Market Rules

Chapter 4 Grid Connection Requirements - Appendices

ieso
Power to Ontario.
On Demand.

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 – Generation and Electricity Storage Facility Requirements

<NTD: Please note that this appendix will be modified as a result of the update to performance requirements project, and there will be a true-up conducted when the Performance Requirements project's rules become final which will outline the requirements for electricity storage.

More information on the changes being contemplated in the Performance Requirements project can be found here;
http://www.ieso.ca/Sector-Participants/Engagement-Initiatives/Engagements/Updates-to-Performance-Requirements-Market-Rule-Appendices-4-2-and-4-3 >

The performance requirements set out below shall apply to *generation facilities* subject to a *connection assessment* finalized after March 6, 2010. These performance requirements shall apply to *electricity storage units* at all times while connected to the *electricity system*, unless the *IESO* identifies specific performance requirements that are not applicable to an *electricity storage unit* for those with a *connection assessment* finalized after[effective date]. Due consideration will be given to inherent limitations.Performance of alternative technologies will be compared at the point of connection to the *IESO-controlled grid* with that of a conforming conventional synchronous *generation unit* with an equal apparent power rating to determine whether a requirement is satisfied.

Each *generation facility* that was authorized to connect to the *IESO-controlled grid* prior to March 6, 2010 shall remain subject to the performance requirements in effect for each system at the time of its authorization to connect to the *IESO-controlled grid* was granted or as agreed to by the *market participant* and the *IESO* (i.e. the "original performance requirements"). These requirements shall prevail until the main elements of an associated system (e.g. governor control mechanism, main exciter) are replaced or substantially modified. At that time, the replaced or substantially modified system shall meet the applicable performance requirements set out below. All other systems, not affected by replacement or substantial modification, shall remain subject to the original performance requirements.

Category	***Generation facility* directly connected to the *IESO-controlled grid*, *generation facility* greater than 50 MW, or *generation unit* greater than 10 MW shall have the capability to:**
1. Off-Nominal Frequency	Operate continuously between 59.4 Hz and 60.6 Hz and for a limited period of time in the region above 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).
2. Speed/Frequency Regulation	Regulate speed 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 shall be controlled in a stable fashion in both interconnected and island operation. A sustained 10% change of rated active power after 10 s in response to a constant rate of change of speed of 0.1%/s 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 governor 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.
Category	***Generation facility* directly connected to the *IESO-controlled grid* shall have the capability to:**
4. Active Power	Supply continuously all levels of active power output for 5% deviations in 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. To satisfy steady-state reactive power requirements, active power reductions to rated active power are permitted.
5. Reactive Power	Inject or withdraw reactive power continuously (i.e. dynamically) at a *connection point* up to 33% of its rated active power at all levels of active power output except where a lesser available capability is permitted by the *IESO*. 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 generator rated apparent power is acceptable.
6. Automatic Voltage Regulator (AVR)	Regulate automatically voltage within ±0.5% of any set point within ±5% of rated voltage at a point whose impedance (based on rated apparent power and rated voltage) is not more than 13% from the highest voltage terminal. If the AVR target voltage is a function of reactive output, the slope $\Delta V / \Delta Q_{max}$ shall be adjustable to 0.5%. 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. AVR reference compensation shall be adjustable to within 10% of the unsaturated direct axis reactance on the unit side from a bus common to multiple units.
7. Excitation System	Provide (a) Positive and negative ceilings not less than 200% and 140% of rated field voltage at rated terminal voltage and rated field current; (b) A positive ceiling not less than 170% of rated field voltage at rated terminal voltage and 160% of rated field current; (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. Rated field current is defined at rated voltage, rated active power and required maximum continuous reactive power.
8. Power System Stabilizer (PSS)	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 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 exciter modes of oscillation at maximum active output unless otherwise specified by the *IESO*. Due consideration will be given to inherent limitations.
9. Phase Unbalance	Provide an open circuit phase voltage unbalance not more than 1% at a *connection point* and operate continuously with a phase unbalance as high as 2%.
10. Armature and Field Limiters	Provide short-time capabilities specified in IEEE/ANSI 50.13 and continuous capability determined by either field current, armature current, or core-end heating. More restrictive limiting functions, such as steady state stability limiters, shall not be enabled without *IESO* approval.
11. Performance Characteristics	Exhibit *connection point* 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 Hydraulic less than 20 MVA, H > 2.0 Hydraulic 20 MVA or larger, H > 4.0 Other synchronized units, X'd < 0.5, T'do > 2.0, and S1.2 < 0.5) except where permitted by the *IESO*.

