Sub 5MW Generator Performance Standard Guideline

CitiPower Pty Ltd and Powercor Australia Ltd
Generation and Major Augmentation Manager
13 24 12

February 2021

Approval and amendment record

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Version			
1.0	Initial Revision	18/02/2021	

Document review	Date
This document shall be reviewed every two (2) years or earlier if required. The next review is due on or before.	31/12/2022

Contents

HV Generator Technical Requirements (Chapter 5A)

1.0 Embedded Generator Performance Standards

These guidelines set out the generator technical standards that are required for non-registered embedded high voltage generators to connect to the CitiPower and Powercor distribution network and the information in this document can be considered written details of the special safety and technical requirements relevant to the proposed plant.

Clause 5.1.2 of the National Electricity Rules (NER) sets out that the Connection Process of Chapter 5 does not apply to non-registered embedded generators who do not make an election for Clause 5.3A and hence, the technical requirements of Schedule 5.2 do not apply to non-registered embedded generators. Therefore, this guideline sets out the technical requirements for these generators in the CitiPower and Powercor network.

These guidelines are written to apply to only to non-registered HV connected embedded generators, it can however be used as general guidance (unless superseded) for LV connected generators in the CitiPower and Powercor network.

System standards are established by the National Electricity Rules (NER), the Victorian Electricity Distribution Code (VEDC) and the Victorian Electricity System Code (VESC). System standards are intended to have application when addressed at any level of voltage throughout the network.

These generator technical standards are based upon Schedule S5.2 of the NER, Section 7 of the VEDC, all applicable Australian Standards, the applicable System Standards, and internal CitiPower and Powercor policies.

CitiPower and Powercor will not accept a proposal, where the plant capability is:

(1) Less than the minimum access standard in this document;

(2) Will adversely affect power system security; or

(3) Will adversely affect the quality of supply for other Network Users

In cases where a requirement has an automatic access standard, CitiPower and Powercor will determine a standard up to the automatic access standard that is required, depending on (2) and (3) above.

1.1 Steady State Reactive Power Capability

The automatic access standard is that a generating system operating at:

- any level of active power output; and
- at any voltage under section 1.4 of this guideline.

must be capable of supplying or absorbing continuously at any of its connection points an amount of reactive power anywhere in the range contained in Table 1, which is based upon the requirements of S5.3.5 and S5.2.5.1 of the NER and Table 2 of the VEDC.

POWER FACTOR REQUIREMENTS				
Supply Voltage in kV	**Load**		**Generation**	
	Minimum Importing	**Minimum Exporting**	**Minimum Importing**	**Maximum Exporting**
< 6.6	0.9	0.9	0.93	0.93
6.6 11 22	0.9	0.9	0.93	0.93
66	0.95	Unity	0.93	0.93

Table 1: Power factor requirements

Due to ambiguity between loads and generators, the terms lagging and leading are to be avoided.

The minimum access standard is that a generating system operating at:

- any level of active power output; and
- at any voltage under section 1.4 of this guideline.

must be capable of continuously supplying or absorbing reactive power in range up to the required amount to meet the reactive power set point as agreed with CitiPower and Powercor.

1.2 Quality of electricity generated

CitiPower and Powercor must use reasonable endeavours to design and operate its distribution system to ensure that:

- its customers are supplied with a power-frequency voltage which fluctuates below the planning levels and AEMO's allocation;
- the effective harmonic voltage distortion at any point in the network will be less than the planning levels and AEMO's allocation; and
- the average levels of negative sequence voltage at all connection points that are less the requirements of NER and AEMO's allocation

AEMO allocations are imposed upon CitiPower and Powercor for compliance at transmission connection points. These allocations are always less than the planning levels as they consider other network users on the transmission network and the potential for future expansion.

CitiPower and Powercor only has minimum access standard requirements for the quality of electricity generated.

1.2(1) Voltage Fluctuations

The planning levels from AS/NZS 61000.3.7:2001 are reproduced in Table 2 below. Each customer is allocated by CitiPower and Powercor whichever is lower between a portion of the planning level and a portion of AEMO's allocation.

Planning Levels	< 66 kV	66 kV
P_{st}	0.9	0.8
P_{lt}	0.7	0.6

Table 2: Voltage Fluctuation Planning Levels

The minimum access standard is that a generating system, when generating and when not generating, must not produce voltage fluctuations greater than the limits allocated by CitiPower and Powercor at any of its connection points.

