit or of the aggregated resource.* • *Unit status if the facility is comprised of a single generation unit.* • *Aggregated resource status if the facility is comprised of aggregated resources, i.e. if at least one unit of the aggregated resource is synchronized, the aggregated resource is synchronized or if no unit in the aggregated resource is synchronized, the aggregated resource is not synchronized.* • *Reactive Power (MX) output, if requested by the IESO for reliable operation of the IESO-controlled grid, of individual generation units or of the aggregated resource.*

TYPE	SYNCHROPHASOR DATA REQUIREMENTS
Generation facility	The following are required unless otherwise specified by the IESO: 1. For *generation units* rated greater than or equal to 100 MVA (name-plate rating), each *generation unit* shall provide positive sequence voltage phasor, positive sequence current phasor and frequency from generator terminal. 2. For *generation units* connected to the IESO-controlled grid through a common connection point, whose aggregated rated size is greater than or equal to 100 MVA (aggregate name-plate rating), positive sequence voltage phasor, aggregated positive sequence current phasor and frequency shall be provided from the generation facility side of the connection point to the grid. 3. For *generation units*, regardless of rated size, whose output power flow is a part of an Interconnection Reliability Operating Limit (IROL) definition, positive sequence voltage phasor, positive sequence current phasor and frequency shall be provided at the terminals defining the IROL.

Unless otherwise specified by the *IESO*, *synchrophasor* data requirements shall comply with the corresponding *Market Manual*.

Appendix 4.16 – IESO Monitoring Requirements: Transmitters

The following information regarding the *IESO-controlled grid*, as a minimum, shall be available on a continual basis to the *IESO* from *transmitters*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements.

Equipment Type	Voltage Level	Monitored Status	Monitored Quantities
Station Bus			
Bus Voltage	*50 kV and higher*		*Specified phase-phase and phase to ground voltages measured at different buses.* *Note: a line voltage may be used if bus PTs are not available.*
Frequency	*50 kV and higher*		*As directed by the IESO for points on the IESO-controlled grid that are significant for reliability purposes. High accuracy PTs & measurements of frequency are required at a number of stations at the discretion of the IESO.*
TRANSFORMATION			
Autotransformers	*50 kV and above*	*Isolating switches* *As described in the "Reactive Devices" section below for ancillary equipment associated with the transformer*	*Megawatts and Megavars for the high voltage winding for each transformer* *Megawatts and Megavars for the low voltage winding for each transformer, if other than station service is connected to the tertiary winding.* *ULTC tap positions for the transformer* *The IESO may require the monitoring of any Off-Load Tap Changer positions.*
Phase Shifting Transformers	*50 kV and higher*	*Bypass and isolating switches*	*Voltage, MW and MVAR may be required as directed by the IESO* *All transformer tap positions*

Equipment Type	Voltage Level	Monitored Status	Monitored Quantities
Step Down Transformers	*50 kV and higher*	*Bypass and isolating switches*	*MW and MVAR* *Phase to ground Voltage, for each winding measured on the high voltage side. Where only LV PTs are available: MW and phase to phase voltages for each LV winding* *ULTC tap positions.*
Voltage Regulating Transformers	*50 kV and higher*	*Bypass and isolating switches*	*MW and MVAR may be required as directed by the IESO* *ULTC tap positions for the transformer* *The IESO may require the monitoring of any Off-Load Tap Changers.*
Isolating Devices			
Breakers and Switches	*50 kV and higher including connected tertiaries*	*All Circuit breakers, including bus tie breakers* *All breakers connecting loads for each tertiary winding of autotransformer other than that for Station Service* *Each capacitor breaker* *All line disconnect switches* *All transformer disconnect and by-pass switches* *All bus sectionalizing switches* *All isolating switches for reactors and capacitors where circuit breakers are not provided* *All in line switches as specified* *Note: The status of breaker isolating switches is not required*	
	Below 50 kV	*Breakers of Low Voltage Capacitors, Reactors, Transformers that are part of or have an impact on the IESO-controlled grid or that are subject to a contracted ancillary services contract including by means or within the scope of an operating agreement* *Each reactor or condensor breaker.*	

