PERFORMANCE REQUIREMENTS FOR LARGE LOADS CONNECTED TO THE LIPA SYSTEM

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1. SCOPE

The technical requirements in this Requirements Document shall apply to all energy consuming facilities defined as Large Load Facilities by this document that are directly interconnected with the LIPA transmission or distribution system, though Large Load Facility interconnections are primarily expected to connect to the transmission system. All requirements for the interconnection apply at the Point Of Interconnection (POI) unless otherwise specified.

Exceptions to individual requirements or individual limits defined in this document may be made on a case-by-case basis at the sole discretion of PSEG Long Island based on project-specific studies that are specified and approved by PSEG Long Island.

2. DEFINITIONS

Aggregate Rating: A rating equal to the sum of two or more devices where the devices have nearly the same or identical electrical and operating characteristics.

Demand-Synchronized Large Load Facilities: Two or more Large Load Facilities connected to the LIPA system that operate such that their demand fluctuates in synchronism, even if the Large Load Facilities have separate points of interconnection.

Emergency Conditions: A temporary operating condition in which PSEG Long Island or NYISO has determined that special operating procedures and special control actions are warranted.

Facility Major Components For a Large Load Facility, the major components of the facility include:

- All lengths of cable or overhead line in excess of 1000ft
- All transformers with an individual or aggregate rating greater than 5% of the Maximum Rated Demand or greater than 10 MVA
- All power-consuming equipment with an individual or aggregate rating greater than 5% of the Maximum Rated Demand or greater than 10 MW
- All power-generating or power-discharging equipment with an individual or aggregate rating greater than 5% of the Maximum Rated Demand or greater than 10 MW

- All reactive power compensation equipment with an individual or aggregate rating greater than 5% of the Maximum Rated Demand or greater than 10 MW

Information Technology (IT): Equipment that consumes active power through performing calculations using computer processors. The active power consumption may or may not be a function of the calculations or algorithms being run on the computer processors.

Infrequent energization: Infrequent energization is defined to include initial Facility commissioning, return to service following faults or failures in the LIPA or Facility systems, or return to service following maintenance. Transformer energization that occurs on a routine, recurring basis is expressly excluded from the definition of infrequent energization.

Large Load Facility For the purposes of this Requirements Document, a *Large Load Facility* is defined to be any Facility directly connected to the LIPA system having a Maximum Gross Demand greater than or equal to 20 MW. In this document, the use of the word "Facility" refers to a Large Load Facility, unless expressly stated otherwise. Large Load Facilities where the aggregate load is comprised of many different types of power consuming equipment (lighting, HVAC, motor, power electronic, etc.) may be exempted from these requirements at the sole discretion of PSEG Long Island. However, if the facility contains a block of non-diversified load (i.e., HVAC system) that exceeds the Maximum Gross Demand threshold for a Large Load Facility, then the facility is subject to this Requirements Document.

Maximum Gross Demand: The maximum active power demand for which the Facility is designed, not considering any generation or storage assets that may also be connected in the Facility.

Maximum Rated Demand: The maximum net active power demand for which the Facility is designed. This value may be equal to or less than the Maximum Gross Demand when considering generation or storage assets that may also be connected in the Facility, if the Facility's assets are operated in a manner to limit the net demand at the POI.

Nominal Short-Circuit Capacity: Nominal short-circuit capacity is defined as the short-circuit capacity of the LIPA system at the POI with no transmission line outage contingencies and with all generation interconnected with the LIPA system offline.

***Nominal Short-Circuit Ratio*:** The ratio of the nominal short-circuit capacity at the POI of the Facility as provided by PSEG Long Island in MVA, divided by the planned peak active power demand of the Facility in MW.

Point Of Interconnection (POI) The point at which the electrical connection is made to the LIPA system, as coordinated by PSEG Long Island and the Large Load Facility and specified by applicable drawings or oneline diagrams.

Remain Online: Performance in which the Resource does not trip (open mechanical breakers) and does not cease injection of current for voltages except where voltage magnitude is less than a defined undervoltage threshold, or greater than a defined overvoltage threshold, and momentary cessation is permitted provided current injection is resumed according to defined criteria.

RMS Magnitude: Root-mean-square magnitude of the quantity measured over a one fundamental-frequency period.

Transmission Event: A disturbance of the transmission inclusive of single- and multi-phase faults, line switching, cable switching, transformer energization, generator tripping, etc. The event is inclusive of all transmission system dynamic response to the initiating events. Successful and unsuccessful line reclosing with less than 30 seconds delay shall be considered as a single event. Reclosing with greater than or equal to a 30-second delay shall constitute an independent event.

Voltage Disturbance: A disturbance in which the change in phase-–to-ground or phase-to-phase voltage at the point of interconnection exceeds +/- 10% of nominal voltage or the voltage phase angle suddenly changes or “jumps” by more than 5 degrees in one fundamental frequency cycle, relative to a continuation of the pre-disturbance waveform.

3. STEADY-STATE PERFORMANCE

3.1 Steady-State Power Factor in Normal Operation

The steady-state power factor of the Facility, determined by the average active power demand and the average reactive power demand over any 15-minute period shall be greater than 0.98.

3.2 Maximum Gross Demand

This value shall be reported explicitly in megawatts (MW).