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

<NTD: Please note that this appendix will be modified as a result of the update to performance requirements project, and there will be a true-up conducted when the Performance Requirements project's rules become final which will outline the requirements for electricity storage.

More information on the changes being contemplated in the Performance Requirements project can be found here;
http://www.ieso.ca/Sector-Participants/Engagement-Initiatives/Engagements/Updates-to-Performance-Requirements-Market-Rule-Appendices-4-2-and-4-3 >

Ref #	***Item***	***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 underfrequency load shedding
3	Special Protection Systems	*Connected wholesale customers* and *distributors connected* to the *IESO-controlled grid* may be required to participate in *special protection systems*.
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*.

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 – Generic Information

Submission Date		
Identification	Identifier	
	Facility identifier	
Service Dates	Initial in-service:	
	Permanent in-service:	
	Permanent out-of-service:	
Protection System Description (all transmitters to provide, also generators and connected wholesale customers upon request)	A functional description of all protective schemes shall be provided to allow a detailed analysis of all credible contingencies. These descriptions shall include, but are not limited to, the following: Operating times for protection components (e.g. primary relaying, auxiliary relaying, communication), General models for normal and delayed (breaker failure) fault clearing, and Exceptions to the general model (e.g. LEO, HIROP). For all recognized contingencies, the functional description must enable fault clearing times at all terminals to be determined for both normal and delayed clearing.	
Thermal Ratings	• For the purposes of making a connection application under section 6.1.6 of Chapter 4, a *connection applicant* shall provide the *IESO* with the transmission equipment thermal ratings as specified in Appendix 4.9. • Prior to placing any new or modified *connected facility* in-service, a *market participant*, including *transmitters*, *generators* and *connected wholesale customers*, that own and operate transmission equipment associated with that *connected facility* shall provide the *IESO* with the equipment thermal ratings as specified in Appendix 4.4.	
Relay Information	Settings and characteristics to enable relay margin analysis of credible contingencies	
Detailed Single-Line	A detailed single-line diagram showing equipment and protection and telemetry points	
Test Results	Copies of all commission tests to all power system components	

Market participants and *connection applicants* also must provide nameplate data for equipment directly *connected* to the *IESO-controlled grid* upon request.

Appendix 4.6 – Generation Facilities

Part A Generation Facilities (Direct Connected and Embedded where Designated)

Unit Data	Identifier							
	Manufacturer							
	Serial Number							
	Type (e.g. salient pole, round rotor, induction)							
	Frequency (Hz)							
	NERC Unit type(e.g. Candu, Steam Turbine, Hydraulic Turbine, Wind Turbine)							
	NERC Status							
	NERC Cooling Water Source							
	NERC Fuel Type (primary, alternate)							
	NERC Fuel Transportation (primary, alternate)							
	Maximum Continuous Rating (summer MCR, winter MCR)							
	Capability above MCR (MW), sustainability per event (hrs)							
	Description of other restriction when operating above MCR (e.g. hours/year)							
	NERC primary fuel heat rate at full load (BTU/kWhr)							
	Rated capability (MVA)							
	Rated voltage (kV)							
	Power Factor							
	Total rotational inertia of generator and turbine (s)							
	Unsaturated reactances in pu on machine base (Xo required only if unit transformer provides a zero sequence path)							
	Xd	X'd	X''d	Xq	X'q	Xl	X_2	Xo
	Unsaturated open circuit time constants (s)							
	T'do		T''do		T'qo		T''qo	
	Speed (RPM)							
	Station load (MW, MVAR)							
	Minimum power (MW)							
	Normal loading and unloading ramp rates (MW/min)							
	Emergency loading and unloading ramp rates (MW/min)							
	Armature (Ra) and field resistance (Rfd*) (Ω)							
	Saturation at rated voltage (S1.0) and 20% above (S1.2)							
	Rotational inertia for generator without turbine (s) (upon request only)							
	Damping							
	Base field current (A)							
	Base field voltage (volts)							
	Losses at 1.0 and 0.9 power factor (MW)							
Characteristics	Open circuit saturation curve							
	Short circuit curve							
	V curves							
	Capability curve							

*Field resistance for hydraulic units should be specified at 75ºC and at 100ºC for thermal units.