Equipment Type	Voltage Level	Monitored Status	Monitored Quantities
Isolating and by-pass switches	*50 kV and higher*	*Isolating and bypass switches for each transformer* *Bus sectionalizing switches* *Reactor and capacitor isolation*	
Circuits			
Circuit forming part of the IESO-controlled grid	*50 kV and higher*		*MW and MVAR line flow at each terminal*
Circuit that is an interconnection with another control area	*50 kV and higher*		• *MW and MVAR line flow* • *(MW from the billing meter point) where practical*
Special Protection Schemes			
Remedial Action Schemes (RAS)	*50 kV and higher*	*As directed by the IESO on a case-by-case basis. Where so directed, must include all associated capacitors and reactors breaker status.*	*As directed by the IESO on a case-by-case basis.*
Reactive Devices			
Capacitors, Synchronous Condensors, Reactors, Static Var Compensators, FACTS	*All levels designated by the IESO as affecting the reliability of the IESO-controlled grid*	*Breaker Status*	*MVARs where output is variable.*

Equipment Type	Voltage Level	Monitored *Syncrophasor* Quantities
Station Buses (a) 500 kV station (b) *Bulk Power System (BPS)* *Required to restore IESO-controlled grid from generating facilities providing black-start capability.*	*50 kv and higher*	Positive sequence voltage phasor magnitude Positive sequence voltage phasor angle
		Frequency
Circuits defining Interconnection Reliability Operating Limits (IROL) and interties	*50 kv and higher*	Positive sequence current phasor magnitude measured at terminals Positive sequence current angle magnitude measured at terminals
		Positive sequence voltage phasor magnitude measured at terminals *Positive sequence voltage phasor angle measured at terminals*
		Frequency
Static Var Compensators (SVCs), Synchronous condensers, and Static synchronous compensators (STATCOMs)	*Below 50 kv*	Positive sequence current phasor magnitude measured at terminals *Positive sequence current angle magnitude measured at terminals*
		Positive sequence voltage phasor magnitude measured at terminals *Positive sequence voltage phasor angle measured at terminals*
		Frequency

Appendix 4.17 – IESO Monitoring Requirements: Connected Wholesale Customers and Distributors

The following information, as a minimum, shall be available on a continual basis to the *IESO* from all *distributors connected* to the *IESO-controlled grid*, *distributors* designated pursuant to section 7.5.2 and *connected wholesale customer*s. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements. A *connected wholesale customer* that is also a *generator* shall also comply with the applicable requirements of Appendix 4.15.

TYPE	*MONITORED QUANTITIES*
Distributor connected to the IESO-controlled grid or designated pursuant to section 7.5.2	• *Where high voltage (HV) Potential Transformers (PTs) are available:* *Circuits: (where applicable)* • *Megawatt (MW), megavars (MVARs) and direction of power flow at each terminal connected to the IESO-controlled grid.* *Transformers:* • *MW, MVARS* • *phase to ground voltages for each HV winding as specified by the IESO* • *Where only low voltage PTs are available:* • *MW, MVARs for each Low Voltage (LV) winding, and* • *phase to phase voltage for each LV winding as specified by the IESO.* • *Under Load Tap Changer (ULTC) tap positions.* • *Off Load Tap Changer (OLTC) tap positions may be required, as directed by the IESO* • *Status of breakers or isolating switches for low voltage capacitors that are part of the IESO-controlled grid, or that are subject to a contracted ancillary services contract including by means or within the scope of an agreement similar in nature to an operating agreement entered into with the connected wholesale customer* • *Status of:* • *All breakers 50 kV and above.* • *All line disconnect switches 50 kV and above.* • *All transformer disconnect and by-pass switches 50 kV and above.* • *All bus sectionalising switches 50 kV and above.* • *transformer LV winding breakers and bus tie breakers for DESN type step-down transformers connected to the IESO-controlled grid* *The status of breaker isolating switches is not required.* • *Remedial Action Schemes as directed by the IESO on a case by case basis.*

