Heywood BESS

Connection Study Report

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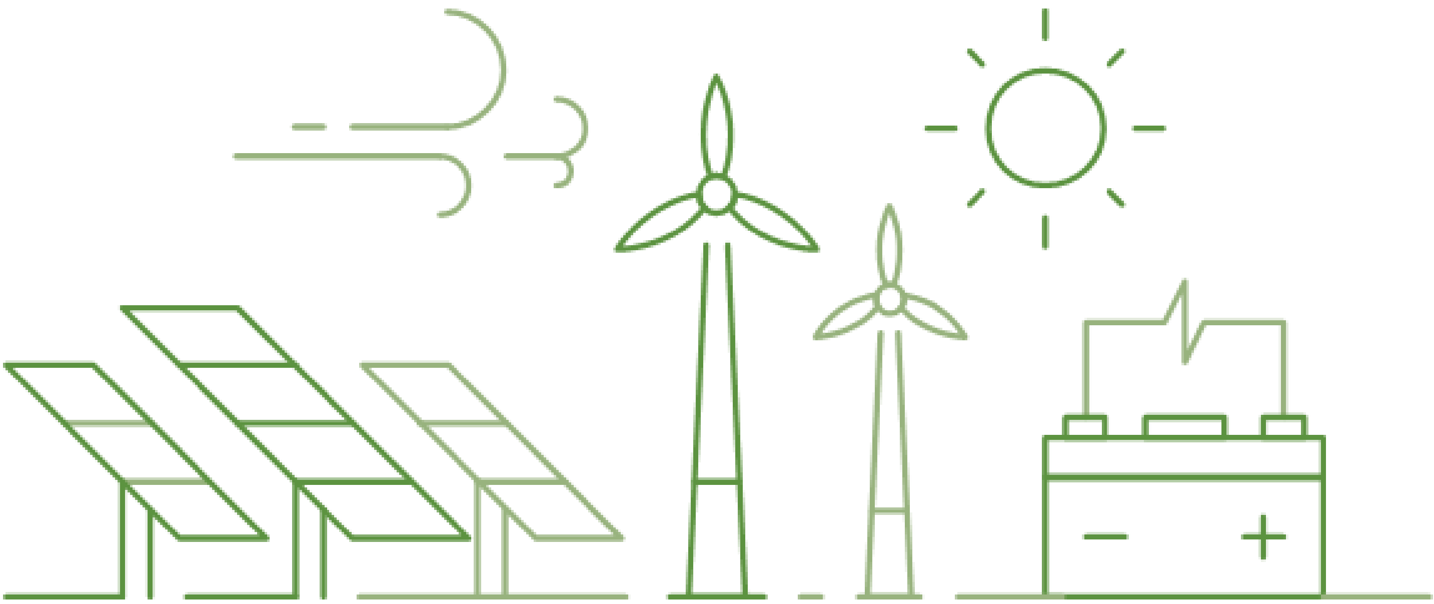

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Contents

Revision History

Table 1: Revision history

Rev.	Date	Prepared By	Reviewed By	Description
1-0-0	25/07/2025	Alvin Bai	Luke Hyett	First release

This document uses *Semantic Versioning for Documents* for revision numbering.

Given a version number *MAJOR-MINOR-FIX*, the

- *MAJOR* is incremented when the document has undergone significant changes
- *MINOR* is incremented when new information has been added to the document or information has been removed from the document, and
- *FIX* is incremented when minor changes are made (e.g. fixing typos)

Where appropriate, several revisions may be represented in one table entry with all notable changes described in the *Description* column.

1. Purpose

This document has been prepared as part of the application for Registration for Heywood Battery Energy Storage System (Heywood BESS). It presents a technical assessment of the compliance of the generating system to its agreed Generator Performance Standards (GPS) for GPS clauses that have been assessed as part of the Connection Studies undertaken at R0 stage, such as fault performance. Table 1.1 provides a summary of the NER clauses assessed and identifies which clauses are examined in this report.

Table 1.1: Summary of access standards

Clause	Description	Version	Standard	In Scope
S5.2.5.1	Reactive power capability	233	AAS	Yes
S5.2.5.2	Quality of electricity generated	233	NAS	Yes
S5.2.5.3	Generating system response to frequency disturbances	233	AAS	Yes
S5.2.5.4	Generating system response to voltage disturbances	233	AAS	Yes
S5.2.5.5	Generating system response to disturbances following contingency events	233	NAS	Yes
S5.2.5.6	Quality of electricity generated and continuous uninterrupted operation	233	NAS	Yes
S5.2.5.7	Partial load rejection	233	AAS	Yes
S5.2.5.8	Protection of generating systems from power system disturbances	233	MAS	Yes
S5.2.5.9	Protection systems that impact on power system security	233	AAS	No
S5.2.5.10	Protection to trip plant for unstable operation	233	AAS	No
S5.2.5.11	Frequency control	233	AAS	Yes
S5.2.5.12	Impact on network capability	233	AAS	Yes
S5.2.5.13	Voltage and reactive power control	233	AAS	Yes
S5.2.5.14	Active power control	233	AAS	Yes

Table 1.1: Summary of access standards

Clause	Description	Version	Standard	In Scope
S5.2.5.15	Short circuit ratio	233	NAS	Yes
S5.2.5.16	Voltage phase angle shift	233	NAS	No
S5.2.6 and 4.11.1	Remote monitoring	233	AAS	No
S5.2.6.2 and 4.11.3	Communications equipment	233	AAS	No
S5.2.7	Power station auxiliary supplies	233	Not Applicable	No
S5.2.8	Fault current	233	AAS	Yes

2. Project Overview

The Heywood Battery Energy Storage System (HEYWOODBESS) is a $\pm 285MW/1140MWh$ Battery Energy Storage Project, is located 5 km from the town of Heywood and 300 km west of Melbourne in Victoria as shown in Figure 2.1. The project is expected to connect directly to the existing 275 kV Heywood terminal station via a single high voltage cable.

HEYWOODBESS will include 92 SMA Sunny Central 4.6 MVA (SCS 4600 UP-S) converters which will be connected to two 275/33/33kV, 160MVA three winding transformers through a 33kV reticulation system. Each converter will have a dedicated 33/0.69kV, 4.6 MVA step up transformer.

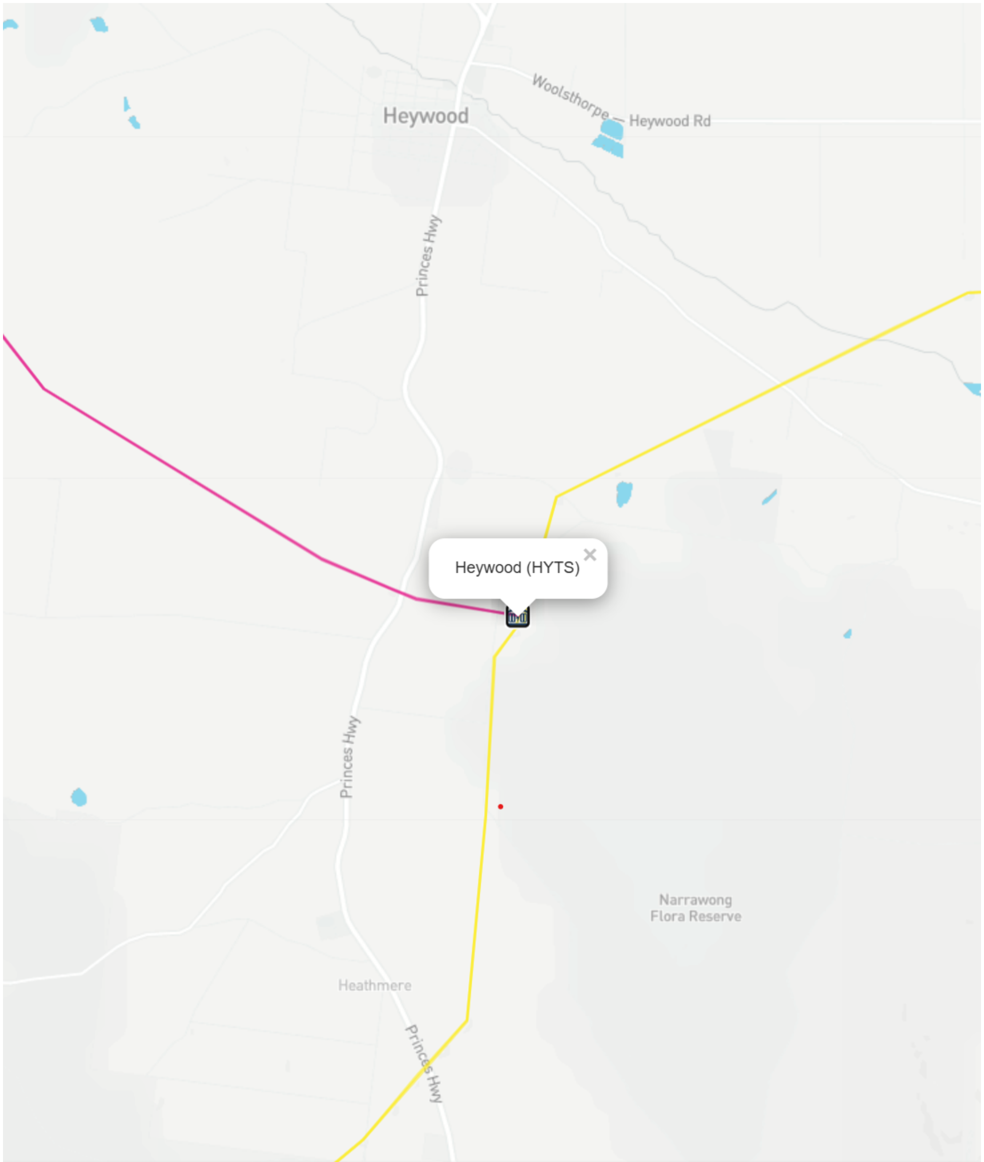

Figure 2.1: Project location

3. Performance Standards

3.1 [S5.2.5.1] Reactive Power Capability and Power Factor Requirements

3.1.1 Automatic Access Standard

Integrated resource system's rated active power = 285 MW as measured at the Connection Point.
While operating at any level of active power output and at any voltage at the Connection Point within the limits of ±10% of Normal Voltage, the integrated resource system is capable of supplying and absorbing at the Connection Point an amount of reactive power at least equal to the product of the rated active power of the integrated resource system and 0.395, as reflected in Figure 1.