1.2(2) Harmonic Distortion

The NER requires the effective harmonic voltage distortion at any point in the network to be less than the planning levels of AS/NZS 61000.3.6:2001. This version of AS/NZS 61000.3.6 is specifically referenced by the NER and therefore must be followed, further the update IEC/TR 61000.3.6:2012 is technical report rather than another standard. Technical reports do not go through the same structured consensus process as standards and therefore are considered publications with lower levels of consensus. To mitigate the risk upon a future transition to the standards highlighted in the 2012 technical report, the lower of the standards used between these two documents will be used by CitiPower and Powercor where there is a difference.

The lower of planning levels from AS/NZS 61000.3.6:2001 and IEC/TR 61000.3.6:2012 are reproduced in Table 3 below. Each customer is allocated by CitiPower and Powercor whichever is lower between a portion of the planning level and a portion of AEMO's allocation.

Odd harmonics non multiple of 3			Odd harmonics multiple of 3			Even harmonics		
Order h	Harmonic Voltage %		Order h	Harmonic Voltage %		Order h	Harmonic Voltage %	
	<66 kV	66 kV		<66 kV	66 kV		<66 kV	66 kV
5	5.0	2.0	3	4.0	2.0	2	1.6	1.4
7	4.0	2.0	9	1.2	1.0	4	1.0	0.8
11	3.0	1.5	15	0.3	0.3	6	0.5	0.4
13	2.5	1.5	21	0.2	0.2	8	0.4	0.4
17	1.6	1.0	27	0.2	0.2	10	0.4	0.35*
19	1.2	1.0	33	0.2	0.2	12	0.2	0.2
23	1.2	0.7	39	0.2	0.2	14	0.2	0.2
25	1.09*	0.7	45	0.2	0.2	16	0.2	0.2
29	0.63	0.63				18	0.2	0.2
31	0.60	0.60				20	0.2	0.2
35	0.56	0.56				22	0.2	0.2
37	0.54	0.54				24	0.2	0.2
41	0.50	0.50*				26	0.2	0.2
43	0.49	0.47*				28	0.2	0.2
47	0.47	0.43*				30	0.2	0.2
49	0.46	0.42*				32	0.2	0.2
						34	0.2	0.2
						36	0.2	0.2
						38	0.2	0.2
						40	0.2	0.2
						42	0.2	0.2
						44	0.2	0.2
						46	0.2	0.2
						48	0.2	0.2*
						50	0.2	0.2*
						THD	6.5	3.0
NOTE *: Indicates that IEC/TR 61000.3.6:2012 is lower than AS/NZS 61000.3.6:2001 for this order								

Table 3: Voltage Harmonics Planning Levels

The VEDC requires that generators keep harmonic currents below specified limits and that emissions also comply with the IEEE Standard 519-2014 'Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems'. This leads to the current harmonic distortion limits reproduced below in Table 4:

h<11	11 ≤ h < 17	17 ≤ h < 23	23 ≤ h < 35	35 ≤ h	THD
4.0	2.0	1.5	0.6	0.3	5.0

Table 4: Maximum Harmonic Current Distortion in Percent of Maximum Current (%)

The minimum access standard is that a generating system, when generating and when not generating, must not produce harmonic voltage distortion and harmonic current distortion greater than the emission limits allocated by CitiPower and Powercor at any of its connection points.

1.2(3) Voltage Unbalance/Negative Sequence Current Injection

The minimum access standard is that a generating system must not exceed the requirements from S5.1a.7 of the NER (reproduced below in Table 5) at any of its connection points.

Nominal supply voltage (kV)	No contingency event	Credible contingency event or protected event	General	Once per hour
>10 kV to ≤ 100	1.3	1.3	2.0	2.5
< 10 kV	2.0	2.0	2.5	3.0

Table 5: Maximum Negative Sequence Voltage (% of nominal voltage)

The generator must also ensure that the current in each phase of a three-phase electrical installation does not deviate from the average of the three phase currents by more than the percentages shown in Table 6 at any of its connection points.

Nominal supply voltage	**Current in each phase must not deviate from the average of the three phase currents by more than:**	
	For periods greater than 2 minutes	**For periods less than 2 minutes**
<1kV	5.0%	10.0%
≥1kV	2.0%	4.0%

Table 6: Load balance for an embedded generator

1.2(4) Inductive Interference

The minimum access standard is that a generating system must not cause inductive interference above the limits specified in AS 2344:2016 (reproduced below in Table 7) at any of its connection points.