TYPE	*MONITORED QUANTITIES*
Connected wholesale customers	*For:* • *All dispatchable loads; and* *Each non-dispatchable load facility that includes a non-dispatchable load rated at 20 MVA or higher or is comprised of non-dispatchable loads the ratings of which in the aggregate equals or exceeds 20 MVA, in each case where directed by the IESO if transmitter data is not adequate the following shall be monitored:* *Where high voltage PTs are available:* *Circuits: (where applicable)* • *Megawatts (MW), and Megavars (MVAR) and direction of power flow at each terminal connected to the IESO-controlled grid.* *Transformers:* • *Megawatts (MW), and Megavars (MVAR) and* • *phase to ground voltages for each HV winding as specified by the IESO.* *Where only low voltage PTs are available:* • *MW, MVARs from each LV winding, and* • *phase to phase voltages for each LV winding as specified by the IESO.* • *Under Load Tap Changer (ULTC) tap positions.* • *Off Load Tap Changer (OLTC) tap positions may be required, as directed by the IESO* • *Status of:* • *All breakers 50 kV and above.* • *All line disconnect switches 50 kV and above.* • *All transformer disconnect and by-pass switches 50 kV and above.* • *All bus sectionalising switches 50 kV and above.* • *Transformer LV winding breakers and bus tie breakers for DESN type step-down transformers connected to the IESO-controlled grid* • *Breakers or isolating switches for low voltage capacitors that are part of the IESO-controlled grid or that are subject to a contracted ancillary services contract including by means or within the scope of an agreement similar in nature to an operating agreement entered into with the connected wholesale customer* *The status of breaker isolating switches is not required* • *Remedial Action Schemes (RAS) as directed by the IESO*

Appendix 4.18 – IESO Monitoring Requirements: Embedded Load Consumers

The following information, as a minimum, shall be available on a continual basis to the *IESO* from all *embedded load consumers* designated by the *IESO* pursuant to section 7.6.1. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements. An *embedded load consumer* that is also a *generator* shall also comply with the applicable requirements of Appendix 4.15.

TYPE	*SIZE*	*MONITORED QUANTITIES*
Dispatchable load		• *Megawatts (MW),* • *megavars (MVAR) as designated by the IESO as required to maintain reliable operation of the IESO-controlled grid,* • *phase to phase voltages as specified by the IESO, and* • *status of breakers or isolating switches for low voltage capacitors that are part of the IESO-controlled grid or that are subject to a contracted ancillary services contract including by means or within the scope of an agreement similar in nature to an operating agreement entered into with the embedded load consumer*
Non-dispatchable load	*For a non-dispatchable load facility that includes a non-dispatchable load rated at 20 MVA or higher or that is comprised of non-dispatchable loads the ratings of which in the aggregate equals or exceeds 20 MVA*	*Where directed by the IESO if transmitter or distributor data is not sufficient,* • *MW, MVAR,* • *phase to phase voltages as specified by the IESO; and* • *status of breakers or isolating switches for low voltage capacitors that are part of the IESO-controlled grid or that are subject to a contracted ancillary services contract including by means or within the scope of an agreement similar in nature to an operating agreement entered into with the embedded load consumer*

Appendix 4.19 – IESO Monitoring Requirements: Generator Performance Standards

The following performance standards, as a minimum, shall be achieved on a continual basis by all *generators* referred to in section 7.3.1 of this Chapter when monitored by the *IESO*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements.

FUNCTION	*Major generation facility or significant generation facility* *(High Performance)*	*Minor generation facility and intermittent generator or transitional scheduling generator designated pursuant to section 7.3.2.3* *(Medium Performance)*	*Small generation facility*
Data measurements available at the IESO communications interface	*Less than 2 seconds from change in field monitored quantity*	1. Less than 10 seconds from change in field monitored quantity or 2. If the *minor generation facility* is embedded within a *distribution system,* less than one minute from change in field monitored quantity unless otherwise designated by the *IESO* to maintain the *reliability* of the *IESO-controlled grid*.	*Not applicable*
Equipment status change available at the IESO communications interface	*Less than 2 seconds from field status change*	1. Less than 10 seconds from field status change or 2. If the *minor generation facility* is embedded within a *distribution system*, less than one minute from change in equipment status unless otherwise designated by the *IESO* to maintain the *reliability* of the *IESO-controlled grid*.	*Not applicable*

FUNCTION	*Major generation facility or significant generation facility* *(High Performance)*	*Minor generation facility and intermittent generator or transitional scheduling generator designated pursuant to section 7.3.2.3* *(Medium Performance)*	*Small generation facility*
IESO scan period for data measurements	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*	*Not applicable*
IESO scan period for Equipment Status	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*	*Not applicable*
Data Skew	*Maximum: 4 seconds*	*Not applicable*	*Not applicable*
[Intentionally left blank – section deleted]			
[Intentionally left blank – section deleted]			

* The *IESO* may scan more frequently than the maximum.