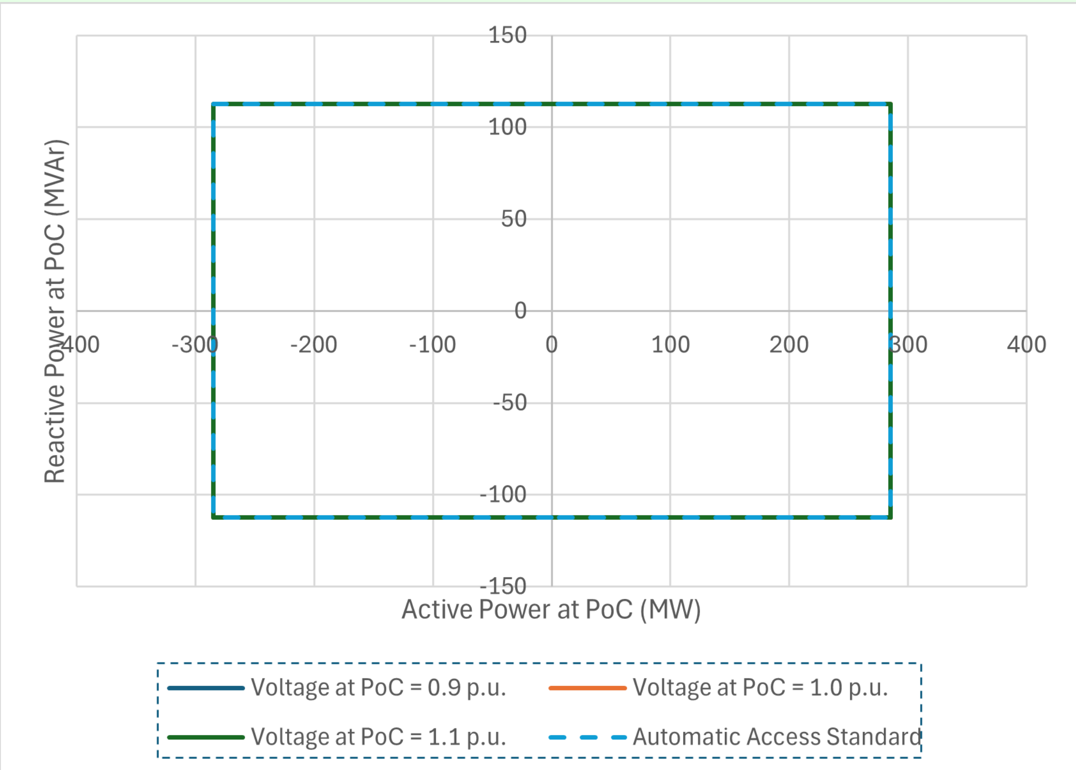

Figure 1: Reactive power capability up to 50°C rating

The integrated resource system, while not generating active power and not supplying or absorbing reactive power under an ancillary services agreement:

- When the production units are connected and the ambient temperature is less than 50OC, follow the voltage regulation control requirement specified in the performance standard under clause S5.2.5.13 with a reactive power capability of ± 1.223 MVAr for each production unit; and
- When the production units are not connected, not supply at its Connection Point reactive

power of more than 0 MVAr and not draw more electricity than XXXX kW of active power and XXXX kVAr of reactive power;

If the reactive power supplied or absorbed at the Connection Point falls outside the range that applies when the production units are not connected, the integrated resource system must, where required by the NSP in order to maintain satisfactory voltage levels at the Connection Point or to restore intra-regional or inter-regional power transfer capability, take action to ensure that the reactive power falls within that range within 30 min.

3.1.2 Assessment Methodology

Reactive capability studies have been performed on a full, detailed model of the plant (including all cables, inverters and transformers), based on inverter reactive capability curves supplied by the OEM. Powerfactory is capable of interpolating between these curves, allowing for accurate reactive power output to be calculated based on the individual terminal voltages of each inverter[1].

For each ambient temperature and connection point voltage to be studied, the appropriate capability curve for the inverter is applied and the connection point voltage is fixed to the target level. With the transformers permitted to tap, the case is first solved with all inverters exporting as much reactive power as possible without leaving their range of terminal voltages for which they are able to individually maintain Continuous Uninterrupted Operation (CUO). This study is repeated with all inverters importing as much reactive power as possible while maintaining CUO. Both processes are then repeated for all levels of inverter active power dispatch and a complete reactive capability curve is developed by recording the connection point active and reactive power outputs for all studies.

To confirm CUO is maintained at a generating system level for s5.2.5.4, the same study is repeated, but prior to recording the results, the transformer On-Load Tap Changers (OLTCs) are then allowed to tap at most twice, and the connection point voltage is stepped to the extents of the CUO voltage band or ±10%, whichever is less onerous[2]. The results for these studies are recorded as alternative, more onerous "CUO curves.". A maximum of two taps was allowed for these tests as with a total time per tap of 10 seconds, the OLTC is actually capable of performing 6 taps in a given 60 second window. This ensures that the plant is able to "exit" the withstand regions seen in Figure 3.8, preventing tripping of the inverter and ensuring CUO is maintained.

The remainder of the s5.2.5.1 clause consists of restrictions around the following:

(1) How much active and reactive power can be imported or exported by the generating system when the inverters are connected but not generating active power, which allows for the consideration of the inverters' ability to provide reactive power when state of charge is maintained, but does not allow for the filters to be out of service as they are required to offset the harmonics produced by inverters. In the operations phase, this would be a time when the generator has bid out, is curtailed.

(2) When the inverters are disconnected, which allows for the disconnection of the harmonic filter and even the 33kV circuit breaker, as this would only occur if there was a significant problem with the control system or a planned maintenance outage of the whole generating system.

[1] Note that Powerfactory is not capable of doing the same for active power, so invalid active power values are removed in post-processing.

[2] Per AEMO recommended rule change.

3.1.3 Results

The reactive capability curves for HEYWOODBESS at 35°C, 40°C and 50°C are shown in Figures 3.1, 3.2 and 3.3. Detailed results in .xslx format can be found in the Capability Curves folder.