Frequency (MHz)	**Field strength (dBµV/m) at the boundary of the line corridor or 30 m from an installation**
0.15 to 0.3	-1.5
0.3 to 3.0	-15.5
3.0 to 30	-15.5 to 28.5[1]
30 to 230	30.0
230 to 1 000	37.0
1 000 to 3 000	60.0
NOTE 1: The limit decreases linearly with the logarithm of the frequency from 3 MHz to 30 MHz	

Table 7: Limits of radiated radio disturbance

1.3 Response to frequency disturbances

Under Clause 4.1.1 of the VEDC, AEMO is responsible for the frequency of the distribution system, having an obligation under the NER to use reasonable endeavours to maintain system frequency at 50 Hz. CitiPower and Powercor has no obligation in respect the frequency observed on its distribution system.

Under the VEDC, an embedded generator must ensure that their embedded generating unit (s) is/are capable of continuous uninterrupted operation at the system frequency of 50 Hz and the permitted variation in accordance with the NER cause S5.1a.2.

The automatic access standard is that a generating system and each of its generating units must be capable of continuous uninterrupted operation at its connection point for frequencies and durations shown in Figure 1 and Table 8.

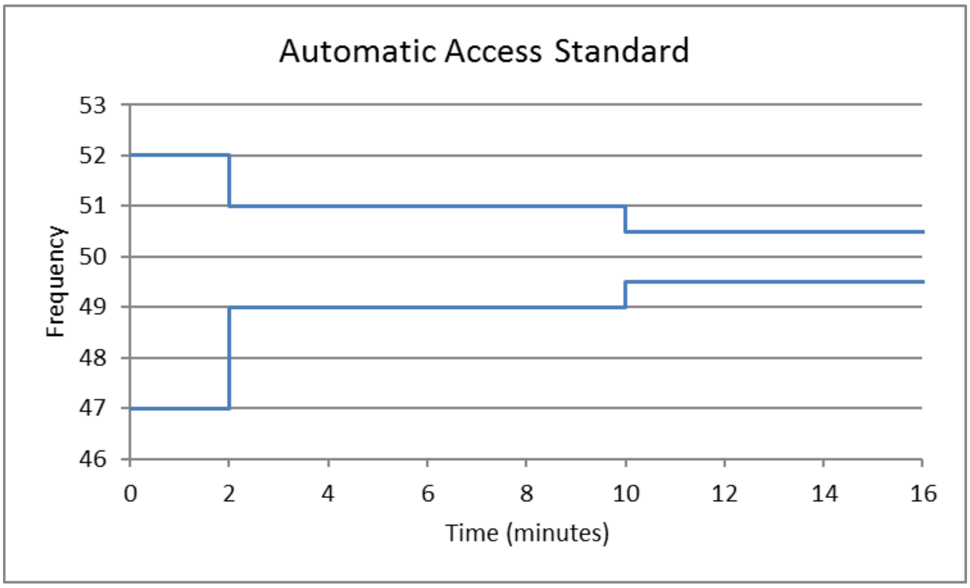

Figure 1: Frequency Disturbance Automatic Access Standard

Frequency Range	Time
49.5 to 50.5 Hz	Continuous
49.0 to 51.0 Hz	10 minutes
47.0 to 52.0 Hz	2 minutes

Table 8: Automatic Access Standard for Frequency

The automatic access standard does not apply if the rate of change of frequency is outside the range of –4 Hz to 4 Hz per second for more than 0.25 seconds, -3 Hz to 3 Hz per second for more than one second.

The minimum access standard is that a generating system and each of its generating units must be capable of continuous uninterrupted operation at its connection point for frequencies and durations shown in Figure 2 and Table 9.