** The *IESO* may scan less frequently than the minimum.

Appendix 4.20 – IESO Monitoring Requirements: Transmitter Performance Standards

The following performance levels, as a minimum, shall be achieved on a continual basis by all *transmitters* when monitored by the *IESO*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements.

PERFORMANCE LEVEL	FACILITIES
For transmission facilities or assets designated by the IESO as high performance at the time of registration, must meet the high performance levels in Appendix 4.21	*All facilities and assets at 50 kV and above which are monitored for system limits such as transformer or switching stations* *All transformer and switching stations with interconnected ties* *An RTU which collects information at several locations on the electricity system* *Step-down transformer facilities that supply a dispatchable load facility that is required to meet high performance monitoring standard* *All other facilities where medium performance is not specified below*
For transmission facilities or assets designated by the IESO as medium performance at the time of registration, must meet the medium performance levels in Appendix 4.21	*Step-down transformer facilities that supply a dispatchable load facility that is required to meet medium performance monitoring standard* *Step-down transformer facilities that supply a non-dispatchable load facility that includes a non-dispatchable load rated at 20 MVA or higher or that comprises non-dispatchable loads the ratings of which in the aggregate equals or exceeds 20 MVA* *Facilities and assets at 50 kV and above designated by the IESO as requiring medium performance*

Appendix 4.21 – IESO Monitoring Requirements: Transmitter Performance Standards

The following performance standards, as a minimum, shall be achieved on a continual basis by all *transmitters* when monitored by the *IESO*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements.

FUNCTION	*Transmission facilities or assets identified as high performance in Appendix 4.20*	*Transmission facilities or assets identified as medium performance in Appendix 4.20*
Data measurements available at the IESO communications interface	*Less than 2 seconds from change in field monitored quantity*	*Less than 10 seconds from change in field monitored quantity*
Equipment status change available at the IESO communications interface	*Less than 2 seconds from field status change*	*Less than 10 seconds from field status change*
Data Skew	*Maximum: 4 seconds*	*N/A*
IESO scan period for data measurements	*Maximum: 4 seconds**	*Minimum:** 4 seconds*
IESO scan period for equipment status	*Maximum: 4 seconds**	*Minimum:** 4 seconds*

* The *IESO* may scan more frequently than the maximum.

** The *IESO* may scan less frequently than the minimum.

Appendix 4.22 – IESO Monitoring Requirements: Distributors and Connected Wholesale Customer Performance Standards

The following performance standards, as a minimum, shall be achieved on a continual basis by all *distributors connected* to the *IESO-controlled grid*, *distributors* designated pursuant to section 7.5.2 and *connected wholesale customers* when monitored by the *IESO*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements. A *connected wholesale customer* that is also a *generator* shall also comply with the requirements of Appendix 4.19.

FUNCTION	*Major Dispatchable Load Facility and Significant Dispatchable Load Facility* *(High Performance)*	*Minor Dispatchable Load Facility and Non-Dispatchable Load Facility*** that includes a non-dispatchable load rated at 20 MVA or higher or is comprised of non-dispatchable loads the ratings of which in the aggregate equals or exceeds 20 MVA* *(Medium Performance)*
Data measurements available at the IESO communications interface	*Less than 2 seconds from change in field monitored quantity*	*Less than 10 seconds from change in field monitored quantity*
Equipment status change available at the IESO communications interface	*Less than 2 seconds from field status change*	*Less than 10 seconds from field status change*
Data skew	*Maximum:* 4 seconds*	*Not applicable*
IESO scan period for data measurements	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*
IESO scan period for equipment status	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*

* The *IESO* may scan more frequently than the maximum.

** The *IESO* may scan less frequently than the minimum.

*** Where directed by the *IESO* if *transmitter* data is not adequate.

Appendix 4.23 – IESO Monitoring Requirements: Embedded Load Consumers Performance Standards

The following performance standards, as a minimum, shall be achieved on a continual basis by all *embedded load consumers* designated pursuant to section 7.6.1 when monitored by the *IESO*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements. An *embedded load consumer* that is also a *generator* shall also comply with the requirements of Appendix 4.19.