EXCITATION SYSTEM MODEL

A block diagram suitable for stability studies or an IEEE standard model type with all in-service parameter values for the exciter. Models for stabilizers, under-excitation limiters, and over-excitation limiters shall be provided where applicable.	For each unit 10 MVA or larger

GOVERNOR AND PRIME MOVER SYSTEM MODEL

A block diagram suitable for stability studies or an IEEE standard model type with all in service parameters values for the governor and prime mover (turbine). More detailed models would be required if off-nominal frequency or shaft torsional studies are required.	For each unit 10 MVA or larger

Part B Embedded Generation Facilities

For each unit	Type (e.g. salient pole, round rotor, induction)	
	Rated capability (MVA)	
	Rated voltage (kV)	
	Rated power factor	
	Maximum continuous rating (MW)	
	Maximum capability under emergency conditions (MW)	
	Fuel Type	
	Emergency Ramp Rate (MW/minute)	

Part C Variable Generation (Directly Connected)

Wind Farm (WF) or Solar Farm (SF) Facilities

Wind Turbine/ PV Inverter			Type 1	Type 2
	Manufacturer			
	Model			
	Technology			
	Rated Voltage			
	Rated MVA			
	Rated MW			
	Qmax (MVAr)			
	Qmin(MVAr)			
	Xd''/Id''(pu)			
	Reactive Capability Curve		Please Attach File	Please Attach File
	Voltage Protection		Please Attach File	Please Attach File
	Frequency Protection		Please Attach File	Please Attach File
	GSU Transformer	Voltage Ratio		
		MVA		
		R(%)		
		X(%)		

	ID	Total MW	# of Type 1	# of Type 2	Equivalent Positive-Sequence Impedance*			Equivalent Zero-Sequence Impedance **		
					R1	X1	B1	R0	X0	R0
Collector System	C1									
	C2									
	C3									

*Reduction approach is based on equal loss criteria.

** Optional upon request.

Functional description of voltage control system	Please Attach File
Functional description of frequency control system	Please Attach File
Parameters for WF/SF dynamic model	Please Attach File
Block diagram for WF/SF dynamic model (if user defined)	Please Attach File
Source code for WF/SF dynamic model (if user defined)	Please Attach File

Appendix 4.7 – Facilities of Connected Wholesale Customers and Distributors Connected to the IESO-controlled Grid

Load Schedule		Date	Peak Load	Power Factor	Load Factor				
	Commissioning		MW	%	%				
	Initial		MW	%	%				
	Ultimate		MW	%	%				
Nature of Load	Composition (e.g. % industrial, % commercial, %residential)								
	Requirement for dual supply								
	Description of unusual sensitivity to voltage or frequency fluctuations								
	Description of unusual consequences of power outages								
Power Quality Upon request	Harmonics (frequency, magnitude)								
	Flicker (voltage change, frequency)								
	Phase Imbalance (%)								
	Variable Speed Drives		Demand (kVA)		Description				
	Welding Equipment		Demand (kVA)		Description				
	Static Converters		Demand (kVA)		Description				
	Furnace		Demand (kVA)		Description				
	Other discontinuous or harmonic rich load		Demand (kVA)		Description				
	Capacitors		Demand (kVA)		Description				
	Generators		Total Size (kVA)		Description				
Load Shape		November to April (Winter) Maximum Demand			May to October (Summer) Maximum Demand				
		Weekday		Weekend		Weekday		Weekend	
	Hours (EST)	MW	MVAR	MW	MVAR	MW	MVAR	MW	MVAR
	00:00-04:00								
	04:00-08:00								
	08:00-12:00								
	12:00-16:00								
	16:00-20:00								
	20:00-24:00								
Motors ≥ 500 HP	Type (e.g. squirrel cage, wound rotor, synchronous)								
	Rated capability (MVA or HP)								
	Power factor								
	Starting method (e.g. full-voltage, resistive, reduced voltage, delta-wye)								
	Starts per day								
Induction Motors ≥ 25,000 HP or ≥ 500 HP per request	Identifier								
	Rated capability (MVA or HP)								
	Rated torque (per unit on machine base)								
	Rated slip (per unit on machine base)								
	Starting torque (per unit on machine base)								
	Starting current (per unit on machine base)								
	Starting power factor								
	Peak torque (per unit on machine base)								
	Locked rotor current (per unit on machine base)								