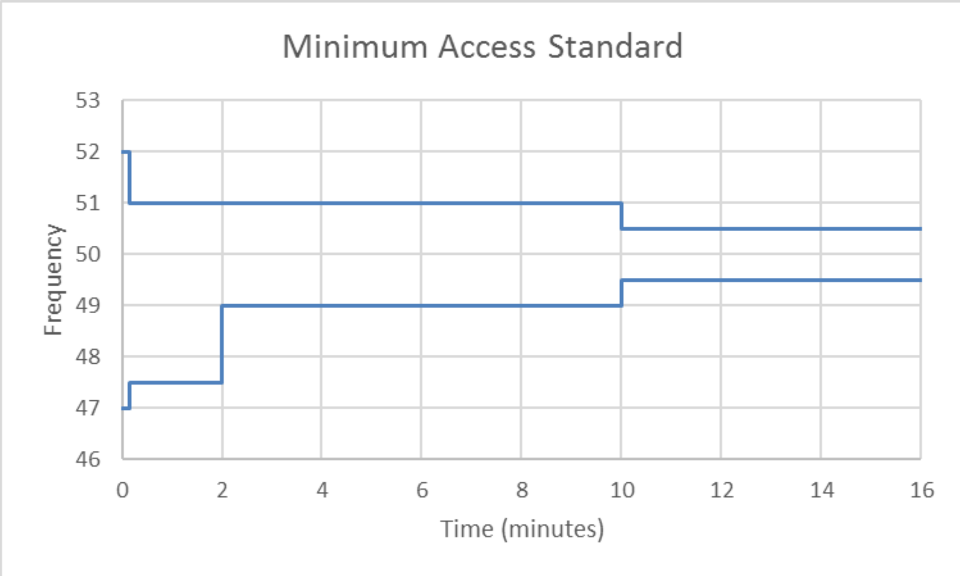

Figure 2: Frequency Disturbance Minimum Access Standard

Frequency Range	Time
49.5 to 50.5 Hz	Continuous
49.0 to 51.0 Hz	10 minutes
47.5 to 49.0 Hz	2 minutes
47.0 to 52.0 Hz	9 seconds

Table 9: Minimum Access Standard for Frequency

The minimum standard does not apply if the rate of change of frequency is outside the range of -2 Hz to 2 Hz per second for more than 0.25 seconds, -1 Hz to 1 Hz per second for more than one second.

The required ranges from both the Automatic and Minimum standards are from the AEMC Reliability Panel - Frequency Operating Standards. Any subsequent updates to these standards will apply as they are made.

1.4 Response to voltage disturbances

CitiPower and Powercor has an obligation under VEDC to operate the distribution network to specific voltage ranges for specific time periods and the generating system is expected to be capable of operation throughout the ranges expected in the network.

Many generating systems however have limitations of operation during undervoltage events, these limitations were explored by the AER for the development of S5.2.5.4. In order to cater for these limitations, CitiPower and Powercor have used this clause to assist in defining the requirements for undervoltage disturbances.

Generating systems should be capable of continuous uninterrupted operation for all allowable operating ranges of the CitiPower and Powercor network for overvoltage ranges in Table 10 and undervoltage ranges in Table 11.

CitiPower and Powercor only has minimum access standard requirements for generating system's responses to voltage disturbances.

<table>
<tr><th rowspan="2">Voltage Level in kV</th><th colspan="3">Voltage Range for Time Periods</th></tr>
<tr><th>Steady State</th><th>Less than 1 minute</th><th>Less than 10 seconds</th></tr>
<tr><td>< 1</td><td colspan="2">+13%
- 10%</td><td>Phase to Earth +50%, -100%
Phase to Phase +20%, -100%</td></tr>
<tr><td>1 to 6.6</td><td rowspan="3">± 6 %
(± 10 % Rural Areas)</td><td rowspan="3">± 10%</td><td rowspan="3">Phase to Earth +80%, -100%
Phase to Phase +20%, -100%</td></tr>
<tr><td>11</td></tr>
<tr><td>22</td></tr>
<tr><td>66</td><td>± 10%</td><td>± 15%</td><td>Phase to Earth +50%, -100%
Phase to Phase +20%, -100%</td></tr>
</table>

Table 10: Standard Nominal Voltage Variations

Voltage Range	Time
80% to 90%	5.0 s
70% to 80%	2.0 s

Table 11: Undervoltage requirements of the Minimum Access Standard of S5.2.5.4

The minimum access standard is that a generating system including all operating generating units must be capable of continuous uninterrupted operation at its connection point where a power system disturbance causes the voltage at the connection point to vary within the variations stated in Table 12:

Voltage Range	Time
110% to 120%	10.0 s
90% to 110%	Continuously
80% to 90%	5.0 s
70% to 80%	2.0 s

Table 12: Minimum Access Standard for Voltage

1.5 Disturbances Following a Contingency Event

CitiPower and Powercor only has minimum access standard requirements for generating system's responses to disturbances following a contingency event.