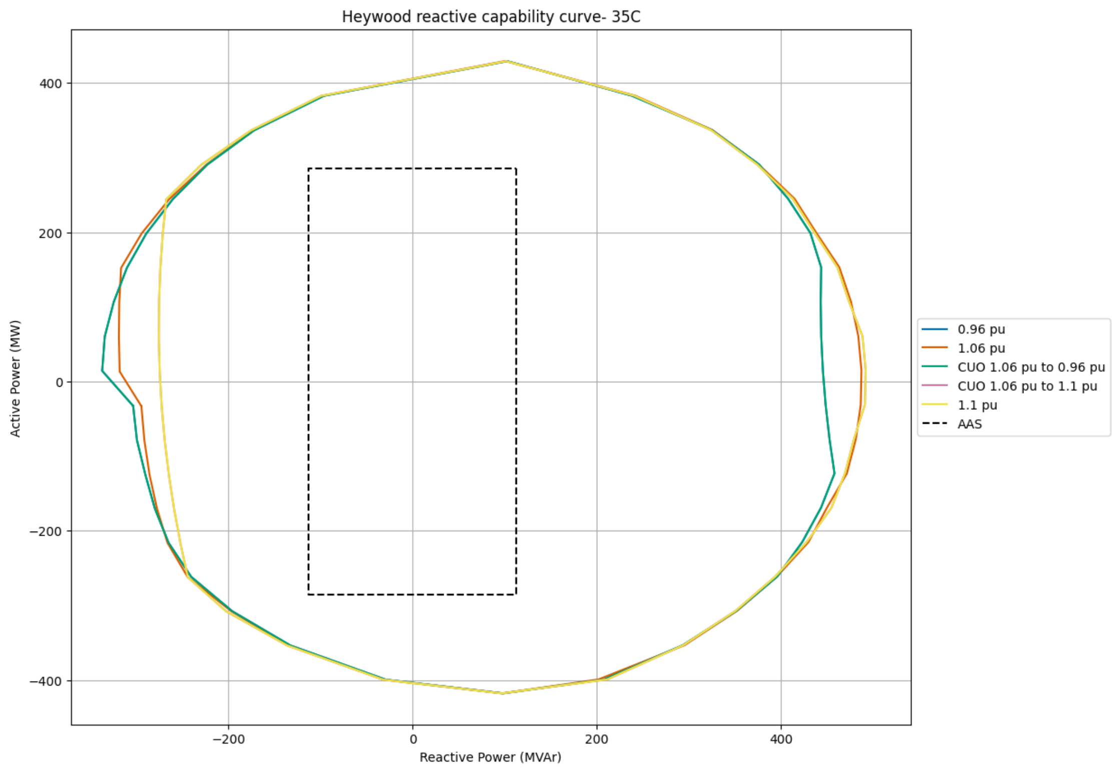

Figure 3.1: 35°C Reactive capability curve for HEYWOODBESS

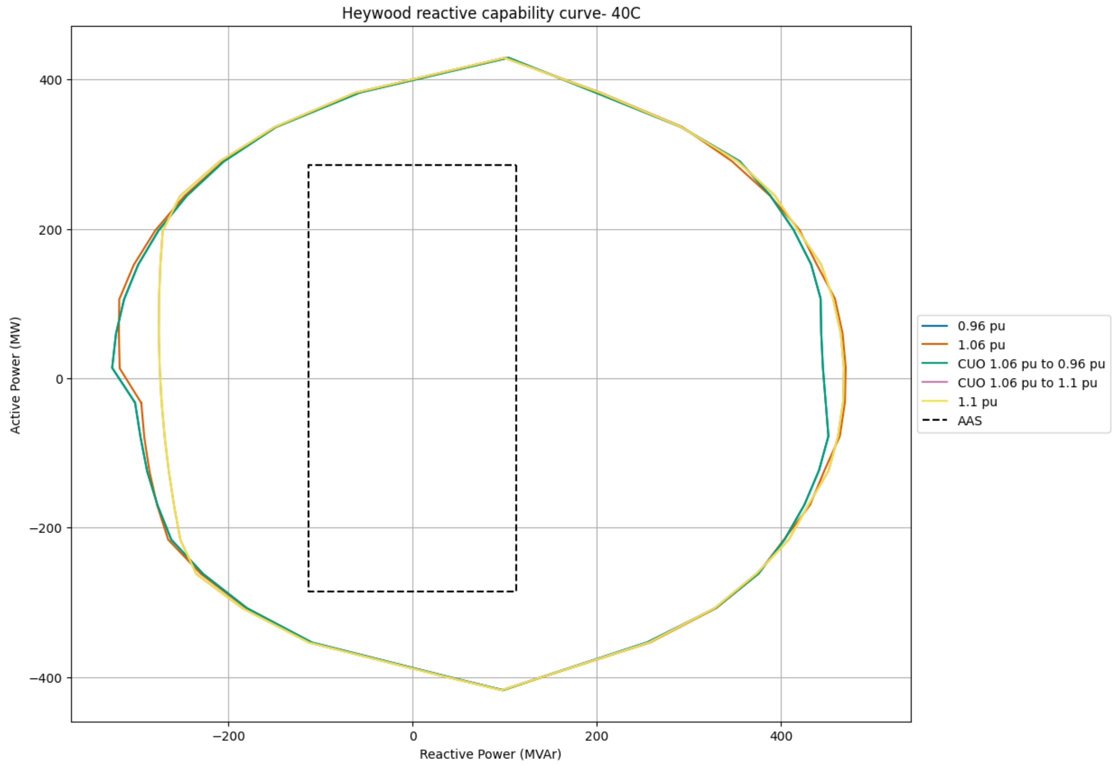

Figure 3.2: 40°C Reactive capability curve for HEYWOODBESS

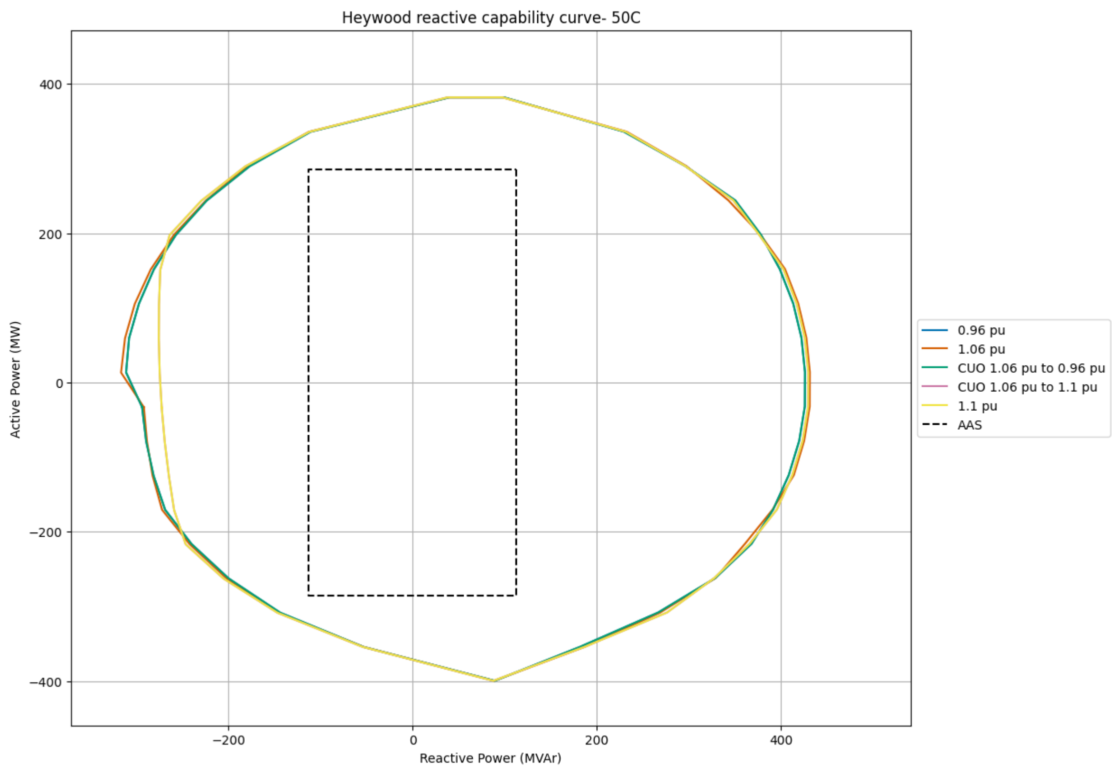

Figure 3.3: 50°C Reactive capability curve for HEYWOODBESS

To assess compliance with the second part of this clause a study in PowerFactory was conducted to examine the power flow at the point of connection when auxiliary loads are connected, but the inverters and harmonic filters are disconnected. The results of this have been included in Table 3.1 which demonstrate that Heywood BESS is compliant.

Table 3.1: Point of connection power flows

Status of Inverters	Status of Aux Loads	Status of HFs	Power flow at the POC
OFF	ON	OFF	P_{meas}=1.5 MW, Q_{meas}=0 MVAr

3.2 [S5.2.5.2] Quality of Electricity Generated and Balancing Load Current Voltage Fluctuations Harmonics and Voltage Notching

3.2.1 Automatic Access Standard

- When generating and when not generating, the integrated resource system does not produce at the Connection Point:
  (a) Voltage fluctuations greater than the limits specified in Table 2.1 by the NSP under clause S5.1.5(a) of the NER, where flicker will be measured in accordance with AS/NZS 61000.3.7:2001:

Pst	Plt
0.35	0.25

(b) Harmonic voltage distortion greater than the limits specified in Table 2.2 by the NSP under clause S5.1.6(a) of the NER and will be measured at the Connection Point in accordance with AS/NZS 61000.3.6:2001:

Harmonic Order (h)	Harmonic Voltage Limits (%)	Harmonic Order (h)	Harmonic Voltage Limits (%)	Harmonic Order (h)	Harmonic Voltage Limits (%)
2	0.1	19	0.12	36	0.1
3	0.1	20	0.1	37	0.1
4	0.1	21	0.1	38	0.1
5	0.1	22	0.1	39	0.1
6	0.1	23	0.1	40	0.1
7	0.1	24	0.1	41	0.1
8	0.1	25	0.1	42	0.1
9	0.1	26	0.1	43	0.1
10	0.1	27	0.1	44	0.1
11	0.18	28	0.1	45	0.1
12	0.1	29	0.1	46	0.1
13	0.18	30	0.1	47	0.1
14	0.1	31	0.1	48	0.1
15	0.1	32	0.1	49	0.1
16	0.1	33	0.1	50	0.1
17	0.12	34	0.1	THD	0.23
18	0.1	35	0.1		

(c) Voltage unbalance greater than the limits specified in Table 2.3 by the NSP under clause S5.1.7(c) of the NER and will be measured in accordance with AS/NZS 61000.3.6:2001:

Nominal Supply Voltage (kV)	Maximum Negative Sequence Voltage (% of Nominal Voltage)			
	No contingency event (30-min average)	*Credible contingency event* (30-min average)	General (10-min average)	Once per hour (1-min average)
275	0.5	0.7	1.0	2.0

3.2.2 Assessment

The Harmonic Emissions Assessment and Filter Design is currently unavailable at the R0 stage.

3.3 [S5.2.5.3] Generating System Response to Frequency Disturbances

3.3.1 Automatic Access Standard

Unless the rate of change of frequency is outside the range of ±4 Hz/s for more than 0.25 s, ±3 Hz/s for more than 1.00 s, the integrated resource system and each of its production units is capable of continuous uninterrupted operation for frequencies in the ranges indicated in Table 2.4:

Frequency Range (Hz)(1)	**Duration**(1)
47 to 48	2 min
48 to 49.5	10 min
49.5 to 50.5	continuous
50.5 to 52	10 min

Table 2.4: Frequency Limits for Continuous Uninterrupted Operation

Notes:
(1) Based on the frequency operating standard effective 1 January 2020.

3.3.2 Assessment Methodology

To assess this clause, a series of 'envelope' tests were performed, where the system frequency was initialised at 50Hz, then ramped to the furthest extent of the Over-Frequency Ride-Through (OFRT) or Under-Frequency Ride-Through (UFRT) ride-through bands, then gradually ramped down such that each band is sustained for the required duration. The results are then analysed to confirm that no generating units tripped during the study.

To implement these tests, F_{grid} is driven with a time-series signal $F_{\text{grid}_1}, F_{\text{grid}_2}, F_{\text{grid}_3}, \ldots, F_{\text{grid}_n}$, as shown in Figure 3.4. The assessment is performed on an infinite grid.

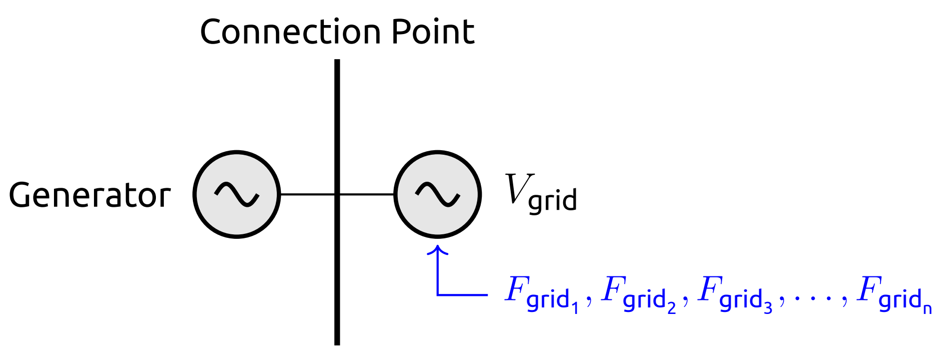

Figure 3.4: s5.2.5.3 assessment methodology

All assessments for this clause have been performed in PSCAD.

3.3.3 Results

The under-frequency and over-frequency ride through performance of the generating system during the envelope tests (performed in PSCAD) relative to the agreed access standard is shown in

Figure 3.5. The project was able to remain connected and in continuous uninterrupted operation for the applied "envelope tests" to simulate the frequency withstand requirements of S5.2.5.3. A summary of the envelope tests performed to produce this plot are shown in Table 3.2. The full results have been provided in Appendix A.

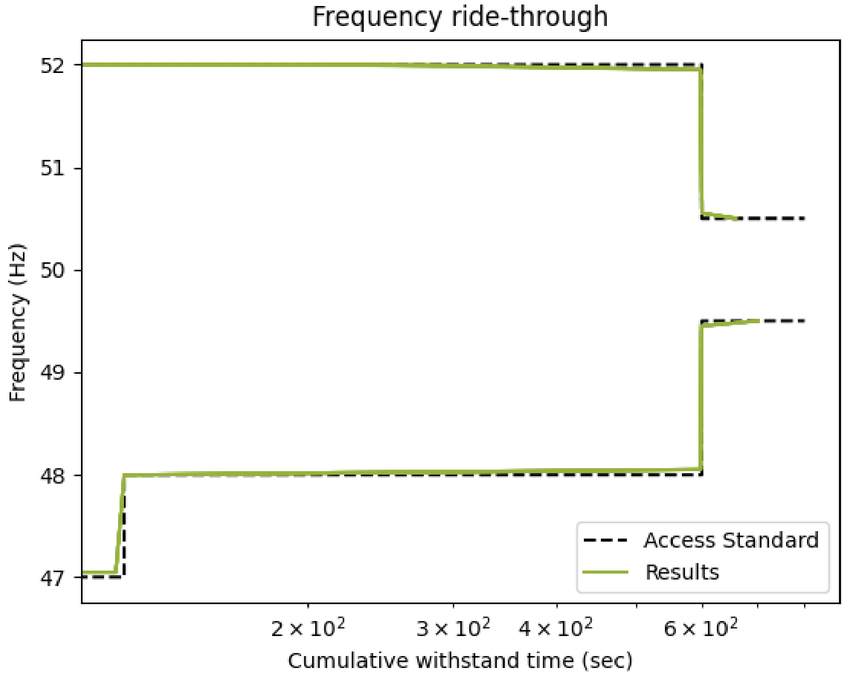

Figure 3.5: Frequency ride-through performance

Table 3.2: s5.2.5.3 frequency ride-through test suite

Test Num	Test Type	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
Test 1	OFRT Envelope	1.06	1	1.1	1	Appendix A CSR F Withstand
Test 2	OFRT Envelope	1.06	-1	1.02	1	Appendix A CSR F Withstand
Test 3	OFRT Envelope	1.06	0	1.06	1	Appendix A CSR F Withstand
Test 4	UFRT Envelope	1.06	1	1.1	1	Appendix A CSR F Withstand
Test 5	UFRT Envelope	1.06	-1	1.02	1	Appendix A CSR F Withstand
Test 6	UFRT Envelope	1.06	0	1.06	1	Appendix A CSR F Withstand
Test 7	OFRT Envelope	1.06	1	1.1	-1	Appendix A CSR F Withstand
Test 8	OFRT Envelope	1.06	-1	1.02	-1	Appendix A CSR F Withstand
Test 9	OFRT Envelope	1.06	0	1.06	-1	Appendix A CSR F Withstand
Test 10	UFRT Envelope	1.06	1	1.1	-1	Appendix A CSR F Withstand
Test 11	UFRT Envelope	1.06	-1	1.02	-1	Appendix A CSR F Withstand
Test 12	UFRT Envelope	1.06	0	1.06	-1	Appendix A CSR F Withstand