3.3 Maximum Rated Demand

The maximum rated demand shall not be exceeded at the POI, with short-term exceptions per the times set forth:

- Power demand shall not exceed 50% of Maximum Rated Demand or greater than 20 MW for longer than 0.10 seconds, occurring not more than once per day, unless authorized by PSEG Long Island Operations.
- Power demand shall not exceed 10% of Maximum Rated Demand for longer than 1.0 second, occurring not more than once per day, unless authorized by PSEG Long Island Operations.
- Power demand shall not exceed 1% of Maximum Rated Demand for longer than 1.0 minute, occurring not more than once per day, unless authorized by PSEG Long Island Operations.

4. DYNAMIC PERFORMANCE, ACTIVE POWER AND FREQUENCY RESPONSE

The following requirements apply to each Large Load Facility and to Demand-Synchronized Large Load Facilities, both individually to each Large Load Facility and in aggregate for Demand-Synchronized Large Load Facilities.

4.1 Active Power Control Response

The Large Load Facility shall limit its active power demand as stated in the interconnection agreement during grid emergency conditions.

4.2 Active Power Ramp Rate Limits

The Facility's maximum power ramp rate shall not exceed 20 MW/minute (measured as a change in active power over any 60 second period) for load increases or decreases under normal operating conditions, unless determined as necessary to meet other performance requirements specified. Under *emergency conditions*, the Facility's ramp rate limit may be exceeded as allowed in the Interconnection Agreement. The ramp rate limits shall apply only when the root-mean-square voltage magnitude of all phases at the POI is above 0.9 pu for the 60 second period.

4.3 Response to Large Deviations in Frequency

a) The Facility shall ride through for fundamental frequency deviations listed in Table 4.1 where the frequency measurement is measured over a reasonable period of time, typically 50 to 100 milliseconds.

Table 4-1: Frequency Ride-Through Requirements

Frequency [Hz]	Minimum Ride-Through Time [sec]
> 61.8	May trip
> 61.2	299
≤ 61.2 and ≥ 58.8	Continuous
< 58.8	299
< 57.0	May Trip

b) The Facility shall not trip for an absolute rate of change of frequency (RoCoF) magnitude of less than 5.0 Hz/sec over an averaging window of at least 100 milliseconds.

c) In the event of frequency at the POI increasing above 60.5 Hz, the Facility shall remain connected and operating at an active power no less than 70% of its pre-disturbance active power for a minimum of ten minutes. This requirement shall not apply if the frequency increases above 61.8 Hz for more than 100msec.

d) In the event of frequency at the POI decreases below 59.5 Hz, active (real) power demand of the Facility shall be decreased by at least the lesser of 17% of the Rated Maximum Demand or 50% of the active power demand immediately prior to the frequency decreasing below the 59.5 Hz threshold. The reduction shall occur within 0.30 seconds of frequency decreasing and remaining below 59.5Hz, in accordance with PRC-006-NPCC-2 Attachment C.

e) After an under-frequency event in which frequency decreases below 59.5 Hz, the active power demand shall remain at or below the required reduction levels until permission to increase active power demand is provided by PSEG Long Island System Operations.

4.4 Response to Small Deviations in the Voltage Phasor

In the continuous operating range (voltage at the POI between 0.9pu and 1.10pu; frequency between 58.8Hz and 61.2Hz), the Facility shall not cause amplification (negative damping) of active or reactive power oscillations in the subsynchronous frequency range defined as 0.1Hz – 55.0Hz. An assessment shall be conducted, which considers the transfer function between the voltage phasor (magnitude and angle) at the POI and the power (active and reactive) of the Facility at the POI. Results should be provided in the frequency domain over the subsynchronous frequency range.

4.5 Active Power Variation Limits

Persistent cyclical variations in active (real) power can stimulate adverse interactions with other power system equipment, controls, and loads. Of particular concern is stimulation of subsynchronous electromechanical oscillations of power generation equipment.

4.5.1 Disclosure of Processes

Facility Owner shall disclose the electrical characteristics of any processes creating cyclic variability of active power demand within a 10-minute period that exceeds more than 5% of Maximum Rated Demand. Characteristics shall include the magnitude of deviations in active power, the range of variation frequency, and the shape of active power variations as well as persistence of cyclic activity.

4.5.2 Impact on Grid-Connected Equipment

The Facility shall not cause unstable behavior on the grid or materially degraded performance or operating life of other equipment connected directly or indirectly to the LIPA system, directly resulting from varying active power.

4.5.3 Quantifying the Active Power Variations

The active power variations shall be quantified using the following process, which is intended to account for the risk of stimulation of one or more modes of the power system. This approach is further intended to consider repetitive variations in power where the variations could be the result of stochastic processes. The method of measurement is designed such that it can be implemented in offline methods or in online real-time monitoring.

The measurements are divided into two adjacent, non-overlapping bands, referred to here as the high sub-synchronous frequency band and the low sub-synchronous frequency band.