1.5(1) Credible Contingency Events

The minimum access standard is that a generating system and each of its generating units must remain in continuous uninterrupted operation at its connection point for any disturbance caused by:

(1) a credible contingency event; or

(2) a single phase to ground, phase to phase or two phase to ground fault in a transmission system or distribution network cleared in the longest time expected to be taken for all relevant primary protection systems to clear the fault

1.5(2) Multiple Fault Ride Through

The minimum access standard is that a generating system and each of its generating units must remain in continuous uninterrupted operation at its connection point for a series of up to six disturbances within any five minute period caused by any combination of the events where:

(1) up to three of the disturbances cause the voltage at the connection point to drop below 50% of normal voltage;

(2) up to one disturbance causes the voltage at the connection point to vary within the ranges agreed by CitiPower and Powercor;

(3) the time difference between the clearance of one disturbance and commencement of the next disturbance exceeds 200 milliseconds;

(4) no more than three of the disturbances occur within 30 seconds; and

(5) all disturbances are caused by faults other than three phase faults.

provided that none of the events would result in:

(6) the islanding of the generating system or cause a material reduction in power transfer capability by removing network elements from service;

(7) the cumulative time that voltage at the connection point is lower than 90% of normal voltage exceeding 1,000 milliseconds within any five minute period; or

(8) the time integral, within any five minute period, of the difference between 90% of normal voltage and the voltage at the connection point when the voltage at the connection point is lower than 90% of normal voltage exceeding 0.5 pu second

and there is a minimum of 30 minutes where no disturbances occur following a five minute period of multiple disturbances.

1.5(3) Synchronous Unit Fault Response

The minimum access standard is, subject to any changed power system conditions or energy source availability beyond the Generator's reasonable control after clearance of the fault, that a generating system comprised of synchronous generating units, in respect of the types of fault described in section 1.5(1) of this guideline must:

(1) deliver active power to the network, and supply or absorb leading or lagging reactive power, sufficient to ensure that the connection point voltage is within the range for continuous uninterrupted operation agreed under clause 1.4; and

(2) return to at least 95% of the pre-fault active power output, after clearance of the fault, within a period of time agreed by the Connection Applicant and CitiPower and Powercor.

1.5(4) Asynchronous Unit Fault Response

The minimum access standard is, subject to any changed power system conditions or energy source availability, that a generating system comprised of asynchronous generating units must:

(1) for the types of fault described in section 1.5(1), have facilities capable of supplying to or absorbing from the network:

  (i) capacitive reactive current in addition to its pre-disturbance level of at least 0% of the maximum continuous current of the generating system for each 1% reduction of voltage at the connection point below the fault ride through threshold agreed with CitiPower and Powercor

  (ii) inductive reactive current in addition to its pre-disturbance level of at least 0% of the maximum continuous current of the generating system for each 1% increase of voltage at the connection point above the fault ride through threshold agreed with CitiPower and Powercor

  during the disturbance and maintained until connection point voltage recovers to between 90% and 110% of normal voltage, or such other range agreed with CitiPower and Powercor, except for voltages 15% or lower of normal voltage.

(2) return to at least 95% of the pre-fault active power output, after clearance of the fault, within a period of time agreed by the Connection Applicant and CitiPower and Powercor

The reactive current injection function referred to in the section above shall be set so that:

(1) the generating system will commence a response when the voltage is in an under-voltage range of 80% to 90% or an over-voltage range of 110% to 120% of normal voltage;

(2) the reactive current rise time settling time must be as soon as practicable and must be adequately damped;

(3) the reactive current contribution and voltage deviation described may be measured at a location other than the connection point (including within the relevant generating system) where agreed with CitiPower and Powercor, in which case the level of injection and absorption will be assessed at that agreed location;

(4) The reactive current contribution referred to in (i) and (ii) may be limited for actual operation (the capability remains the same) as required by CitiPower and Powercor to ensure no adverse on affect power system security and the quality of supply for other Network Users

1.6 Quality of Supply Tolerance

Customers and generators on the distribution network cause voltage fluctuation, harmonic voltage distortion and voltage unbalance throughout the distribution and transmission network. The generating system must be designed to still operate appropriately under the conditions caused by other customers.