FUNCTION	*Major Dispatchable Load Facility and Significant Dispatchable Load Facility* *(High Performance)*	*Minor Dispatchable Load Facility and Non-dispatchable Load Facility*** *that includes a non-dispatchable load rated at 20 MVA or higher or is comprised of non-dispatchable loads the ratings of which in the aggregate equals or exceeds 20 MVA* *(Medium Performance)*
Data measurements available at the IESO communications interface	*Less than 2 seconds from change in field monitored quantity*	1. Less than one minute from change in field monitored quantity; or 2. Less than 10 seconds from change in field monitored quantity if designated by the *IESO* as required to maintain *reliable* operation of the *IESO-controlled grid*.
Equipment status change available at the IESO communications interface	*Less than 2 seconds from field status change*	1. Less than one minute from change in field monitored quantity; or 2. Less than 10 seconds from field status change if designated by the *IESO* as required to maintain *reliable* operation of the *IESO-controlled grid*.
Data skew	*Maximum:* 4 seconds*	*Not applicable*
IESO scan period for data measurements	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*
IESO scan period for equipment status	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*

* The *IESO* may scan more frequently than the maximum.

** The *IESO* may scan less frequently than the minimum.

*** Where directed by *IESO* if *transmitter* or *distributor* data is not adequate.

Appendix 4.24 – IESO Monitoring Requirements: Electricity Storage Participants

The following information, as a minimum, shall be available on a continual basis to the *IESO* from:

(a) any *electricity storage participant* (i) whose *electricity storage facility* is connected to the *IESO-controlled grid*, or (ii) that is participating in the *IESO-administered markets*; and

(b) any *embedded electricity storage participant* (i) that is not a *market participant* or whose *embedded electricity storage facility* is not a *registered facility*; (ii) whose *embedded electricity storage facility* includes an *electricity storage unit* with an *electricity storage unit* size rated at greater than 20 MVA or that comprises multiple *electricity storage units*, the aggregated *electricity storage unit size* ratings of which exceeds 20 MVA; and (iii) that is designated by the *IESO* for the purposes of section 7.3.1 of this Chapter as being required to provide such data in order to enable the *IESO* to maintain the *reliability* of the *IESO-controlled grid*.

TYPE	INFORMATION REQUIREMENTS
Major electricity storage facility	*Monitored Quantities* *1. Active Power (MW) and Reactive Power (MX) injected or withdrawn* a) The standard requirement for active and reactive power is the provision of *net MW* and *net MX* or *gross MX*. *Gross MW* and *gross MX* or *net MX* are also to be provided, if designated by the *IESO* as required for: (i) determination of operating *security limits*; (ii) to maintain *reliable* operation of the *IESO-controlled grid*; (iii) for compliance monitoring purposes; or (iv) if provision of only the standard requirement values as defined above would have a negative impact on other *market participants* through reduced operating *security limits*. b) For *electricity storage units* with an *electricity storage unit size* greater than or equal to 100 MVA, the standard requirement as defined in part a) for each *electricity storage unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *electricity storage unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). c) For *electricity storage units* with an *electricity storage unit size* of less than 100 MVA: (i) for a group of *electricity storage units* if those *electricity storage units* are similar in size and operating characteristics, the standard requirement as defined in part a) shall be provided as a total for these *electricity storage units*, and total *gross MW* and *gross MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); or