High Subsynchronous Frequency Band (5.0 – 55.0 Hz)

- Measure three-phase active power continuously using instrument transducers that provide a reasonable level of fidelity up to 600Hz. The sample rate of active power shall be at least 600Hz. It shall be performed phase-wise per the following formula. There shall be no filtering of the phase voltage or phase currents that impact (cause a change in magnitude greater than 1% or change in phase greater than 6º) the 600Hz range beyond what is instructed here.

$$P(t) = V_a(t) * I_a(t) + V_b(t) * I_b(t) + V_c(t) * I_c(t)$$

- Perform a Fast Fourier Transform (FFT) on the active power signal
- The FFT window size shall be exactly 1.0 seconds, achieving 1.0Hz bins in the frequency domain.
- The zero-to-peak value of the active power for each of the 56 frequency bins (5 – 55Hz) shall be reported at the sample rate (>600Hz), where each sample reflects the active power (computed as a zero-to-peak quantity) in that frequency bin that was present in the signal over the preceding 1.0 second.
- The resulting set of time-series data capturing the active power zero-to-peak MW for each frequency bin shall be averaged over the preceding 10 second rolling window. The result will be a set of time-series data capturing the $P_{0\text{-}pk,avg}$ for each frequency bin.

Low Subsynchronous Frequency Band (0.1 – 5.0 Hz)

- Measure three-phase active power continuously. The sample rate of active power shall be at least 60Hz. It shall be performed phase-wise per the following formula or using a method that is demonstrably equivalent. There shall be no filtering of the phase voltage or phase currents that impact (cause a change in magnitude greater than 1% or change in phase greater than 6º) the 60Hz range beyond what is instructed here.

$$P(t) = V_a(t) * I_a(t) + V_b(t) * I_b(t) + V_c(t) * I_c(t)$$

- Perform a Fast Fourier Transform (FFT) on the active power signal
- The FFT window size shall be exactly 10 seconds, achieving 0.10Hz bins in the frequency domain.
- The zero-to-peak value of the active power for each of the 50 frequency bins (0.1 – 5.0Hz) shall be reported at the sample rate (>60Hz), where each sample reflects the active power (computed as a zero-peak quantity) in that frequency bin that was present in the signal over the preceding 10.0 seconds.
- The resulting set of time-series data capturing the active power zero-to-peak MW for each frequency bin shall be averaged over the preceding 60-second

window. The result will be a set of time-series data capturing the $P_{0\text{-pk,avg}}$ for each frequency bin.

$$P_{0-pk,avg}(t, bin) = \left(\frac{1}{w}\right)\int_{t-w}^{t} P_{bin}(t)\, dt$$

Where:

- $P_{0\text{-pk,avg}}$ is the time-series output of the average zero-peak active power in MW, that is averaged over a preceding period of duration w, for each frequency bin.
- P_{bin} is the time-series output from the FFT with a 1-sec window, active power, $MW_{0\text{-pk}}$
- w is the rolling window period in seconds
- bin is each frequency bin within the frequency band
- t is time in seconds

4.5.4 Active Power Variation Limits

The resulting set of time-series data capturing the $P_{0\text{-pk,avg}}$ for each frequency bin shall, as computed in the Quantifying the Active Power Variations shall not exceed the following limits of Table 1. For performance verification, the $P_{0\text{-pk,avg}}$ calculations for each row of Table 4-2 shall be performed for a measurement period of at least 600 seconds for each of the different normal operating modes of the Facility, as identified in Disclosure of Processes.

Table 4-2: Limits for Active Power Variation

Frequency Band	Limit	Rolling Window (w) for Calculation
High Subsynchronous (5.0 – 55.0 Hz)	The $P_{0\text{-pk,avg}}$ for the sum of any two adjacent frequency bins shall not exceed 3.5 $MW_{0\text{-pk,avg}}$	10 second rolling window

Low Subsynchronous (0.1 – 5.0 Hz)	The $P_{0\text{-pk,avg}}$ for the sum of any two adjacent frequency bins shall not exceed 10.0 $MW_{0\text{-pk,avg}}$	60 second rolling window
Low Subsynchronous (0.1 – 5.0 Hz)	The $P_{0\text{-pk,avg}}$ for the sum of all bins shall not exceed 20.0 $MW_{0\text{-pk,avg}}$	60 second rolling window

5. DYNAMIC PERFORMANCE, REACTIVE POWER AND VOLTAGE RESPONSE

5.1 Response to Large Voltage Magnitude Deviations

The Facility shall be required to remain online for all voltage disturbances with the following modifications:

a) The Facility shall not be required to *remain online* for low voltage disturbance at the POI such that the least RMS magnitude of any phase-ground or phase-phase voltage is lower than the values specified in Figure 5-1 and Table 5-1 in excess of the cumulative durations shown.

b) The Facility shall not be required to remain online for high voltages at the POI such that the greatest RMS magnitude of any phase-ground or phase-phase voltage is higher than the values specified in Table 5-2 in excess of the duration shown.

c) The Facility shall not be required to remain online for high voltages at the POI such that the greatest magnitude of any phase-ground or phase-phase voltage is higher than the values specified in Figure 5-3 and Table 5-3 in excess of the cumulative durations shown and illustrated in Figure 5-4 in any 1.0 second period.

d) The Facility shall ride through at least three distinct voltage deviation events (where the voltage between events re-enters the continuous operating range) within 10 seconds. The Facility shall not trip or change its power consumption by greater than 10% of maximum rated demand due solely to a certain number of voltage sags within a certain period of time.

During voltages less than 0.9 per unit, the Facility may temporarily reduce the load consumption, but the load shall return to at least 90% pre-disturbance consumption from grid within one second of voltage recovery to 0.90 per unit. During this period of low voltage, the Facility's active current shall not increase in response to a voltage decrease.