3.4 [S5.2.5.4] Generating System Response to Voltage Disturbances

3.4.1 Automatic Access Standard

The integrated resource system and each of its production units is capable of continuous uninterrupted operation where a power system disturbance causes the voltage at the Connection Point to vary within the ranges indicated in Table 2.5:

Voltage Range (% of Normal Voltage)	Duration
>130%	0.02 s[(1)]
125% to 130%	0.2 s[(1)]
120% to 125%	2 s[(1)]
115% to 120%	20 s[(1)]
110% to 115%	20 mins[(1)]
90% to 110%	continuous
80% to 90%	10 s[(2)]
70% to 80%	2 s[(2)]

Table 2.5: Voltage Limits for Continuous Uninterrupted Operation

Notes:
[(1)] After the Connection Point voltage first varied above 110% of Normal Voltage before returning to between 90% and 110% of Normal Voltage.
[(2)] After the Connection Point voltage first varied below 90% of Normal Voltage before returning to between 90% and 110% of Normal Voltage.

3.4.2 Assessment Methodology

S5.2.5.4 tests assess the ability of the generator to ride-through and maintain Continuous Uninterrupted Operation (CUO) to a changing Connection Point voltage.

Three types of studies are run:

1. "Envelope" tests, where the Connection Point voltage is initialised to a normal value, then stepped up to the furthest extent of the Under-Voltage Ride-Through (UVRT) or Over-Voltage Ride-Through (OVRT) ride-through bands, then gradually stepped down such that each band is sustained for the required duration.

2. "Withstand" tests, where the Connection Point voltage is initialised to a normal value, then stepped to the furthest extent of one of the ride-through bands and held for the required withstand time.

3. CUO studies, where the Connection Point voltage is initialised to a normal value, then stepped to 0.9pu (or 0.1pu lower than the initial voltage, whichever is higher) or to 1.1pu (or 0.1pu higher than the initial voltage, whichever is lower). These studies test the ability of the generator to maintain $P_{\text{POC}_{\text{pre-fault}}}$ and $Q_{\text{POC}_{\text{pre-fault}}}$ after the disturbance.

To perform these tests, V_{grid_1} is selected to correspond to the required V_{POC_1}, as these studies are performed on an infinite grid. Subsequent V_{grid} values $V_{\text{grid}_2}, V_{\text{grid}_3}, \ldots, V_{\text{grid}_n}$ can then be chosen to match the desired V_{POC} values $V_{\text{POC}_2}, V_{\text{POC}_3}, \ldots, V_{\text{POC}_n}$ values for the test, as shown in Figure 3.6.

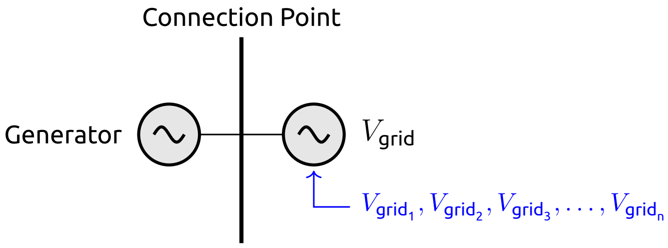

Figure 3.6: Grid voltage disturbance methodology

All assessments for this clause have been performed in PSCAD.

3.4.3 Results

The under-voltage and over-voltage ride through performance of the generating system during the envelope tests relative to the agreed access standard is shown in Figure 3.7. This plot illustrates the connection point voltage for all envelope tests over simulation time. Please refer to results of the envelope tests in Appendix 3.3, which demonstrate that the solar farm was able to remain connected for at least the duration required by the access standard through simulation [3].

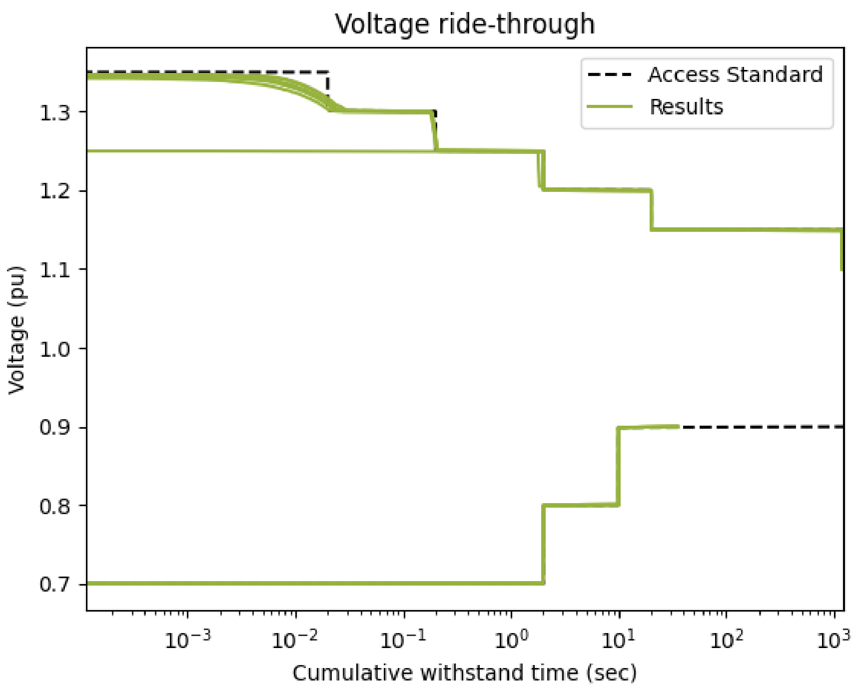

Figure 3.7: Over-voltage ride-through performance

Table 3.3: s5.2.5.4 envelope withstand test suite

Test Num	Test Type	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
1	OVRT Envelope from Vpoc = 1.0	1	1	1.04	1	Appendix B CSR V Withstand
2	OVRT Envelope from Vpoc = 1.0	1	-1	0.96	1	Appendix B CSR V Withstand

[3] Please note that for the first HVRT step down to 1.3pu the reason the trace is seen to be thicker for this segment is because several envelope test results have been overlayed, which have small variations in point of connection voltage

Test Num	Test Type	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
3	OVRT Envelope from Vpoc = 1.0	1	0	1	1	Appendix B CSR V Withstand
4	UVRT Envelope from Vpoc = 1.0	1	1	1.04	1	Appendix B CSR V Withstand
5	UVRT Envelope from Vpoc = 1.0	1	-1	0.96	1	Appendix B CSR V Withstand
6	UVRT Envelope from Vpoc = 1.0	1	0	1	1	Appendix B CSR V Withstand
7	OVRT Envelope from Vpoc = 1.0	1	1	1.04	-1	Appendix B CSR V Withstand
8	OVRT Envelope from Vpoc = 1.0	1	-1	0.96	-1	Appendix B CSR V Withstand
9	OVRT Envelope from Vpoc = 1.0	1	0	1	-1	Appendix B CSR V Withstand
10	UVRT Envelope from Vpoc = 1.0	1	1	1.04	-1	Appendix B CSR V Withstand
11	UVRT Envelope from Vpoc = 1.0	1	-1	0.96	-1	Appendix B CSR V Withstand
12	UVRT Envelope from Vpoc = 1.0	1	0	1	-1	Appendix B CSR V Withstand

The ability of the generating system and the individual generating units to maintain CUO can be confirmed through the combination of the following: reactive capability studies (presented in 3.1) and the chart in Figure 3.8, which shows that the inverter terminal voltages settle within the continuous operating limits prior to any protection timers operating for all CUO test cases in Table 3.4. All test cases have been overlayed on the plot to demonstrate that all inverters settle to within their continuous operating voltage limits for all CUO tests.

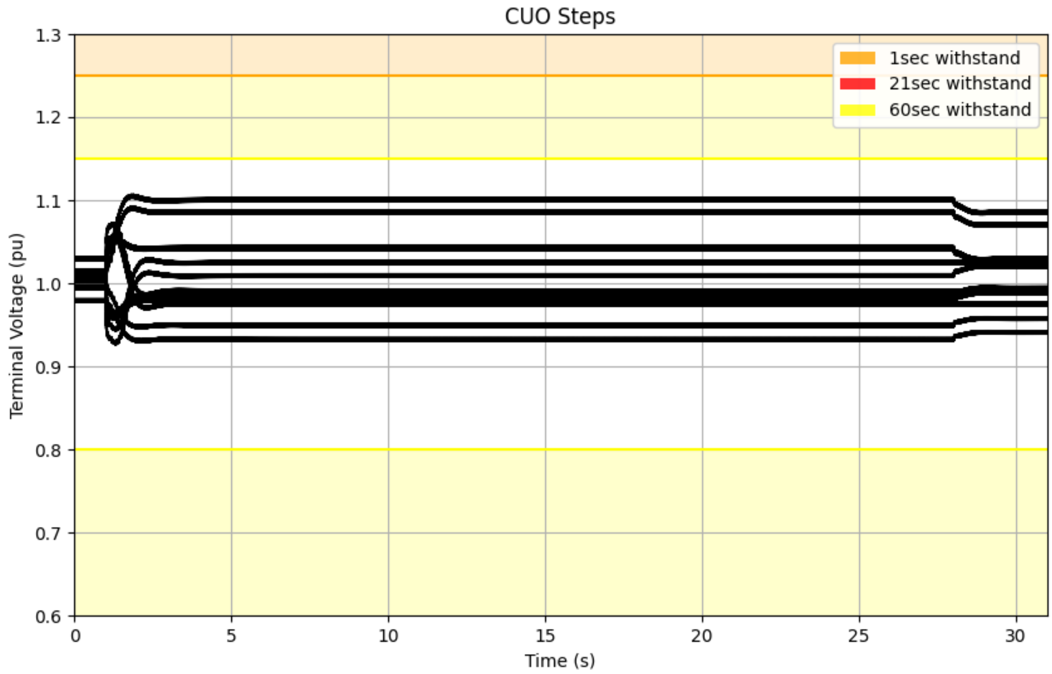

Figure 3.8: Inverter CUO performance summary plot (PSCAD)

Please refer to Appendix C which includes the results for each test.