TYPE	INFORMATION REQUIREMENTS
	(ii) if designated by the *IESO* as required for determination of operating *security limits* or to maintain reliable operation of the *IESO-controlled grid* or for compliance monitoring purposes, the standard requirement as defined in part a) for each *electricity storage unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *electricity storage unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). d) For *electricity storage facilities* that have been aggregated pursuant to Chapter 7 section 2.3: (i) the standard requirement as defined in part a) shall be provided as an aggregated total, and an aggregated total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); or (ii) if so designated by the *IESO* as required for determination of operating *security limits* or to maintain *reliable* operation of the *IESO-controlled grid* or for dispatch compliance monitoring purposes, the standard requirement as defined in part a) for each *electricity storage unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *electricity storage unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). *2. State of Charge and Charge Limit* a) For each *electricity storage unit* or *electricity storage facility*, the *state of charge* of the applicable *electricity storage unit* or *electricity storage facility* b) For each *electricity storage unit* or *electricity storage facility*, the economic maximum charge limit and the economic minimum charge limit expressed in MWh as per the applicable *market manual*. *3. Base point* a) For each *electricity storage unit* or *electricity storage facility*, providing *regulation*, the basepoint, if applicable, of the *electricity storage unit* expressed in MW, according to the applicable *market manual*. *4. Dynamic Maximum and Minimum Power* a) For each *electricity storage unit* or *electricity storage facility*, the economic maximum power mode and economic minimum power mode, expressed in MW. *5. Voltage:* a) For each *electricity storage unit*, unit terminal voltage, except if *electricity storage units* are connected to a common low voltage bus section, then the bus section voltage is adequate for those *electricity storage units*. *6. Equipment Status* a) Voltage Control status and stabilizer status (if applicable) for each *electricity storage unit* with an *electricity storage unit size* > 100 MVA. When applicable, stabilizer status reporting is only required if it can be switched off by electricity storage participant personnel remotely or at the facility. b) AGC status for each *electricity storage unit* providing *regulation*. c) Voltage control status and stabilizer status (if applicable) for each *electricity storage unit* with an *electricity storage unit size* < 100 MVA if the status of this equipment is designated by the IESO as required for determination of operating security limits or to maintain reliable operation of the *IESO-controlled grid*. When applicable, stabilizer status reporting is only required if it can be switched on or off by market participant operating personnel remotely or at the *facility*. d) Synchronizing Breaker status for each *electricity storage unit*. Where a *electricity storage facility* is designed such that no low voltage synchronizing breaker is installed for each *electricity storage unit*, the status of the appropriate HV breaker(s) and disconnect switch(es) normally used to isolate the electricity storage unit must be provided. Where this results in access to the majority of breakers on a bus, the status of the remainder of the breakers shall be provided to complete the bus configuration.

TYPE	INFORMATION REQUIREMENTS
	e) Where a *electricity storage facility* is designed such that there are disconnect switches in parallel, or directly in series, with the synchronizing breaker, the status of those switches is also required. f) *Remedial Action Scheme* status for each applicable *electricity storage unit*.
Significant electricity storage facility and minor electricity storage facility connected to IESO-controlled grid	Monitored Quantities 1. Active Power (MW) and Reactive Power (MX) injected or withdrawn: a) The standard requirement for active and reactive power is the provision of *net MW* and *net MX* or *gross MX* facility. *Gross MW* and *gross MX* or *net MX* are also to be provided, if designated by the IESO as required for: (i) determination of operating security limits; (ii) to maintain reliable operation of the *IESO-controlled grid*; (iii) for compliance monitoring purposes; or (iv) if provision of only the standard requirement values as defined above would have a negative impact on other *market participants* through reduced operating security limits. b) For *electricity storage facilities* that have not been aggregated pursuant to Chapter 7 section 2.3: (i) for a group of *electricity storage units* if those *electricity storage units* are similar in size and operating characteristics, the standard requirement as defined in part a) shall be provided as a total for these electricity storage units, and total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the IESO as required using the criteria listed above in part a); (ii) if designated by the IESO as required for determination of operating security limits or to maintain reliable operation of the IESO-controlled grid or for compliance monitoring purposes, the standard requirement as defined in part a) for each electricity storage unit shall be provided, and gross MW and gross or net MX for each electricity storage unit shall be provided if designated by the IESO as required using the criteria listed above in part a). c) For *electricity storage facilities* that have been aggregated pursuant to Chapter 7 section 2.3: (i) the standard requirement as defined in part a) shall be provided as an aggregated total, and an aggregated total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the IESO as required using the criteria listed above in part a); or (ii) if so designated by the IESO as required for determination of operating security limits or to maintain reliable operation of the IESO-controlled grid or for dispatch compliance monitoring purposes, the standard requirement as defined in part a) for each electricity storage unit shall be provided, and *gross MW* and *gross MX* or *net MX* for each *electricity storage unit* shall be provided if designated by the IESO as required using the criteria listed above in part a). 2. Voltage: a) For *electricity storage units* that are VAR dispatchable, unit terminal voltage, except if the electricity storage units are connected to a common low voltage bus section, then the bus section voltage is adequate for those electricity storage units. 3. State of Charge and Charge Limit a) For each *electricity storage unit* or *electricity storage facility*, the *state of charge* of the applicable *electricity storage unit* or *electricity storage facility* b) For each *electricity storage unit* or *electricity storage facility*, the economic maximum charge limit and the economic minimum charge limit expressed in MWh as per the applicable *market manual*. 4. Dynamic Maximum and Minimum Power