Furthermore, CitiPower and Powercor may send, in accordance with AS/NZS 61000.2.2, signals for the following:

(a) ripple control systems; or

(b) medium-frequency power-line carrier systems; or

(c) radio-frequency power-line carrier systems

CitiPower and Powercor only has minimum access standard requirements for generating system's quality of supply tolerance.

The minimum access standard is that a generating system must be:

- capable of continuous uninterrupted operation to the level of voltage fluctuation, harmonic voltage distortion and voltage unbalance listed in Table 2, Table 3, and Table 5 and must be suitably designed and where necessary de-rated to allow for the presence of this quality of electricity supply.
- designed so it is not adversely affected by and does not adversely attenuate ripple control, medium-frequency power-line carrier or radio-frequency power-line carrier signal

1.7 Partial Load Rejection

The minimum access standard is that a generating system must be capable of continuous uninterrupted operation at its connection point during and following a power system load reduction in Table 13 or equivalent impact from separation of part of the power system in less than 10 seconds:

Access Standard	Load Reduction (% of pre-disturbance level)
Automatic	30 %
Minimum	5 %

Table 13: Partial Load Rejection

1.8 Protection of generating systems

This access standard is satisfied by provision of a protection studies report that complies with CitiPower and Powercor's requirements.

CitiPower and Powercor only has minimum access standard requirements for the protection of generating systems.

CitiPower and Powercor must agree on the specification of conditions for which the generating unit or generating system must trip and must not trip.

CitiPower and Powercor is not liable for any loss or damage incurred by the Generator or any other person as a consequence of a fault on either the power system, or within the Generator's facility.

Specific requirements on some important protection items are provided in this section but this list is not exhaustive.

1.8(1) Anti-Islanding Protection

Under no circumstance shall an embedded generator be permitted to island any part of the electricity distribution network that supplies third party customers. Islanding refers to the situation whereby the embedded generator remains connected to a section of the electricity distribution network which has been isolated from the normal source of supply.

Islanding shall be avoided for the following reasons:

- It creates a serious health and safety risk to operational personnel, contractors and the general public.
- Quality of electricity supply to customers connected to the islanded electricity distribution network will be determined solely by the generator's own control systems and may breach the operating limits imposed on CitiPower and Powercor by the VEDC and other standards.
- It could cause severe damage to assets on the electricity distribution network and/or other connected customer's equipment.

The minimum access standard requires duplicate (at least two off) levels of anti-islanding protection between the customers generation source and the incoming CitiPower and Powercor point of connection.

This anti-islanding protection usually comprises;

- 2 levels of Rate-of-Change of Frequency
- 2 levels of Vector Shift – (If it can be reliably set not to mal-operate)
- 2 levels of Under/Over Frequency
- 2 levels of Under/Over Voltage

Powercor does not provide any anti-islanding protection for 66 kV generation customers.

1.8(2) Automatic Reclose

Most parts of the distribution network include automatic reclose by closing the feeder circuit breaker or line recloser after a pre-defined time delay (typically 3 to 10 seconds), multi shot reclose may also be used in some cases. This is intended to restore supply following transient network faults as quickly as practicable.

Whenever network supply is lost the generator must disconnect as quickly as possible to avoid islanding and shall not reclose.

CitiPower and Powercor is not liable for any damage or injury that might arise because of a legitimate reclose carried out in a manner consistent with the normal operation of the distribution network.

1.8(3) Insulation Co-ordination

Insulation co-ordination is required to ensure safety clearances, separation of live parts and voltage impulse withstand levels are compliant with AS 2067, AS 4070 and AS 1824.1.

Insulation co-ordination and impulse withstand capability is to be consistent with the design of insulation levels in the CitiPower and Powercor network and is to be implemented as agreed with CitiPower and Powercor. In general, the temporary (short duration) and impulse voltage rating of each item of plant will match or exceed the following:

Nominal voltage	**Short duration (60 sec) power frequency withstand voltage rating**	**Lightning impulse withstand level voltage rating (1.2µsec / 50µsec)**
66kV	140kVrms	325kVp
22kV	50kVrms	150kVp
11kV	28kVrms	95kVp
6.6kV	20kVrms	60kVp
230V/400V	275Vrms	6kVp

Table 14: Generation plant insulation level ratings

Surge arresters must comply with AS 1307. The short term and continuous voltage rating of surge arresters connected to the CitiPower and Powercor network must equal or exceed the network maximum phase to phase voltage as will be experienced during phase to ground faults where the distribution network uses an earthing system deploying either a neutral earthing resistor or ground fault neutraliser (REFCL).