Table 3.4: s5.2.5.4 CUO test suite (PSCAD)

Test Num	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Voltage Step [pu]	Appendix Reference
Test 1	1	1	1.04	1	0.9	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 2	1	-1	0.96	1	0.9	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 3	1	0	1	1	0.9	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 4	1	1	1.04	1	1.1	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 5	1	-1	0.96	1	1.1	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 6	1	0	1	1	1.1	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 7	1	1	1.04	-1	0.9	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 8	1	-1	0.96	-1	0.9	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 9	1	0	1	-1	0.9	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 10	1	1	1.04	-1	1.1	Appendix C Continuous uninterrupted operation S5.2.5.4

Test Num	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Voltage Step [pu]	Appendix Reference
Test 11	1	-1	0.96	-1	1.1	Appendix C Continuous uninterrupted operation S5.2.5.4
Test 12	1	0	1	-1	1.1	Appendix C Continuous uninterrupted operation S5.2.5.4

3.5 [S5.2.5.5] Generating System Response to Disturbances Following Contingency Events

3.5.1 Negotiated Access Standard

For the purposes of this performance standard, a **fault** includes a fault of the relevant type having a metallic conducting path. Fault clearance times for relevant equipment are specified in Table 2.6:

System	Transmission system fault clearance time
Primary protection system	100 ms
Breaker fail protection system	250 ms
Automatic reclose equipment	Three-phase auto-reclose with 3-second deadtime and 1 shot

Table 2.6: Protection clearance times in transmission and distribution system

Single disturbance (reflects clause S5.2.5.5(c) of the NER): Provided that the event is not one that would disconnect the integrated resource system from the power system by removing network elements from service, the integrated resource system and each of its production units will remain in continuous uninterrupted operation for any disturbance caused by:

1. A credible contingency event;
2. A three-phase fault in a transmission system cleared by all relevant primary protection systems;
3. A two-phase-to-ground, phase-to-phase or phase-to-ground fault in the transmission system cleared in:
   (a) the longest time expected to be taken for a relevant breaker fail protection system to clear the fault or
   (b) if a breaker fail protection system is not installed, the greater of the time specified in Table 2.7;

Nominal voltage at fault location (kV)	Time (ms)
>400 kV	175 ms
>250 kV and <400 kV	250 ms
>100 kV and <250 kV	430 ms
<100 kV	430 ms

Table 2.7: Fault Clearance Times

and the longest time expected to be taken for all relevant primary protection systems to clear the fault.

4. A three-phase, two-phase-to-ground, phase-to-phase or phase-to-ground fault in a distribution network cleared in:

i the longest time expected to be taken for a relevant breaker fail protection system to clear the fault; or

ii if a breaker fail protection system is not installed, the greater of 430 ms and the longest time expected to be taken for all relevant primary protection systems to clear the fault.

Multiple disturbances (reflects clause S5.2.5.5(d), (s), and (t) of the NER): When assessing multiple disturbances, a fault that is re-established following operation of automatic reclose equipment is counted as a separate disturbance. The integrated resource system and each of its production units will remain in continuous uninterrupted operation for a series of up to 15 disturbances within any 5-min period caused by any combination of the events described above where:

1. Up to 6 disturbances cause the Connection Point voltage to drop below 50% of Normal Voltage;
2. In parts of the network where three-phase automatic reclosure is permitted, up to two disturbances are three-phase faults, and otherwise up to one three-phase fault where the Connection Point voltage drops below 50% of Normal Voltage;
3. Up to one disturbance is cleared by a breaker fail protection system or similar backup protection system;
4. Up to one disturbance causes the Connection Point voltage to vary within the ranges under clause S5.2.5.4(a)(7) and (8) of the NER;
5. The minimum clearance from the end of one disturbance and commencement of the next disturbance may be zero milliseconds; and
6. All remaining disturbances are caused by faults other than three-phase faults, provided that none of the events would result in:
7. The islanding of the integrated resource system or cause a material reduction in power transfer capability by removing network elements from service;
8. The cumulative time that the Connection Point voltage is lower than 90% of Normal Voltage exceeding 1,800 milliseconds within any 5-min period; or
9. Within any 5-min period, the time integral of the difference between 90% of Normal Voltage and the Connection Point voltage when the Connection Point voltage is lower than 90% of Normal Voltage exceeding 1 pu second. The integrated resource system will not, as a consequence of its connection, cause other generating plant or loads to trip as a result of an event, when they would otherwise not have tripped for the same event.

For asynchronous integrated resource systems (reflects clause S5.2.5.5(f)-(i) and (u) of the NER): Subject to any changed power system conditions or energy source availability beyond the Integrated Resource Provider's reasonable control, the integrated resource system, including all operating asynchronous production units (in the absence of a disturbance), in respect of fault types described in clause S5.2.5.5(c)(2) to (4) of the NER, will supply to, or absorb from, the network:

1. During the disturbance and maintained until the Connection Point voltage recovers to between 90% and 110% of Normal Voltage, to assist the maintenance of power system voltages during the fault:
   (a) Capacitive reactive current in addition to its pre-disturbance level of at least 2.94% of the maximum continuous current for each 1% reduction of the Connection Point voltage below the range of 85% to 90% of Normal Voltage up to the maximum continuous current;
   (b) Inductive reactive current in addition to its pre-disturbance level of at least 3.1% of its maximum continuous current for each 1% increase of the Connection Point

voltage above the range of 110% to 115% of Normal Voltage up to its maximum continuous current to maintain its rated apparent power; and
(c) the reactive current response will have a rise time of no greater than 40 ms and a settling time of no greater than 133 ms and will be adequately damped; and
(d) the reactive current contribution is calculated using sequence components
2. from 230 ms after clearance of the fault, active power of at least 95% of the level existing just prior to the fault.

3.5.2 Assessment Methodology

Assessment of s5.2.5.5 is performed in by applying a variety of different types of faults with different impedances to observe the generating system response and measure characteristics such as settling times and i_q injection performance.

In PSCAD and PSSE SMIB studies, faults are applied to the connection point (as shown in Figure 3.9) with characteristics that are representative of how real world faults would appear from the generating system's connection point, while in PSSE wide area studies, faults with credible characteristics are applied to the real network assets.

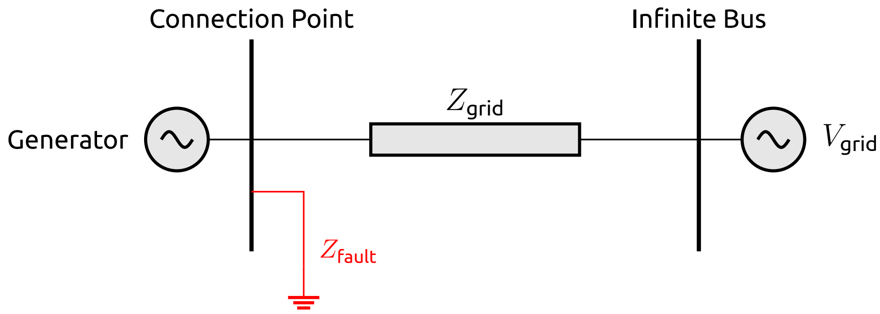

Figure 3.9: SMIB fault application methodology

In addition to faults, Temporary Over-Voltage (TOV) scenarios are studied in PSCAD SMIB by tapping a dummy transformer connected between the point of connection and the grid impedance in order to push the voltage at the point of connection up to a specific value. This allows finer control of the disturbance seen at the point of connection, as the voltage drop across the grid impedance doesn't need to be considered.

In order to assess the impact of the project on the South Australian electrical network, four wide area cases were prepared based on recommendations provided by ElectraNet. Descriptions of the four cases are available in Section 3.12.2 [S5.2.5.12] Impact on Network Capability.

All SMIB assessments for this clause have been performed in PSCAD and all wide-area contingency assessments have been performed in PSS/E.

3.5.3 Results

SMIB studies

The list of faults performed in SMIB studies has been provided in Tables 3.5 and 3.6.

Figure 3.10 shows the amount of positive and negative sequence i_q injection at the inverter terminals to the change in connection point voltage across all faults studied. It can be read as follows:

- Grey circles indicate that the generating system is supplying more than the *maximum continuous current* of the generating system[4], which automatically fulfills the GPS requirement for reactive current injection, regardless of the additional i_q injected.
- Red markers indicate the amount of additional i_q injected for a particular fault. For compliance, the marker should be above the access standard characteristic (for faults) or below the characteristic (for TOV tests).

We note that for all tests studied, the generating system was capable of providing sufficient positive sequence reactive current.

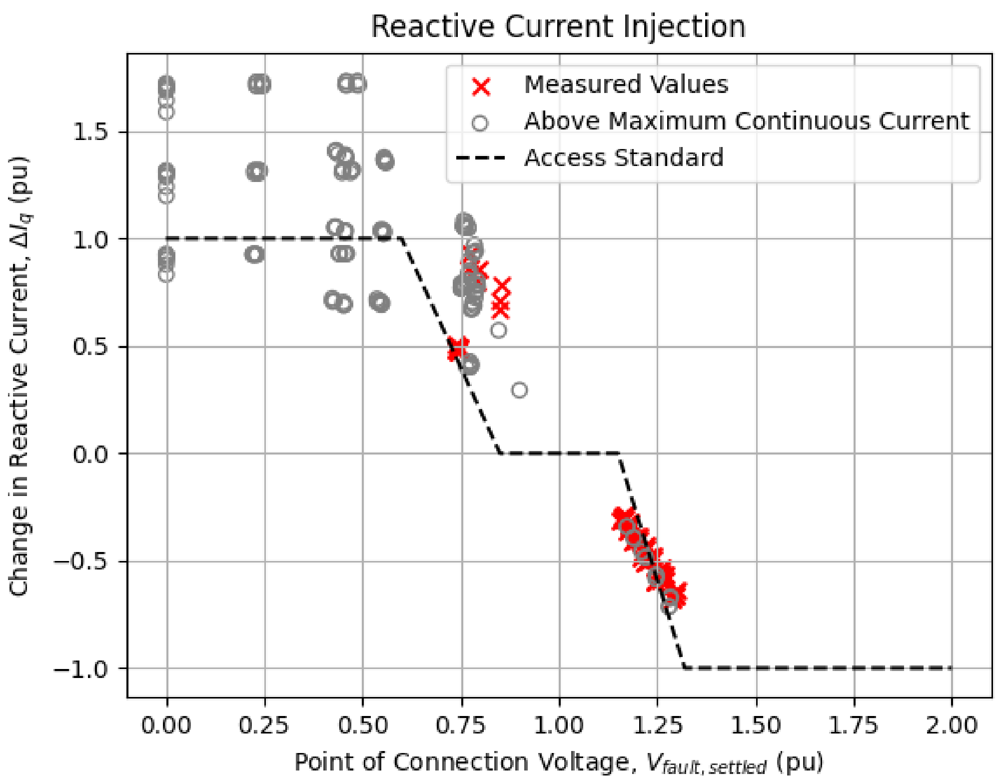

Figure 3.10: POC Positive Sequence Reactive Current Injection Performance

The full list of balanced faults, unbalanced faults, and TOV tests assessed can be found in Tables 3.5, 3.6, and 3.7 respectively.