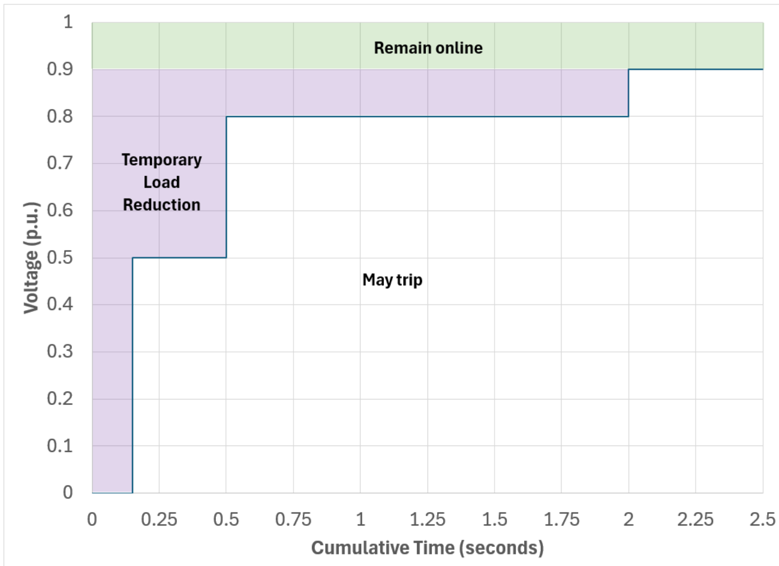


Figure 5-1: RMS Low-Voltage Ride-Through Requirements

Table 5-1: RMS Low-Voltage Ride-Through Requirements

Voltage [p.u.]	Duration [sec]
< 0.5	0.15
< 0.8	0.5
< 0.9	2.0

Table 5-2: RMS High-Voltage Ride-Through Requirements

Voltage [p.u.]	Duration [sec]
V > 1.2	Refer to Cumulative Instantaneous High-Voltage Ride-Through Requirements
V > 1.1	2.0

Figure 5-3: Cumulative Instantaneous High-Voltage Ride-Through Requirements

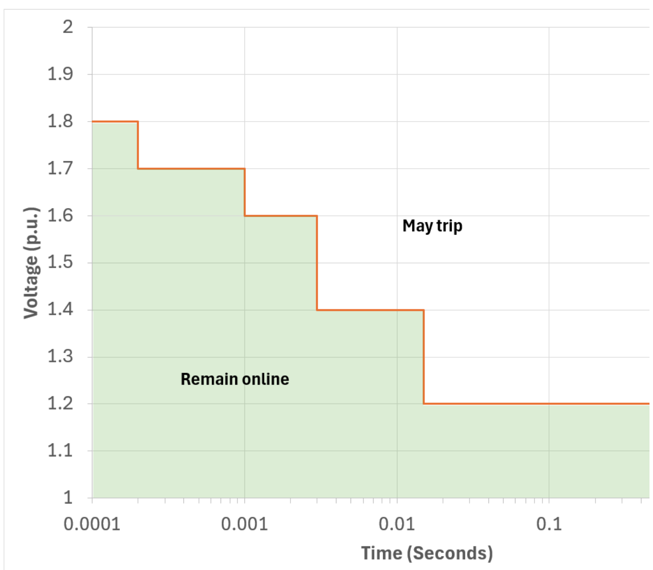
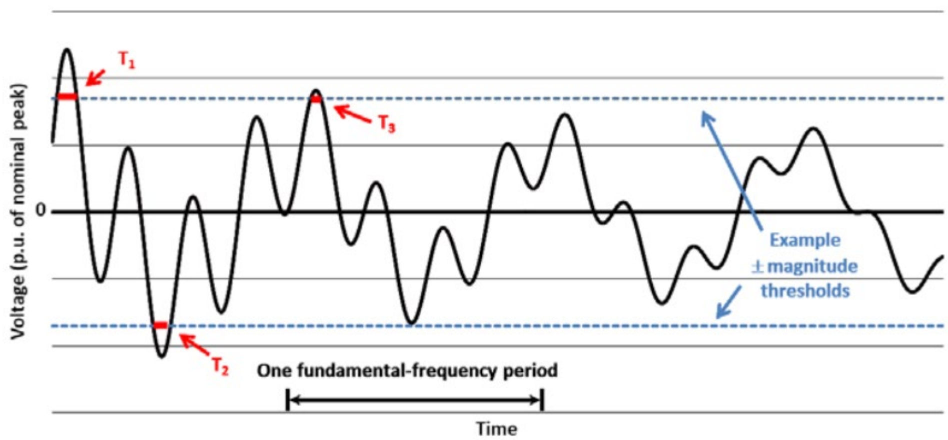


Table 5-3: Cumulative Instantaneous High-Voltage Ride-Through Requirements

Voltage [p.u.]	Cumulative Duration [sec]
V > 1.8	May Trip
V > 1.7	0.0002
V > 1.6	0.001
V > 1.4	0.003
V > 1.2	0.015

Figure 5-4: Cumulative Instantaneous High-Voltage Measurement



5.2 Response to Large Voltage Angle Deviations

Facility shall be required to *remain online* for voltage phase angle disturbances at the POI in which the phase angle of the positive sequence fundamental frequency voltage waveform suddenly (within one 60Hz period) changes, or “jumps”, by up to 25 electrical degrees in either direction. Resources shall ride through the phase angle jump events described provided the voltage magnitude remains within 0.90 to 1.1 p.u. or the voltage magnitude ride through requirements.