1.9 Coordination of Protection Systems

CitiPower and Powercor only has minimum access standard requirements for coordination of protection systems.

The minimum access standard is, in general CitiPower and Powercor and the Generator must cooperate in the design and implementation of protection systems, including:

(1) the use of current transformer and voltage transformer secondary circuits (or equivalent) of one party by the protection system of the other;

(2) tripping of one party's circuit breakers by a protection system of the other party; and

(3) co-ordination of protection system settings to ensure inter-operation.

The generator's protection system design must:

(1) be coordinated with other protection systems;

(2) avoid consequential disconnection of other Network Users' facilities; and

(3) take into account existing obligations of CitiPower and Powercor under connection agreements with other Network Users.

1.10 Unstable Behaviour

CitiPower and Powercor only has minimum access standard requirements for unstable behaviour.

The minimum access standard is:

(1) The generating system generating system will not cause the active power, reactive power or voltage at the Connection Point to become unstable as assessed in accordance with AEMO's Power System Stability Guidelines (established under clause 4.3.4(h) of the NER).

(2) The generating system generating system will not cause voltage disturbance at the connection point due to sustained unstable behaviour of more than the maximum level specified in Table 7 of Australian Standard AS/NZS 61000.3.7:2001 reproduced below in Table 15.

r (hour^{-1})	**$\Delta U_{dyn}/U_N$ (%)**	
	MV	HV
r ≤ 1	4	3
r ≤ 10	3	2.5
r ≤ 100	2	1.5
r ≤ 1000	1.25	1

Table 15: Allowable voltage fluctuations per hour

(3) The generating system has the following protection systems to disconnect its generating units promptly for conditions where the active power, reactive power or voltage at the Connection Point becomes unstable as assessed in accordance with AEMO's Power System Stability Guidelines (established under clause 4.3.4(h) of the NER):

- Anti-Islanding enabled by over/under frequency protection at the inverter terminals
- Anti-islanding enabled by over/under voltage protection at the inverter terminals

1.11 Frequency Control

All synchronous generator units over 1MW must have a governor system responsive to system frequency changes.

CitiPower and Powercor only has minimum access standard requirements for frequency control.

The minimum access standard is:

(1) for a generating system under relatively stable input energy, power transfer to the power system must not:

(i) increase in response to a rise in the frequency of the power system as measured at the connection point; and

(ii) decrease more than 2% per Hz in response to a fall in the frequency of the power system as measured at the connection point; and

(2) a generating system must be capable of operating in frequency response mode such that, subject to energy source availability, it automatically provides:

(iii) a decrease in power transfer to the power system in response to a rise in the frequency of the power system as measured at the connection point; or

(iv) an increase in power transfer to the power system in response to a fall in the frequency of the power system as measured at the connection point,

where the change in active power is either proportional or otherwise as agreed with CitiPower and Powercor.

1.12 Impact on network capability

CitiPower and Powercor only has minimum access standard requirements for the generating system's impact on network capability.

In most cases, generators connected to the distribution network will be too small to create adverse impacts on network capability.

The minimum access standard is that a generating system must not reduce any inter-regional or intra-regional power transfer capability below the level that would apply if the generating system were not connected.

1.13 Voltage and reactive power control

CitiPower and Powercor only has minimum access standard requirements for voltage and reactive power control.

The minimum access standard is that a generating system must have plant capabilities and control systems, sufficient to ensure that:

(i) power system oscillations, for the frequencies of oscillation of the generating unit against any other generating unit, are adequately damped;

(ii) operation of the generating unit does not degrade:

(A) any mode of oscillation that is within 0.3 nepers per second of being unstable, by more than 0.01 nepers per second; and

(B) any other mode of oscillation to within 0.29 nepers per second of being unstable; and

(iii) operation of the generating unit does not cause instability (including hunting of tap-changing transformer control systems);

A generating system must also have facilities with a control system to regulate voltage, reactive power or power factor with the accuracy, range, rise and settling times in Table 16.