Synchronous Motors ≥ 500 HP	Identifier								
	Rated capability (MVA or HP)								
	X''d (unsaturated subtransient reactance in per unit on machine base)								
	For each synchronous motor ≥ 5000 HP								
	Rotational inertia constant H of motor and load (s)								
	Unsaturated reactances (per unit on machine base)								
	Xd	X'd	X''d	Xq	X'q	X''q	Xl	X_2	Xo
	Unsaturated open circuit time constants (s)								
	T'do		T''do		T'qo			T''qo	
	Armature resistance (Ra) (per unit on machine base)								
	Saturation at rated voltage (S1.0) and 20% above (S1.2)								

EXCITATION SYSTEM MODEL

A block diagram suitable for stability studies or an IEEE standard model type with all in-service parameter values for the exciter. Models for stabilizers, under-excitation limiters, and over-excitation limiters shall be provided where applicable.	For each synchronous motor 10 MVA or larger

Appendix 4.8 – Network Impact Information: Ancillary Services Providers

Target In-Service Dates	Initial In-Service:					
	Permanent Station In-Service:					
Reactive Support Service and Voltage Control Service	VAR Source	Type	Minimum	Min Required	Maximum MX	Max Required
Black Start Capability	Minimum Number of Starts					
	Maximum Time on In-house Load (minutes)					
	Island Governing Capability					
	Interconnected Governing Capability					
	Maximum Reactive Capability (MVAR)					
	Minimum Reactive Capability (MVAR)					
	Maximum Load Pickup Capability (MW)					
Automatic Generation Control	Maximum Power (MW)					
	Minimum Power (MW)					
	Power Ramping Rate (MW/min)					
Operating Reserve	Starting Time (for Non-synchronized Reserve only)					
	Maximum Power (MW)					
	Minimum Power (MW)					
	Power Ramping Rate (MW/min)					

Appendix 4.9 – Transmission Facilities

Shunt Capacitors	Identifier	
	Station	
	Manufacturer and serial number	
	Rated voltage (kV)	
	Rated capability (MVAR)	
	Discharge time (ms)	
	Current limiting reactor (ohms)	
	Synchronous closing unit	
	Bank arrangement (e.g. delta, wye, double-wye, etc)	
	Description of protection	
	Description of automatic switching	
	Anticipated switching restrictions	
Circuit Breakers	Identifier	
	Station	
	Manufacturer and serial number	
	Rated voltage (kV)	
	Interrupting time (ms)	
	Interrupting media (e.g. air, oil, SF_6)	
	Rated continuous current (A)	
	Rated symmetrical short circuit capability (A)	
Shunt Reactors	Identifier	
	Station	
	Manufacturer and serial number	
	Rated voltage (kV)	
	Rated capability (MVAR)	
	Winding configuration (e.g. delta, wye)	
	Description of protection	
	Description of automatic switching	
	Description of anticipated switching restrictions	

Transformers	Identifier								
	Station								
	Manufacturer and serial number								
	Construction (e.g. shell or core)								
	Configuration (e.g. 3 phase or three single phase)								
	Temperature rise (ºC)								
	Cooling types (e.g. ONAN, ONAF, OFAF)								
	Associated Thermal Rating for each cooling type (MVA)								
	Winter (10ºC) continuous, 15 minute and 10 day thermal ratings (A)								
	Summer (30ºC) continuous ,15 minute, and 10 day thermal ratings (A)								
	Connection for each winding H, X, Y (e.g. wye, delta, zig-zag)								
	Rated voltage for each winding (kV)								
	Rated capability for each winding (MVA)								
	Impedance to ground for each winding H, X, Y (ohms)								
Impedance Test Data	See IEEE C57.12.90 for	Positive Sequence Impedance (%)	HX		HY		XY		
(see IEEE C57.12.90)	measurement techniques	R							
		X							
	H	MVA							
Zero sequence	H winding energized	Closed tertiary zero seq. impedance (%)	H		X		HX		XH
data is required for	all others open	R							
transformers with		X							
1 or 2 external	HX	MVA							
neutrals	H winding energized	Open tertiary zero sequence impedance (%)	H		X		HX		XH
	X winding shorted	R							
		X							
		MVA							
	In-service off-load tap (kV)								
	Off –load taps (kV)								
	On-load taps (kV) (max tap, min tap, number of steps)								
	Core and Excitation Losses (kW, kvar)								