Table 3.5: s5.2.5.5 balanced fault test suite (PSCAD)

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Type	Duration [s]	Impedance (Zf/Zs)	Appendix Reference
Test 1	19.61754386	12.04	1.06	0	1.06	1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 2	19.61754386	12.04	1.06	-1	1.02	1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 3	19.61754386	12.04	1.06	1	1.1	1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 4	19.61754386	12.04	1.06	0	1.06	0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 5	19.61754386	12.04	1.06	-1	1.02	0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 6	19.61754386	12.04	1.06	1	1.1	0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults

[4] The current associated with maximum active power and maximum reactive power while at 1.0pu voltage.

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Type	Duration [s]	Impedance (Zf/Zs)	Appendix Reference
Test 7	19.61754386	12.04	1.06	0	1.06	-1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 8	19.61754386	12.04	1.06	-1	1.02	-1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 9	19.61754386	12.04	1.06	1	1.1	-1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 10	19.61754386	12.04	1.06	0	1.06	-0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 11	19.61754386	12.04	1.06	-1	1.02	-0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 12	19.61754386	12.04	1.06	1	1.1	-0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 13	11.1754386	11.24	1.06	0	1.06	1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 14	11.1754386	11.24	1.06	-1	1.02	1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 15	11.1754386	11.24	1.06	1	1.1	1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 16	11.1754386	11.24	1.06	0	1.06	0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 17	11.1754386	11.24	1.06	-1	1.02	0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 18	11.1754386	11.24	1.06	1	1.1	0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 19	11.1754386	11.24	1.06	0	1.06	-1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 20	11.1754386	11.24	1.06	-1	1.02	-1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 21	11.1754386	11.24	1.06	1	1.1	-1	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 22	11.1754386	11.24	1.06	0	1.06	-0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 23	11.1754386	11.24	1.06	-1	1.02	-0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 24	11.1754386	11.24	1.06	1	1.1	-0.05	3PHG	0.43	0	Appendix E CSR Balanced Faults
Test 25	19.61754386	12.04	1.06	0	1.06	1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 26	19.61754386	12.04	1.06	-1	1.02	1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 27	19.61754386	12.04	1.06	1	1.1	1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 28	19.61754386	12.04	1.06	0	1.06	0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 29	19.61754386	12.04	1.06	-1	1.02	0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 30	19.61754386	12.04	1.06	1	1.1	0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 31	19.61754386	12.04	1.06	0	1.06	-1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 32	19.61754386	12.04	1.06	-1	1.02	-1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 33	19.61754386	12.04	1.06	1	1.1	-1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 34	19.61754386	12.04	1.06	0	1.06	-0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 35	19.61754386	12.04	1.06	-1	1.02	-0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 36	19.61754386	12.04	1.06	1	1.1	-0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 37	11.1754386	11.24	1.06	0	1.06	1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 38	11.1754386	11.24	1.06	-1	1.02	1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 39	11.1754386	11.24	1.06	1	1.1	1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 40	11.1754386	11.24	1.06	0	1.06	0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 41	11.1754386	11.24	1.06	-1	1.02	0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 42	11.1754386	11.24	1.06	1	1.1	0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 43	11.1754386	11.24	1.06	0	1.06	-1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 44	11.1754386	11.24	1.06	-1	1.02	-1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 45	11.1754386	11.24	1.06	1	1.1	-1	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 46	11.1754386	11.24	1.06	0	1.06	-0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 47	11.1754386	11.24	1.06	-1	1.02	-0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 48	11.1754386	11.24	1.06	1	1.1	-0.05	3PHG	0.43	0.25	Appendix E CSR Balanced Faults
Test 49	19.61754386	12.04	1.06	0	1.06	1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 50	19.61754386	12.04	1.06	-1	1.02	1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 51	19.61754386	12.04	1.06	1	1.1	1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 52	19.61754386	12.04	1.06	0	1.06	0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 53	19.61754386	12.04	1.06	-1	1.02	0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 54	19.61754386	12.04	1.06	1	1.1	0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 55	19.61754386	12.04	1.06	0	1.06	-1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 56	19.61754386	12.04	1.06	-1	1.02	-1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 57	19.61754386	12.04	1.06	1	1.1	-1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 58	19.61754386	12.04	1.06	0	1.06	-0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 59	19.61754386	12.04	1.06	-1	1.02	-0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 60	19.61754386	12.04	1.06	1	1.1	-0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 61	11.1754386	11.24	1.06	0	1.06	1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 62	11.1754386	11.24	1.06	-1	1.02	1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 63	11.1754386	11.24	1.06	1	1.1	1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 64	11.1754386	11.24	1.06	0	1.06	0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 65	11.1754386	11.24	1.06	-1	1.02	0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 66	11.1754386	11.24	1.06	1	1.1	0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 67	11.1754386	11.24	1.06	0	1.06	-1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 68	11.1754386	11.24	1.06	-1	1.02	-1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 69	11.1754386	11.24	1.06	1	1.1	-1	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 70	11.1754386	11.24	1.06	0	1.06	-0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 71	11.1754386	11.24	1.06	-1	1.02	-0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 72	11.1754386	11.24	1.06	1	1.1	-0.05	3PHG	0.43	0.66	Appendix E CSR Balanced Faults
Test 73	19.61754386	12.04	1.06	0	1.06	1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 74	19.61754386	12.04	1.06	-1	1.02	1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 75	19.61754386	12.04	1.06	1	1.1	1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 76	19.61754386	12.04	1.06	0	1.06	0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 77	19.61754386	12.04	1.06	-1	1.02	0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 78	19.61754386	12.04	1.06	1	1.1	0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 79	19.61754386	12.04	1.06	0	1.06	-1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 80	19.61754386	12.04	1.06	-1	1.02	-1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 81	19.61754386	12.04	1.06	1	1.1	-1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 82	19.61754386	12.04	1.06	0	1.06	-0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 83	19.61754386	12.04	1.06	-1	1.02	-0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 84	19.61754386	12.04	1.06	1	1.1	-0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Type	Duration [s]	Impedance (Zf/Zs)	Appendix Reference
Test 85	11.1754386	11.24	1.06	0	1.06	1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 86	11.1754386	11.24	1.06	-1	1.02	1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 87	11.1754386	11.24	1.06	1	1.1	1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 88	11.1754386	11.24	1.06	0	1.06	0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 89	11.1754386	11.24	1.06	-1	1.02	0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 90	11.1754386	11.24	1.06	1	1.1	0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 91	11.1754386	11.24	1.06	0	1.06	-1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 92	11.1754386	11.24	1.06	-1	1.02	-1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 93	11.1754386	11.24	1.06	1	1.1	-1	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 94	11.1754386	11.24	1.06	0	1.06	-0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 95	11.1754386	11.24	1.06	-1	1.02	-0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults
Test 96	11.1754386	11.24	1.06	1	1.1	-0.05	3PHG	0.43	2.3	Appendix E CSR Balanced Faults

Table 3.6: s5.2.5.5 unbalanced fault test suite (PSCAD)