Control System	Accuracy/Deadband (of the setpoint[1])	Range	Settling Time[2]
Voltage	≤ 0.5%	95% to 105%	< 30 sec
Reactive Power	≤ 100 kVAR	Agreed reactive power capability	< 30 sec
Power Factor	≤ 100 kVAR	Agreed reactive power capability	< 30 sec
NOTE 1: Setpoint may be adjusted to incorporate any droop or reactive current compensation agreed with CitiPower and Powercor NOTE 2: For a step change in setpoint of at least 50% of the reactive power capability agreed with CitiPower and Powercor under clause 1.1, or a 5% step change in the voltage, or a 5% voltage disturbance where the voltage disturbance			

Table 16: Voltage and Reactive Power Control Capability

A generating system must also have facilities with a control system to regulate voltage, reactive power or power factor capable of, subject to energy source availability:

(i) ramping its reactive power output linearly from one set point to another; and

(ii) receiving and automatically responding to signals delivered from CitiPower and Powercor's Distributed Energy Resource Management System (DERMS), as updated at a rate of once every 4 seconds (or such other period specified by CitiPower and Powercor as required).

1.14 Active Power Control

CitiPower and Powercor only has minimum access standard requirements for active power control.

The minimum access standard is that a generating system must have an active power control system capable of, subject to energy source availability:

(i) automatically reducing within 5 minutes at a constant rate, to or below the level specified in an instruction electronically issued or verbally by CitiPower and Powercor;

(ii) automatically limiting its active power output, to or below the level specified in subparagraph (i);

(iii) ramping its active power output linearly from one level of output to another; and

(iv) receiving and automatically responding to signals delivered from CitiPower and Powercor's Distributed Energy Resource Management System (DERMS), as updated at a rate of once every 4 seconds (or such other period specified by CitiPower and Powercor as required).

1.15 Remote Monitoring and control

CitiPower and Powercor only has minimum access standard requirements for remote monitoring and control.

The minimum access standard is that a generating system that has remote monitoring equipment and remote control equipment to transmit to, and receive from, CitiPower and Powercor.

The remote monitoring quantities referred above are:

- the status of all switching devices that carry the generation;
- active power and reactive power aggregated for groups of identical generating units;
- the number of generating units operating
- active power and reactive power for the generating system
- voltage control system setpoint and mode (as applicable)
- reactive power setpoint and mode (as applicable) of non-generating unit plant

The remote control quantities from the CitiPower and Powercor Distributed Energy Resource Management System (DERMS), referred above are:

- Active power limits
- Reactive power control setpoint; and
- Reactive power control mode (where applicable)

1.16 Fault current

CitiPower and Powercor only has minimum access standard requirements for fault current.

1.16(1) Generator Fault Current Contribution

The minimum access standard is that a generating system must design and operate its embedded generating unit so that it does not cause fault levels in the distribution system to exceed the levels in the VEDC, replicated in Table 17 for the duration of the applicable breaker fail protection system fault clearance times, as specified by CitiPower and Powercor.

However, if the generating system is in fault level constrained area, the generating system shall limit their fault current contribution to less than or equal to 2 x continuous rated nameplate rating to the connection point.

The generation station transformer(s) must be connected to the CitiPower and Powercor distribution network via an unearthed winding to prevent the generating station being a source of earth fault current

Voltage Level (kV)	System Fault Level (MVA)	Short Circuit Level (kA)
66	2 500	21.9
22	500	13.1
11	350	18.4
6.6	250	21.9
<1	36	50.0

Table 17: Distribution system fault levels

1.16(2) Generation plant short circuit specifications

The minimum access standard is the short circuit ratings of generator installation plant of each item of plant should be capable of safely carrying (withstanding) or interrupting the fault current up to the level and time listed in Table 18.

Voltage (kV)	Fault current / time
66	21.9kA / 3s
22	13.1kA / 3s
11	18.4kA / 3s
6.6	21.9kA / 3s
<1	50.0kA / 3s

Table 18: Generation plant short circuit ratings

Definitions

Term	Definition
ACR	Automatic Circuit Recloser
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CB	Circuit breaker
DLF	Distribution Loss Factor
DNSP	Distribution Network Service Provider
ESC	Essential Services Commission
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
NSP	Network Service Provider
ROCOF	Rate of Change of Frequency
SIR	Service and Installation Rules
TNSP	Transmission Network Service Provider
VEDC	Victorian Electricity Distribution Code

References

Document no.	Document name
April 2020, Version 11	Electricity Distribution Code
December 2020, Version 156	National Electricity Rules
October 2000	Electricity System Code