5.3 Ride-Through of Negative Sequence Voltages

The Facility shall be required to *remain online* for any condition in the continuous range of voltage at the POI (0.9pu to 1.1pu) except where the negative sequence voltages exceed 2% of the nominal voltage for greater than 60 seconds or 5% for greater than 3 seconds.

5.4 Transient Reactive Current Demand During Large Disturbances

Reactive current demand of the Facility shall not exceed

- 50% of the current at Maximum Gross Demand for a period exceeding 10 seconds, or
- 100% of the current at Maximum Gross Demand for a period exceeding 1 second

during and after voltage disturbances where the magnitude of any phase voltage at the POI is less than 0.9 times the nominal voltage.

5.5 Limitation of Overvoltage

Sudden discontinuation of any amount of Facility apparent power demand shall not cause voltage at the POI to increase by more than

- 5% of the nominal voltage for longer than 1 second, or
- 20% of the nominal voltage for longer than 0.1 seconds.

Dynamically-controlled reactive power demand by the Facility may be used as a means to mitigate excessive load rejection voltage rise.

5.6 Transient and Temporary Overvoltages

a) The Facility shall not cause transient or temporary phase-to-ground or phase-to-phase overvoltages at the POI with cumulative instantaneous magnitudes exceeding the magnitudes and durations specified in Table 5-3.

b) The Facility shall not cause the root-mean-square magnitude of the POI phase-to-phase or phase-to-ground voltage, measured over a 1/60th second window, to exceed 1.2 p.u. of the nominal voltage, or to exceed 1.1 p.u. of the nominal voltage for a period exceeding 1.0 seconds.

Table 5-3 – Instantaneous Voltage Limits

Instantaneous Voltage Threshold (p.u.)	Maximum Cumulative Duration of Instantaneous Voltage Exceeding Threshold Magnitude (ms)
1.7	0.2
1.6	1.0
1.4	3.0
1.2	15.0

6. POWER QUALITY

6.1 Repetitious Voltage Variations (Flicker)

Contributions of the Facility to Point of Interconnection voltage variations shall not exceed $P_{ST} = 0.35$ or $P_{LT} = 0.25$ as defined in IEEE Std 1453.

6.2 Abrupt and Rapid Voltage Changes (RVC)

a) The Facility shall not cause Frequent Rapid Voltage Change, as defined in the latest version of IEEE Std 2800, at the Point of Interconnection greater than 0.025 times the nominal voltage. This requirement applies, non-exclusively, to any de-energization or energization of capacitors, reactors, cables, or transformers (other than on an infrequent basis).

b) Abrupt change in POI RMS voltage magnitude and Rapid Voltage Change due to infrequent power transformer switching shall not exceed 10% of the nominal voltage for any duration exceeding one cycle of a 60 Hz period, shall not exceed 5% of the nominal voltage for greater than 0.1 seconds and shall not exceed 2.5% for 1.0 seconds.

c) With the exception of *infrequent energization* of power transformers connected at or near the Point of Interconnection, Facility shall not cause abrupt changes to the root-mean-squared (rms) voltage magnitude at the POI greater than 2.5% of the nominal voltage and that occur at a rate of voltage change that exceed 0.025 times the nominal voltage per second, averaged over a one second period. This requirement applies, non-exclusively, to any de-energization or energization of capacitors, reactors, cables, or transformers (other than on an infrequent basis).

d) With the exception of restoration of operation following LIPA system faults, clearance from System Operations is required prior to any transformer energization producing a change in the rms magnitude of the POI voltage exceeding 2.5% of the nominal value for any duration exceeding one fundamental frequency cycle.

6.3 Harmonic Performance Requirements for Facilities Connected to Strong Systems

The requirements of this sub-clause shall apply to Facilities connected to the LIPA system where the nominal short circuit ratio at the POI is greater than 20. Facility owners may opt to comply with Clause 6.3 in lieu of the requirements stated in this sub-clause.

a) Non-fundamental-frequency current components flowing between the Facility and the LIPA system at any given harmonic order, shall be less than the values specified in Table 6-1. The magnitude of the current considered at each harmonic order (h) shall be the square root of the sum of the squares of the magnitudes of all current components (I) with frequencies (f) between the frequency of the integer harmonic order minus 30 Hz to plus 30 Hz.

$$|I_h| = \sqrt{\sum_{f=-30}^{30} \left(I(60h+f)\right)^2}$$

The per-unit base is the (rated) current of the Facility when delivering the Maximum Rated Demand. The Total Rated Distortion (TRD) metric is the square root of the difference of the squares of the total *RMS magnitude* of current, inclusive of all fundamental and non-fundamental frequency components) and the *RMS magnitude* of the fundamental frequency component, all relative to the Facility rating. This is indicated in equation form as:

$$.TRD = \sqrt{{I_{RMS}}^2 - {I_{fundamental}}^2}$$

Table 6-1 – Harmonic Current Limits

	Harmonic Order		
	h < 11	11 ≤ h	TRD
Current Limit	2.0%	1.0%	3.0%

b) The current distortion specifications are applicable to all frequency components above 120 Hz and less than or equal to 3 kHz. Interpolation of the weighting factors shall be used for non-integer harmonics.

c) Harmonic current limitations specified in this sub-clause apply to the currents caused by the Facility inclusive of harmonic currents caused by background harmonic voltages existing in the LIPA system exclusive of the Facility. The current limitations shall not apply to harmonic current flow that decreases the voltage distortion at the Point of Interconnection at the same harmonic order as the current.