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Type	Duration [s]	Impedance Zf/Zs	Appendix Reference
Test 1	19.61754386	12.04	1.06	0	1.06	1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 2	19.61754386	12.04	1.06	-1	1.02	1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 3	19.61754386	12.04	1.06	1	1.1	1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 4	19.61754386	12.04	1.06	0	1.06	0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 5	19.61754386	12.04	1.06	-1	1.02	0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 6	19.61754386	12.04	1.06	1	1.1	0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 7	19.61754386	12.04	1.06	0	1.06	-1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 8	19.61754386	12.04	1.06	-1	1.02	-1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 9	19.61754386	12.04	1.06	1	1.1	-1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 10	19.61754386	12.04	1.06	0	1.06	-0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 11	19.61754386	12.04	1.06	-1	1.02	-0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 12	19.61754386	12.04	1.06	1	1.1	-0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 13	11.1754386	11.24	1.06	0	1.06	1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 14	11.1754386	11.24	1.06	-1	1.02	1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 15	11.1754386	11.24	1.06	1	1.1	1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 16	11.1754386	11.24	1.06	0	1.06	0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 17	11.1754386	11.24	1.06	-1	1.02	0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 18	11.1754386	11.24	1.06	1	1.1	0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 19	11.1754386	11.24	1.06	0	1.06	-1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 20	11.1754386	11.24	1.06	-1	1.02	-1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 21	11.1754386	11.24	1.06	1	1.1	-1	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 22	11.1754386	11.24	1.06	0	1.06	-0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 23	11.1754386	11.24	1.06	-1	1.02	-0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 24	11.1754386	11.24	1.06	1	1.1	-0.05	2PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 25	19.61754386	12.04	1.06	0	1.06	1	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 26	19.61754386	12.04	1.06	-1	1.02	1	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 27	19.61754386	12.04	1.06	1	1.1	1	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 28	19.61754386	12.04	1.06	0	1.06	0.05	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 29	19.61754386	12.04	1.06	-1	1.02	0.05	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 30	19.61754386	12.04	1.06	1	1.1	0.05	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 31	19.61754386	12.04	1.06	0	1.06	-1	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 32	19.61754386	12.04	1.06	-1	1.02	-1	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 33	19.61754386	12.04	1.06	1	1.1	-1	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 34	19.61754386	12.04	1.06	0	1.06	-0.05	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 35	19.61754386	12.04	1.06	-1	1.02	-0.05	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 36	19.61754386	12.04	1.06	1	1.1	-0.05	2PHG	0.5	0.25	Appendix F CSR Unbalanced Faults
Test 37	11.1754386	11.24	1.06	0	1.06	1	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 38	11.1754386	11.24	1.06	-1	1.02	1	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 39	11.1754386	11.24	1.06	1	1.1	1	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 40	11.1754386	11.24	1.06	0	1.06	0.05	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 41	11.1754386	11.24	1.06	-1	1.02	0.05	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 42	11.1754386	11.24	1.06	1	1.1	0.05	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 43	11.1754386	11.24	1.06	0	1.06	-1	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 44	11.1754386	11.24	1.06	-1	1.02	-1	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 45	11.1754386	11.24	1.06	1	1.1	-1	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 46	11.1754386	11.24	1.06	0	1.06	-0.05	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 47	11.1754386	11.24	1.06	-1	1.02	-0.05	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 48	11.1754386	11.24	1.06	1	1.1	-0.05	2PHG	0.43	0.25	Appendix F CSR Unbalanced Faults
Test 49	19.61754386	12.04	1.06	0	1.06	1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 50	19.61754386	12.04	1.06	-1	1.02	1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 51	19.61754386	12.04	1.06	1	1.1	1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 52	19.61754386	12.04	1.06	0	1.06	0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 53	19.61754386	12.04	1.06	-1	1.02	0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 54	19.61754386	12.04	1.06	1	1.1	0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 55	19.61754386	12.04	1.06	0	1.06	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 56	19.61754386	12.04	1.06	-1	1.02	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 57	19.61754386	12.04	1.06	1	1.1	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 58	19.61754386	12.04	1.06	0	1.06	-0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 59	19.61754386	12.04	1.06	-1	1.02	-0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 60	19.61754386	12.04	1.06	1	1.1	-0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Type	Duration [s]	Impedance Zf/Zs	Appendix Reference
Test 61	11.1754386	11.24	1.06	0	1.06	1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 62	11.1754386	11.24	1.06	-1	1.02	1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 63	11.1754386	11.24	1.06	1	1.1	1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 64	11.1754386	11.24	1.06	0	1.06	0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 65	11.1754386	11.24	1.06	-1	1.02	0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 66	11.1754386	11.24	1.06	1	1.1	0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 67	11.1754386	11.24	1.06	0	1.06	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 68	11.1754386	11.24	1.06	-1	1.02	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 69	11.1754386	11.24	1.06	1	1.1	-1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 70	11.1754386	11.24	1.06	0	1.06	-0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 71	11.1754386	11.24	1.06	-1	1.02	-0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 72	11.1754386	11.24	1.06	1	1.1	-0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 73	19.61754386	12.04	1.06	0	1.06	1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 74	19.61754386	12.04	1.06	-1	1.02	1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 75	19.61754386	12.04	1.06	1	1.1	1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 76	19.61754386	12.04	1.06	0	1.06	0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 77	19.61754386	12.04	1.06	-1	1.02	0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 78	19.61754386	12.04	1.06	1	1.1	0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 79	19.61754386	12.04	1.06	0	1.06	-1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 80	19.61754386	12.04	1.06	-1	1.02	-1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 81	19.61754386	12.04	1.06	1	1.1	-1	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 82	19.61754386	12.04	1.06	0	1.06	-0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 83	19.61754386	12.04	1.06	-1	1.02	-0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 84	19.61754386	12.04	1.06	1	1.1	-0.05	1PHG	0.43	0	Appendix F CSR Unbalanced Faults
Test 85	11.1754386	11.24	1.06	0	1.06	1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 86	11.1754386	11.24	1.06	-1	1.02	1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 87	11.1754386	11.24	1.06	1	1.1	1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 88	11.1754386	11.24	1.06	0	1.06	0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 89	11.1754386	11.24	1.06	-1	1.02	0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 90	11.1754386	11.24	1.06	1	1.1	0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 91	11.1754386	11.24	1.06	0	1.06	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 92	11.1754386	11.24	1.06	-1	1.02	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 93	11.1754386	11.24	1.06	1	1.1	-1	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 94	11.1754386	11.24	1.06	0	1.06	-0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 95	11.1754386	11.24	1.06	-1	1.02	-0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 96	11.1754386	11.24	1.06	1	1.1	-0.05	1PHG	0.43	1	Appendix F CSR Unbalanced Faults
Test 97	19.61754386	12.04	1.06	0	1.06	1	1PHPH	0.43	1	Appendix F CSR Unbalanced Faults
Test 98	19.61754386	12.04	1.06	-1	1.02	1	1PHPH	0.43	1	Appendix F CSR Unbalanced Faults
Test 99	19.61754386	12.04	1.06	1	1.1	1	1PHPH	0.43	1	Appendix F CSR Unbalanced Faults
Test 100	19.61754386	12.04	1.06	0	1.06	0.05	1PHPH	0.43	1	Appendix F CSR Unbalanced Faults
Test 101	19.61754386	12.04	1.06	-1	1.02	0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 102	19.61754386	12.04	1.06	1	1.1	0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 103	19.61754386	12.04	1.06	0	1.06	-1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 104	19.61754386	12.04	1.06	-1	1.02	-1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 105	19.61754386	12.04	1.06	1	1.1	-1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 106	19.61754386	12.04	1.06	0	1.06	-0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 107	19.61754386	12.04	1.06	-1	1.02	-0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 108	19.61754386	12.04	1.06	1	1.1	-0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 109	11.1754386	11.24	1.06	0	1.06	1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 110	11.1754386	11.24	1.06	-1	1.02	1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 111	11.1754386	11.24	1.06	1	1.1	1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 112	11.1754386	11.24	1.06	0	1.06	0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 113	11.1754386	11.24	1.06	-1	1.02	0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 114	11.1754386	11.24	1.06	1	1.1	0.05	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 115	11.1754386	11.24	1.06	0	1.06	-1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 116	11.1754386	11.24	1.06	-1	1.02	-1	1PHPH	2	0	Appendix F CSR Unbalanced Faults
Test 117	11.1754386	11.24	1.06	1	1.1	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 118	11.1754386	11.24	1.06	0	1.06	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 119	11.1754386	11.24	1.06	-1	1.02	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 120	11.1754386	11.24	1.06	1	1.1	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 121	19.61754386	12.04	1.06	0	1.06	1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 122	19.61754386	12.04	1.06	-1	1.02	1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 123	19.61754386	12.04	1.06	1	1.1	1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 124	19.61754386	12.04	1.06	0	1.06	0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 125	19.61754386	12.04	1.06	-1	1.02	0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 126	19.61754386	12.04	1.06	1	1.1	0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 127	19.61754386	12.04	1.06	0	1.06	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 128	19.61754386	12.04	1.06	-1	1.02	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 129	19.61754386	12.04	1.06	1	1.1	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 130	19.61754386	12.04	1.06	0	1.06	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 131	19.61754386	12.04	1.06	-1	1.02	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 132	19.61754386	12.04	1.06	1	1.1	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 133	11.1754386	11.24	1.06	0	1.06	1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 134	11.1754386	11.24	1.06	-1	1.02	1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 135	11.1754386	11.24	1.06	1	1.1	1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 136	11.1754386	11.24	1.06	0	1.06	0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 137	11.1754386	11.24	1.06	-1	1.02	0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 138	11.1754386	11.24	1.06	1	1.1	0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Type	Duration [s]	Impedance Zf/Zs	Appendix Reference
Test 139	11.1754386	11.24	1.06	0	1.06	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 140	11.1754386	11.24	1.06	-1	1.02	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 141	11.1754386	11.24	1.06	1	1.1	-1	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 142	11.1754386	11.24	1.06	0	1.06	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 143	11.1754386	11.24	1.06	-1	1.02	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults
Test 144	11.1754386	11.24	1.06	1	1.1	-0.05	1PHPH	0.43	0	Appendix F CSR Unbalanced Faults

Table 3.7: s5.2.5.5 TOV test suite (PSCAD)