TYPE	INFORMATION REQUIREMENTS
	a) For each *electricity storage unit* or *electricity storage facility*, the economic maximum power mode and economic minimum power mode, expressed in MW. 5. Base point a) For each *electricity storage unit* or *electricity storage facility*, providing *regulation*, the basepoint, if applicable, of the storage unit expressed in MW, according to the applicable *market manual*. 5. Equipment Status a) Automatic Voltage Control and stabilizer status (if applicable) for each *electricity storage unit* if the status of this equipment is designated by the IESO as required for determination of operating security limits or to maintain reliable operation of the IESO-controlled grid. When applicable, stablizer status reporting is only required if it can be switched on or off by the *market participant* operating personnel remotely or at the facility. b) Synchronizing Breaker Status for each *electricity storage unit*. Where an *electricity storage facility* is designed such that no low voltage synchronizing breaker is installed for each *electricity storage unit*, the status of the appropriate HV breaker(s) and disconnect switch(es) normally used to isolate the *electricity storage unit* must be provided. Where this results in access to the majority of breakers on a bus, the status of the remainder of the breakers shall be provided to complete the bus configuration. Where an *electricity storage facility* is designed such that there are disconnect switches in parallel, or directly in series, with the synchronizing breaker, the status of those switches is also required. c) *Remedial Action Scheme* status for each applicable *electricity storage unit*.
Self-scheduling electricity storage facility with a name-plate rating of less than 10 MW	Monitored Quantities 1. Active Power (MW) and Reactive Power (MX) injected or withdrawn: a) The standard requirement for active and reactive power is the provision of *net MW* and *net MX* or *gross MX*. *Gross MW* and *gross MX* or *net MX* are also to be provided, if designated by the IESO as required for: (i) determination of operating *security limits*; (ii) to maintain reliable operation of the *IESO-controlled grid*; (iii) for compliance monitoring purposes; or (iv) if provision of only the standard requirement values as defined above would have a negative impact on other *market participants* through reduced operating *security limits*. b) For *electricity storage facilities* that have not been aggregated pursuant to Chapter 7 section 2.3: (i) for a group of *electricity storage units* if those *electricity storage units* are similar in size and operating characteristics, the standard requirement as defined in part a) shall be provided as a total for these *electricity storage units*, and total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the *IESO* as required using the criteria listed above in part a); (ii) if designated by the *IESO* as required for determination of operating *security limits* or to maintain reliable operation of the *IESO-controlled grid* or for compliance monitoring purposes, the standard requirement as defined in part a) for each *electricity storage unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *electricity storage unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). c) For *electricity storage facilities* that have been aggregated pursuant to Chapter 7 section 2.3: (i) the standard requirement as defined in part a) shall be provided as an aggregated total, and an aggregated total *gross MW* and *gross MX* or *net MX* shall be provided if designated by the IESO as required using the criteria listed above in part a); or (ii) if so designated by the *IESO* as required for determination of operating *security limits* or to maintain reliable operation of the *IESO-controlled grid* or for *dispatch* compliance monitoring