6.4 Harmonic Performance Requirements for Facilities Connected to Weaker Systems

The requirements of this sub-clause shall apply to Facilities connected to the LIPA system where the nominal short circuit ratio at the date of initial interconnection to the LIPA system is less than or equal to 20. Each of the following requirements shall apply:

a) Interconnection of the Facility shall not cause individual harmonic components of the Point of Interconnection voltage to exceed the values specified in Table 6-2, inclusive of any harmonic components, not exceeding these limits, present without the Facility connected (ambient distortion). These limitations apply, nonexclusively, to any passive or active amplification or magnification of ambient harmonic distortion. Where the ambient distortion exceeds these limits, the Facility shall not cause any increase in the magnitude of the harmonic voltage components exceeding the limits.

b) The Facility shall not cause an incremental increase in voltage distortion at any non-fundamental order from harmonic orders 2 to 4 or 6 to 50 by greater than 1% of the nominal voltage.

c) The Facility shall not create an incremental fifth harmonic voltage component at the Point of Interconnection, exclusive of ambient distortion, greater than 0.3% of the nominal voltage.

d) The distortion specifications are applicable to all frequency components above 120 Hz and less than or equal to 3 kHz. Interpolation of the weighting factors shall be used for non-integer harmonics.

Table 6-2 – Harmonic Voltage Limits

POI Nominal Voltage	Individual Harmonic	THD_V
69 kV and below	3.0%	5.0%
138 kV	1.5%	2.5%
345 kV	1.0%	1.5%

6.5 Radio Frequency Interference

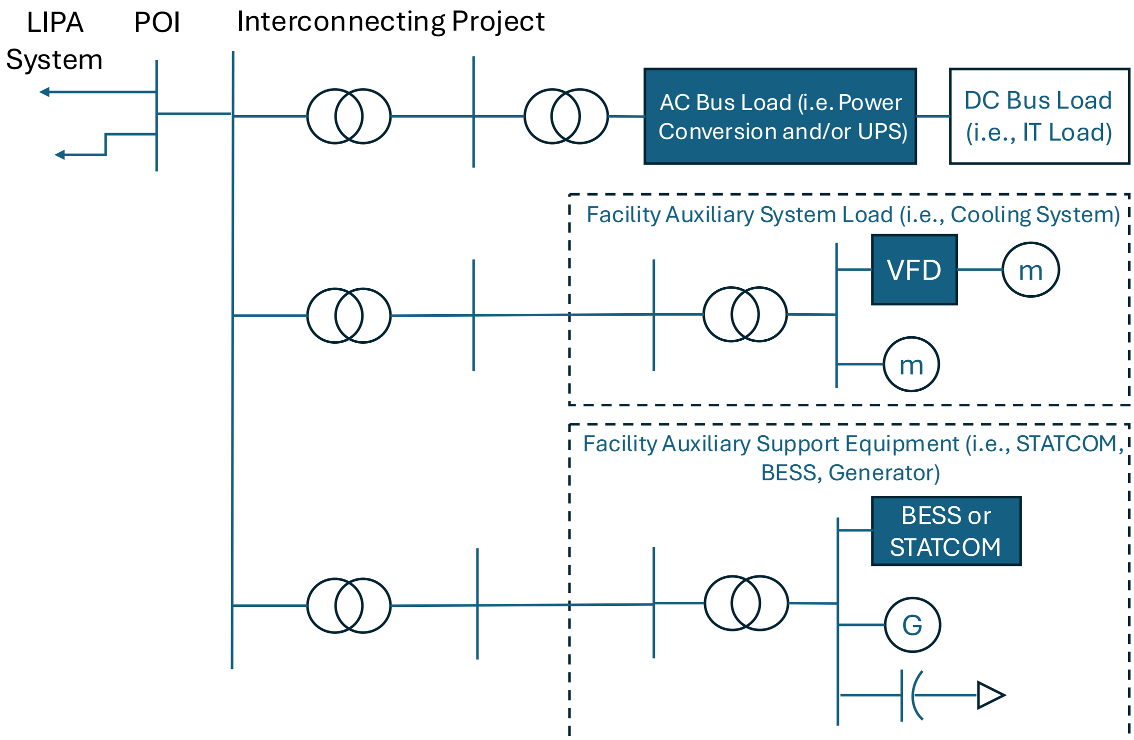
a) The Facility owner is responsible for any radio frequency interference radiated from the Facility installation or the connection line between the Facility and the LIPA point of interconnection.

b) The Facility shall not cause radio frequency noise to be radiated from any LIPA transmission line or substation that is of greater intensity than 200 uV/m measured at any point greater than 50’ beyond the perimeter of any substation, or 50’ from the centerline of any LIPA transmission line. Measurements of radio interference shall be in accordance with IEEE Standard 430-1986 (R1991), and made by instruments compliant with ANSI Standard C63.2-1996.