Overhead Circuits (For each section)	Identifier			
	Terminal station(s)			
	Voltage (kV)			
	Length (km)			
	Identifier(s) and length of circuit(s) on common towers			
	Positive sequence impedance (R, X, B)			
	Zero sequence impedance (Ro, Xo, Bo)			
	Winter (10ºC) continuous and limited time* thermal ratings (A)			
	Summer (30ºC) continuous and limited time* thermal ratings (A)			
Overhead Circuits (For each segment)	Identifier			
	Length (km)			
	Distance from the "from" terminal (km)			
	Ground resistivity (ohms)			
	Identifier and length of circuits sharing the same right of way			
	Mutual impedance to other circuits (Z_{zero})			
Underground Circuits	Identifier			
	Complete steady state and dynamic electrical and physical parameters of conductors, insulators and surrounding material			
Buses	Identifier			
	Station			
Surge Arresters	Identifier			
	Station			
	Manufacturer and serial number			
	Voltage rating (kV)			
	Type (e.g. ZnO, SiC)			
	Class (e.g. secondary, distribution, intermediate, station)			
Switches	Identifier			
	Station			
	Manufacturer and serial number			
	Voltage rating (kV)			
	Type (e.g. disconnect, interrupt)			
	Continuous current rating (amps)			
Wavetraps	Identifier			
	Station			
	Manufacturer and serial number			
	Continuous current rating (amps)			
Current Transformers	Identifier			
	Station			
	Manufacturer and serial number			
	Continuous current rating (amps)			
DC Lines	Identifier			
	Complete steady state (loadflow) parameters and dynamic parameters			
FACTS Devices	Identifier			
	Complete steady state (loadflow) parameters and dynamic parameters			

*Limited time thermal ratings shall be 15-minute ratings, unless mutually agreed by the *IESO* and *market participant*.

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* or *gross MX*. *Gross MW and gross* 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* 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* 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* 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: (i) the standard requirement as defined in part a) shall be provided as an aggregated total, and an aggregated total *gross MW and gross* or *net MX* shall be provided if designated by the

TYPE	INFORMATION REQUIREMENTS
	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* 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) *Special Protection System* status for each applicable *generation unit*.
Significant generation facility and minor generation facility connected to IESO-controlled grid	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* or *gross MX*. *Gross MW and gross* or *net MX* are also to be provided, if designated by the *IESO* as required for: (i) determination of operating *security limits*;

TYPE	INFORMATION REQUIREMENTS
	(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* 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* 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* 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* 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: 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

TYPE	INFORMATION REQUIREMENTS
	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) *Special Protection System* 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.

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
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

Equipment Type	Voltage Level	Monitored Status	Monitored Quantities
			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.	
Isolating and by-pass switches	50 kV and higher	Isolating and bypass switches for each transformer Bus sectionalizing switches Reactor and capacitor isolation	
Circuits			

Equipment Type	Voltage Level	Monitored Status	Monitored Quantities
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			
Special Protection Systems(SPS)	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.

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. • *Special Protection Systems* 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 • Special Protection Systems (SPS) 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 an *aggregate electricity storage unit size* that 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 or gross MX. Gross MW and gross 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 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 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 *electricity storage unit* shall be

TYPE	INFORMATION REQUIREMENTS
	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). 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 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 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 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. 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.

TYPE	INFORMATION REQUIREMENTS
	f) Special Protection System 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 or gross MX facility. Gross MW and gross 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 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 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 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 a) For each electricity storage unit or electricity storage facility, the economic maximum power mode and economic minimum power mode, expressed in MW.

TYPE	INFORMATION REQUIREMENTS
	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. 4. 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 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. 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) Special Protection System 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 or gross MX. Gross MW and gross 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 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 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 or net 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 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 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). 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, 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) Special Protection System status for each applicable electricity storage unit.
Small electricity storage facility	None
Minor electricity storage facility that is embedded in a distribution	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*.

TYPE	INFORMATION REQUIREMENTS
system and registered as a dispatchable electricity storage participant	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. 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.