TYPE	INFORMATION REQUIREMENTS
	purposes, the standard requirement as defined in part a) for each *electricity storage unit* shall be provided, and *gross MW* and *gross MX* or *net MX* for each *electricity storage unit* shall be provided if designated by the *IESO* as required using the criteria listed above in part a). 2. Voltage: a) For *electricity storage unit*s that are VAR dispatchable, unit terminal voltage, except if the *electricity storage units* are connected to a common low voltage bus section, then the bus section voltage is adequate for those *electricity storage units*. 3. State of Charge and Charge Limit a) For each electricity storage unit or electricity storage facility, the state of charge of the applicable *electricity storage unit* or *electricity storage facility* b) For each *electricity storage unit* or *electricity storage facility* the economic maximum charge limit, the economic minimum charge limit expressed in MWh 4. Dynamic Maximum and Minimum Power a) For each *electricity storage unit*, the economic maximum power mode and economic minimum power mode, expressed in MW. 5. Base point a) For each *electricity storage unit*, providing *regulation*, the basepoint of the applicable *electricity storage unit* expressed in MW according to the applicable *market manual*. 6. Equipment Status a) Automatic Voltage Control status and Stabilizer status (if applicable) for each *electricity storage unit* if the status of this equipment is designated by the *IESO* as required for determination of operating *security limits* or to maintain reliable operation of the *IESO-controlled grid*. When applicable, stablizer status reporting is only required if it can be switched on or off by *market participant* operating personnel remotely or at the *facility*. b) Synchronizing Breaker Status for each *electricity storage unit*. Where an *electricity storage facility* is designed such that no low voltage synchronizing breaker is installed for each *electricity storage unit*, the status of the appropriate HV breaker(s) and disconnect switch(es) normally used to isolate the *electricity storage unit* must be provided. Where this results in access to the majority of breakers on a bus, the status of the remainder of the breakers shall be provided to complete the bus configuration. Where an *electricity storage facility* is designed such that there are disconnect switches in parallel, or directly in series, with the synchronizing breaker, the status of those switches is also required. c) *Remedial Action Scheme* status for each applicable *electricity storage unit*.
Small electricity storage facility	*None*
Minor electricity storage facility that is embedded in a distribution system and registered as a dispatchable electricity storage participant	*Monitored Quantities* *1. Total active power (MW) output of the individual electricity storage unit or of the aggregated resource.* *a) Unit status if the facility is comprised of a single electricity storage unit.* *b) Aggregated resource status if the facility is comprised of aggregated resources, i.e. if at least one unit of the aggregated resource is synchronized, the aggregated resource is synchronized or if no unit in the aggregated resource is synchronized, the aggregated resource is not synchronized.*

TYPE	INFORMATION REQUIREMENTS
	c) Reactive Power (MX) output, if requested by the IESO for reliable operation of the IESO-controlled grid, of individual electricity storage units or of the aggregated resource. *d) Unit terminal voltage (kV) if requested by the IESO for reliable operation of the IESO controlled grid* *2. State of Charge and Charge Limit* *a) For each electricity storage unit or electricity storage facility, the state of charge of the applicable electricity storage unit or electricity storage facility expressed as a percentage* *b) For each electricity storage unit or electricity storage facility, the economic maximum charge limit, the economic minimum charge limit expressed in MWh* *3. Dynamic Maximum and Minimum Power* *a) For each electricity storage unit or electricity storage facility, the economic maximum power mode and economic minimum power mode, expressed in MW.* *4. Base point* *a) For each electricity storage unit or electricity storage facility, providing regulation, the basepoint, if applicable, of the electricity storage unit expressed in MW according to the applicable market manual.*

Appendix 4.25 – IESO Monitoring Requirements: Electricity Storage Performance Standards

The following performance standards, as a minimum, shall be achieved on a continual basis by all *electricity storage participants* referred to in section 7.3.A of this Chapter when monitored by the *IESO*. Needs of the state estimation process or other reasons may result in additional requirements. The direction of all real and reactive power flows shall be indicated measurements.

FUNCTION	*Major electricity storage facility or significant electricity storage facility* *(High Performance)*	*Minor electricity storage facility and self-scheduling electricity storage facility (electricity storage facility unit size <10MW)* *(Medium Performance)*	*Small electricity storage facility*
Data measurements available at the IESO communications interface	*Less than 2 seconds from change in field monitored quantity*	1. Less than 10 seconds from change in field monitored quantity or 2. If the *minor electricity storage facility* is embedded within a *distribution system,* less than one minute from change in field monitored quantity unless otherwise designated by the *IESO* to maintain the *reliability* of the *IESO-controlled grid*.	*Not applicable*

FUNCTION	*Major electricity storage facility or significant electricity storage facility* *(High Performance)*	*Minor electricity storage facility and self-scheduling electricity storage facility (electricity storage facility unit size <10MW)* *(Medium Performance)*	*Small electricity storage facility*
Equipment status change available at the IESO communications interface	*Less than 2 seconds from field status change*	1. Less than 10 seconds from field status change or 2. If the *minor electricity storage facility* is embedded within a *distribution system*, less than one minute from change in equipment status unless otherwise designated by the *IESO* to maintain the *reliability* of the *IESO-controlled grid*.	*Not applicable*
IESO scan period for data measurements	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*	*Not applicable*
IESO scan period for Equipment Status	*Maximum:* 4 seconds*	*Minimum:** 4 seconds*	*Not applicable*
Data Skew	*Maximum: 4 seconds*	*Not applicable*	*Not applicable*

* The *IESO* may scan more frequently than the maximum.

** The *IESO* may scan less frequently than the minimum.