7. REQUIRED MODELS AND CHARACTERIZATIONS

7.1 Model Requirements Overview

A generalized representation of a large load facility is shown below to illustrate the major components identified for representation in the simulation models.



The following table summarizes the major components and the functional representation required for the simulation model platforms.

Large Load Equipment	**Example Equipment Variants**	**Phasor Domain Dynamic Model Representation**	**EMT Model Representation**
Facility Major Components	Facility-Specific	Required for all Facility Major Components[1]	Required for all Facility Major Components[1]
DC Bus Load	IT Load: Algorithm-Specific, Software-Driven Load Cycling; Post-Rectification Load	Simplified Representation is Acceptable[2]	Simplified Representation is Acceptable[2]

AC Bus Load	Power Electronics - Diode-Front-End or Active-Front-End Rectification	Required, Explicit Representation[3]	Required, Facility-Specific Representation with original equipment manufacturer (OEM) Models[4]
Facility Auxiliary System Load	Large Motors for Pumps/Fans, which may be variable-frequency drive (VFD)-interfaced or line-connected induction motors	Required, Explicit Representation[5]	Required, Facility-Specific Representation with OEM Models[6]
Facility Supplementary Support Equipment	STATCOMs, Battery Systems, Generation, etc.	Required, Explicit Representation[7]	Required, Facility-Specific Representation with OEM Models[8]

Footnotes and additional descriptions:

1. All Facility Major Components shall be represented in the steady-state powerflow case and facility one-line diagram. Identically-performing equipment should be appropriately aggregated.

2. The facility-specific fast fluctuations in demand that are driven by the specific processes being performed by the large load are not required nor expected to be represented in the dynamic models. The fluctuations of demand must meet the requirements of this document and compliance will be demonstrated by other means described herein. A simplified DC-side load is permissible for use in the models, for instance, a current source or a resistance that can be modulated according to a user-provided time-series data file.

3. Facility Major Components that are AC-connected power-electronic equipment shall be represented explicitly using dynamic models, aggregated as appropriate. Protection of this equipment shall be explicitly represented. For instance, representation using generic renewable energy models (as commonly used for

battery systems in a charging mode) are permissible for voltage-source converter (VSC) interfaced equipment.

4. Facility Major Components that are AC-connected power-electronic equipment shall be represented explicitly using OEM-provided, facility-specific models, aggregated as appropriate. Protection of this equipment shall be represented. If the OEM is unable to provide a suitable model, then an alternate model that is well-documented and benchmarked closely to the equipment may be accepted at the sole discretion of PSEG Long Island.

5. Facility Major Components that are AC-connected power-electronic equipment shall be represented explicitly using dynamic models, aggregated as appropriate. Protection of this equipment shall be explicitly represented. For instance, representation using generic renewable energy models (as commonly used for battery systems in a charging mode) are permissible for VFD-interfaced equipment which other induction motor load models are permissible for line-connected induction motors.

6. Facility Major Components that are VFD-interfaced motor equipment shall be represented explicitly using OEM-provided, facility-specific models, aggregated as appropriate. If there are significant levels of line-connected motors, these shall be represented using appropriate standard library models. Protection of this equipment shall be represented. If the OEM is unable to provide a suitable model, then an alternate model that is well-documented and benchmarked closely to the equipment may be accepted at the sole discretion of PSEG Long Island.

7. Facility Major Components (power electronics and/or synchronous generation) shall be represented explicitly using dynamic models and aggregated as appropriate. For instance, co-located generation in the form of a battery storage system and/or a synchronous generator shall not be aggregated, but represented separately, each with its own protection system represented.

8. Facility Major Components (power electronics and/or synchronous generation) shall be represented explicitly using OEM-supplied (for power electronic equipment), facility-specific dynamic models and aggregated as appropriate. If the OEM is unable to provide a suitable model, then an alternate model that is well-documented and benchmarked closely to the equipment may be accepted at the sole discretion of PSEG Long Island.

9. Representation of internal facility protection systems susceptible to operation as a result of external transmission system events shall be included.

7.2 Steady-State Positive-Sequence Fundamental-Frequency Model

The Facility Owner shall provide a model representing the plant design, overall topology, major components, and a one-line diagram of the facility. The model shall be provided in Siemens PTI PSS/E format of the current version in use by NYISO.

7.3 Phasor Domain Dynamic Model Requirements

a) This model shall represent the facility's performance in accordance with Section 7.1 for Phasor Domain models.

b) The Facility owner shall provide a model, implemented in the Siemens PTI PSS/E dynamic simulation software, formatted for the PSSE version associated with the FERC 715 filing that NYISO is also using. Upgrades and modification of the models to maintain compatibility with these PSS/E versions shall be the responsibility of the Resource owner.

c) This model shall be provided prior to the Facility being placed into commercial operation.

d) The Facility owner shall provide documentation with the model that describes the choices for the parameterization of the model and how those choices correspond with the design of the Facility and its equipment.

e) The PSS/E model must be non-proprietary and shall be accessible to other utilities, system operators, asset owners, and other entities associated with the interconnected transmission network.

f) The PSS/E model shall be updated by the Facility owner prior to any change to the Facility controls or protections that materially affect the dynamic performance.

7.4 Electromagnetic Transient Model Requirements

a) The Facility owner shall provide an electromagnetic transients model, implemented in the PSCAD simulation software in the version currently in use by PSEG Long Island.

b) This EMT model shall represent the facility's performance in accordance with Section 7.1 for EMT models.

c) The EMT model shall be configured for the specific Facility. This model shall be provided to PSEG Long Island prior to the Resource being placed into commercial operation.

d) The EMT model shall have a revision control code embedded in the model that is accessible to the user that identifies the version of the compiled code. The revision control code shall be different if there is a change that could impact the response of the model during a simulation.

e) Documentation shall be provided establishing the validity of the EMT model, such as comparisons between model results and full-scale test results for a sufficient range of tests.

f) The EMT model may be proprietary and be bound by reasonable non-disclosure agreements. The model must be made available to LIPA, PSEG Long Island, agents and consultants of Long Island, NYISO, and any other party as directed by Long Island, provided that the party is not in direct competition with the Facility owner or the equipment manufacturer used in the Facility.

g) The EMT model documentation shall be provided instructing the user on the setup and configuration of running the model in an accurate manner.

h) The EMT model shall comply with NYISO Electromagnetic Transient (EMT) Modeling Guideline, UG 28.

8. MODIFICATIONS OF FACILITY

For any material change to the Facility, which is any change that could impact the performance of the facility with respect to these requirements, including but not limited to: changes in control parameters, firmware, or IT algorithms on any of the Major Facility Components, a detailed description of the proposed changes shall be submitted to PSEG Long Island – including updates to all affected simulation models as appropriate per Section 7 – at least 60 days prior to intended implementation at site. PSEG Long Island may approve or reject any or all proposed changes at its sole discretion.

9. PERFORMANCE VERIFICATIONS

9.1 Performance Verifications

Within 60 days of interconnection or within 60 days of a modification of the Facility per Section 8, the Facility owner shall provide verification of performance of the Facility to these requirements. Compliance may be demonstrated through field tests, laboratory tests on equipment of the same type in use at the Facility, simulations based on detailed models, or a combination thereof.

For every Facility Major Component that is also AC-connected power-electronic equipment, the Facility owner shall provide a document containing:

- The description and manufacturer of the equipment
- The revision control code for the firmware running on the equipment
- The parameter list and value for every parameter with the potential to impact these requirements
- A description of how each parameter relates to each parameter in the provided EMT model

9.2 Active Power Variation Verification

Prior to interconnection, the Facility owner shall provide measurements or detailed simulation results of active power consumption that is representative of the Facility across the range of operating conditions that would be expected to occur for more than 600 consecutive seconds. Acceptable measurement data may include measurement from a similar existing facility that is performing sufficiently similar processes, or a scaled-down version of the facility that is performing representative processes. If simulation data is used for verification, then the simulation model shall be documented in detail with clear explanations of how the simulation model is representative of the active power consumption of the Facility.

The resulting active power variation data verifying compliance with the active power variation requirements shall be submitted to PSEG Long Island at least 60 days prior to implementation at site.

10. PROTECTION

10.1 Power Variation Protection Relay

A power variation monitoring relay shall be implemented to continuously monitor the active power at the POI and evaluate it against the limits in accordance with the Active Power Variation Limits section. If the limits are exceeded for a window period as defined in the Active Power Variation Limits section, then the relay shall initiate an immediate disconnection of the Facility from the system. If the relay is out of service for any period of time for any reason (planned or unplanned), PSEG Long Island shall be notified immediately.

The Facility owner shall provide documentation that demonstrates the proper operation and configuration of the relay.

Exceptions may be made at the sole discretion of PSEG Long Island for Facilities that are determined by PSEG Long Island to not pose a risk of cyclic power variability.

10.2 Ground Source Behavior

The Large Load Facility shall not present a ground source to the LIPA transmission system unless otherwise stated in the Interconnection Agreement.

If the Large Load Facility has on-site generation, then the generation portion of the interconnection is subject to the generation interconnection requirements and may be required to provide a ground source.

11. MONITORING

Facility Owner shall, at its own expense, provide and service monitoring equipment described in this clause. This equipment shall record Facility performance at the Point of Interconnection for the durations specified when triggered according to voltage, frequency, power, or current criteria as specified by PSEG Long Island. Trigger criteria are subject to change from time to time. Data shall be retained for 90 days after a triggered event. Facility Owner shall provide recorded data to PSEG Long Island within 10 days on request.

11.1 Digital Fault Recorder

A digital fault recorder (DFR) shall record instantaneous voltage and current at the Point of Interconnection for a duration of 10 seconds when triggered. Data resolution shall be at least 128 samples per 60 Hz cycle.

11.2 Dynamic Data Recorder

A dynamic data recorder (DDR) shall record active power, reactive power, and phasor magnitude and angle for voltage and current at the Point of Interconnection for a duration of at least 600 seconds when triggered. Data resolution shall be at least one sample per 60 Hz cycle. If the DFR can capture at least 600 seconds of event data, then it may also perform as the DDR.

11.3 Power Quality Meter

A power quality meter shall be provided that is capable of measuring and recording rapid and abrupt voltage change events, flicker, harmonic currents and harmonic voltages at the Point of Interconnection.

12. APPENDIX