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Duration [s]	Uov [pu]	Appendix Reference
Test 1	19.61754386	12.04	1.06	0	1.06	1	1.2	0.43	Appendix D CSR TOV
Test 2	19.61754386	12.04	1.06	-1	1.02	1	1.2	0.43	Appendix D CSR TOV
Test 3	19.61754386	12.04	1.06	1	1.1	1	1.2	0.43	Appendix D CSR TOV
Test 4	19.61754386	12.04	1.06	0	1.06	0.05	1.2	0.43	Appendix D CSR TOV
Test 5	19.61754386	12.04	1.06	-1	1.02	0.05	1.2	0.43	Appendix D CSR TOV
Test 6	19.61754386	12.04	1.06	1	1.1	0.05	1.2	0.43	Appendix D CSR TOV
Test 7	19.61754386	12.04	1.06	0	1.06	-1	1.2	0.43	Appendix D CSR TOV
Test 8	19.61754386	12.04	1.06	-1	1.02	-1	1.2	0.43	Appendix D CSR TOV
Test 9	19.61754386	12.04	1.06	1	1.1	-1	1.2	0.43	Appendix D CSR TOV
Test 10	19.61754386	12.04	1.06	0	1.06	-0.05	1.2	0.43	Appendix D CSR TOV
Test 11	19.61754386	12.04	1.06	-1	1.02	-0.05	1.2	0.43	Appendix D CSR TOV
Test 12	19.61754386	12.04	1.06	1	1.1	-0.05	1.2	0.43	Appendix D CSR TOV
Test 13	11.1754386	11.24	1.06	0	1.06	1	1.2	0.43	Appendix D CSR TOV
Test 14	11.1754386	11.24	1.06	-1	1.02	1	1.2	0.43	Appendix D CSR TOV
Test 15	11.1754386	11.24	1.06	1	1.1	1	1.2	0.43	Appendix D CSR TOV
Test 16	11.1754386	11.24	1.06	0	1.06	0.05	1.2	0.43	Appendix D CSR TOV
Test 17	11.1754386	11.24	1.06	-1	1.02	0.05	1.2	0.43	Appendix D CSR TOV
Test 18	11.1754386	11.24	1.06	1	1.1	0.05	1.2	0.43	Appendix D CSR TOV
Test 19	11.1754386	11.24	1.06	0	1.06	-1	1.2	0.43	Appendix D CSR TOV
Test 20	11.1754386	11.24	1.06	-1	1.02	-1	1.2	0.43	Appendix D CSR TOV
Test 21	11.1754386	11.24	1.06	1	1.1	-1	1.2	0.43	Appendix D CSR TOV
Test 22	11.1754386	11.24	1.06	0	1.06	-0.05	1.2	0.43	Appendix D CSR TOV
Test 23	11.1754386	11.24	1.06	-1	1.02	-0.05	1.2	0.43	Appendix D CSR TOV
Test 24	11.1754386	11.24	1.06	1	1.1	-0.05	1.2	0.43	Appendix D CSR TOV
Test 25	19.61754386	12.04	1.06	0	1.06	1	1.25	0.43	Appendix D CSR TOV
Test 26	19.61754386	12.04	1.06	-1	1.02	1	1.25	0.43	Appendix D CSR TOV
Test 27	19.61754386	12.04	1.06	1	1.1	1	1.25	0.43	Appendix D CSR TOV
Test 28	19.61754386	12.04	1.06	0	1.06	0.05	1.25	0.43	Appendix D CSR TOV
Test 29	19.61754386	12.04	1.06	-1	1.02	0.05	1.25	0.43	Appendix D CSR TOV
Test 30	19.61754386	12.04	1.06	1	1.1	0.05	1.25	0.43	Appendix D CSR TOV
Test 31	19.61754386	12.04	1.06	0	1.06	-1	1.25	0.43	Appendix D CSR TOV
Test 32	19.61754386	12.04	1.06	-1	1.02	-1	1.25	0.43	Appendix D CSR TOV
Test 33	19.61754386	12.04	1.06	1	1.1	-1	1.25	0.43	Appendix D CSR TOV
Test 34	19.61754386	12.04	1.06	0	1.06	-0.05	1.25	0.43	Appendix D CSR TOV
Test 35	19.61754386	12.04	1.06	-1	1.02	-0.05	1.25	0.43	Appendix D CSR TOV
Test 36	19.61754386	12.04	1.06	1	1.1	-0.05	1.25	0.43	Appendix D CSR TOV
Test 37	11.1754386	11.24	1.06	0	1.06	1	1.25	0.43	Appendix D CSR TOV
Test 38	11.1754386	11.24	1.06	-1	1.02	1	1.25	0.43	Appendix D CSR TOV
Test 39	11.1754386	11.24	1.06	1	1.1	1	1.25	0.43	Appendix D CSR TOV
Test 40	11.1754386	11.24	1.06	0	1.06	0.05	1.25	0.43	Appendix D CSR TOV
Test 41	11.1754386	11.24	1.06	-1	1.02	0.05	1.25	0.43	Appendix D CSR TOV
Test 42	11.1754386	11.24	1.06	1	1.1	0.05	1.25	0.43	Appendix D CSR TOV
Test 43	11.1754386	11.24	1.06	0	1.06	-1	1.25	0.43	Appendix D CSR TOV
Test 44	11.1754386	11.24	1.06	-1	1.02	-1	1.25	0.43	Appendix D CSR TOV
Test 45	11.1754386	11.24	1.06	1	1.1	-1	1.25	0.43	Appendix D CSR TOV
Test 46	11.1754386	11.24	1.06	0	1.06	-0.05	1.25	0.43	Appendix D CSR TOV
Test 47	11.1754386	11.24	1.06	-1	1.02	-0.05	1.25	0.43	Appendix D CSR TOV
Test 48	11.1754386	11.24	1.06	1	1.1	-0.05	1.25	0.43	Appendix D CSR TOV
Test 49	19.61754386	12.04	1.06	0	1.06	1	1.3	0.43	Appendix D CSR TOV
Test 50	19.61754386	12.04	1.06	-1	1.02	1	1.3	0.43	Appendix D CSR TOV
Test 51	19.61754386	12.04	1.06	1	1.1	1	1.3	0.43	Appendix D CSR TOV
Test 52	19.61754386	12.04	1.06	0	1.06	0.05	1.3	0.43	Appendix D CSR TOV
Test 53	19.61754386	12.04	1.06	-1	1.02	0.05	1.3	0.43	Appendix D CSR TOV
Test 54	19.61754386	12.04	1.06	1	1.1	0.05	1.3	0.43	Appendix D CSR TOV
Test 55	19.61754386	12.04	1.06	0	1.06	-1	1.3	0.43	Appendix D CSR TOV
Test 56	19.61754386	12.04	1.06	-1	1.02	-1	1.3	0.43	Appendix D CSR TOV
Test 57	19.61754386	12.04	1.06	1	1.1	-1	1.3	0.43	Appendix D CSR TOV
Test 58	19.61754386	12.04	1.06	0	1.06	-0.05	1.3	0.43	Appendix D CSR TOV
Test 59	19.61754386	12.04	1.06	-1	1.02	-0.05	1.3	0.43	Appendix D CSR TOV
Test 60	19.61754386	12.04	1.06	1	1.1	-0.05	1.3	0.43	Appendix D CSR TOV
Test 61	11.1754386	11.24	1.06	0	1.06	1	1.3	0.43	Appendix D CSR TOV
Test 62	11.1754386	11.24	1.06	-1	1.02	1	1.3	0.43	Appendix D CSR TOV
Test 63	11.1754386	11.24	1.06	1	1.1	1	1.3	0.43	Appendix D CSR TOV
Test 64	11.1754386	11.24	1.06	0	1.06	0.05	1.3	0.43	Appendix D CSR TOV
Test 65	11.1754386	11.24	1.06	-1	1.02	0.05	1.3	0.43	Appendix D CSR TOV
Test 66	11.1754386	11.24	1.06	1	1.1	0.05	1.3	0.43	Appendix D CSR TOV

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Duration [s]	Uov [pu]	Appendix Reference
Test 67	11.1754386	11.24	1.06	0	1.06	-1	1.3	0.43	Appendix D CSR TOV
Test 68	11.1754386	11.24	1.06	-1	1.02	-1	1.3	0.43	Appendix D CSR TOV
Test 69	11.1754386	11.24	1.06	1	1.1	-1	1.3	0.43	Appendix D CSR TOV
Test 70	11.1754386	11.24	1.06	0	1.06	-0.05	1.3	0.43	Appendix D CSR TOV
Test 71	11.1754386	11.24	1.06	-1	1.02	-0.05	1.3	0.43	Appendix D CSR TOV
Test 72	11.1754386	11.24	1.06	1	1.1	-0.05	1.3	0.43	Appendix D CSR TOV
Test 73	19.61754386	12.04	1.06	0	1.06	1	1.35	0.43	Appendix D CSR TOV
Test 74	19.61754386	12.04	1.06	-1	1.02	1	1.35	0.43	Appendix D CSR TOV
Test 75	19.61754386	12.04	1.06	1	1.1	1	1.35	0.43	Appendix D CSR TOV
Test 76	19.61754386	12.04	1.06	0	1.06	0.05	1.35	0.43	Appendix D CSR TOV
Test 77	19.61754386	12.04	1.06	-1	1.02	0.05	1.35	0.43	Appendix D CSR TOV
Test 78	19.61754386	12.04	1.06	1	1.1	0.05	1.35	0.43	Appendix D CSR TOV
Test 79	19.61754386	12.04	1.06	0	1.06	-1	1.35	0.43	Appendix D CSR TOV
Test 80	19.61754386	12.04	1.06	-1	1.02	-1	1.35	0.43	Appendix D CSR TOV
Test 81	19.61754386	12.04	1.06	1	1.1	-1	1.35	0.43	Appendix D CSR TOV
Test 82	19.61754386	12.04	1.06	0	1.06	-0.05	1.35	0.43	Appendix D CSR TOV
Test 83	19.61754386	12.04	1.06	-1	1.02	-0.05	1.35	0.43	Appendix D CSR TOV
Test 84	19.61754386	12.04	1.06	1	1.1	-0.05	1.35	0.43	Appendix D CSR TOV
Test 85	11.1754386	11.24	1.06	0	1.06	1	1.35	0.43	Appendix D CSR TOV
Test 86	11.1754386	11.24	1.06	-1	1.02	1	1.35	0.43	Appendix D CSR TOV
Test 87	11.1754386	11.24	1.06	1	1.1	1	1.35	0.43	Appendix D CSR TOV
Test 88	11.1754386	11.24	1.06	0	1.06	0.05	1.35	0.43	Appendix D CSR TOV
Test 89	11.1754386	11.24	1.06	-1	1.02	0.05	1.35	0.43	Appendix D CSR TOV
Test 90	11.1754386	11.24	1.06	1	1.1	0.05	1.35	0.43	Appendix D CSR TOV
Test 91	11.1754386	11.24	1.06	0	1.06	-1	1.35	0.43	Appendix D CSR TOV
Test 92	11.1754386	11.24	1.06	-1	1.02	-1	1.35	0.43	Appendix D CSR TOV
Test 93	11.1754386	11.24	1.06	1	1.1	-1	1.35	0.43	Appendix D CSR TOV
Test 94	11.1754386	11.24	1.06	0	1.06	-0.05	1.35	0.43	Appendix D CSR TOV
Test 95	11.1754386	11.24	1.06	-1	1.02	-0.05	1.35	0.43	Appendix D CSR TOV
Test 96	11.1754386	11.24	1.06	1	1.1	-0.05	1.35	0.43	Appendix D CSR TOV

The corresponding i_q rise time, settle time and active power recovery times have been prepared below. Analysis was undertaken across all balanced and unbalanced faults in order to determine the positive and negative sequence current rise and settle times, in addition to the generating systems active power recovery time. Please refer to Table 3.8.

All faults were found to be compliant with the requirement for a 40ms i_q rise time. For faults entering FRT, 15 faults have a settling time greater than 70ms, and 198 faults are slightly over 70ms, with the maximum settling time being 132ms.

For a select number of temporary over-voltage and balanced/unbalanced faults, the reactive current settle time was found to exceed 70ms. By examining the reactive current waveform for these tests we see that there is a spike in reactive current approximately 80ms into the disturbance. The calculation for reactive current settle time is sensitive to this behaviour and as a consequence we arrive at a value larger than 70ms. This behaviour has been queried with SMA to which SMA has confirmed that this phenomenon is known and unavoidable. The spike introduced shortly after application of the disturbance is due to the Phase-Locked Loop (PLL) responding to changes in the network voltage phase angle. While PLLs can be tuned, it is SMAs advice that regardless of the parameters selected for the PLL mechanism, signal filtering will always be required and therefore some time delays in obtaining the phase angle of the network during fast transients will always be present. Please refer to SMAs technical memo on this subject [**?**]. This phenomenon will be discussed further with ElectraNet to understand whether it requires an amendment the exiting GPS or whether it is understood to be a modelling artifact.

Table 3.8: s5.2.5.5 Fault test suite analysis (PSCAD)

Name	Iq Settling Time (s)	Iq Rise Time (s)	Ppoc Recovery Time (s)	Enters FRT	Assessment
CSR_5255_CSRBalancedFaults_003_FL5591_X2R12.04_P1_Q1_V1.06	0.07	0.01375	0.13675	TRUE	Compliant
CSR_5255_CSRBalancedFaults_006_FL5591_X2R12.04_P0.05_Q1_V1.06	0.07	0	0.15825	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_003_FL5591_X2R12.04_P1_Q1_V1.06	0.06875	0.01	0.13675	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_018_FL3185_X2R11.24_P0.05_Q1_V1.06	0.06375	0.01125	0.18975	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_111_FL3185_X2R11.24_P1_Q1_V1.06	0.06375	0.01125	0.10025	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_135_FL3185_X2R11.24_P1_Q1_V1.06	0.06375	0.01125	0.14175	TRUE	Compliant
CSR_5255_CSRBalancedFaults_013_FL3185_X2R11.24_P1_Q0_V1.06	0.0625	0.01375	0.14	TRUE	Compliant

Name	Iq Settling Time (s)	Iq Rise Time (s)	Ppoc Recovery Time (s)	Enters FRT	Assessment
CSR_5255_CSRBalancedFaults_001_FL5591_X2R12.04_P1_Q0_V1.06	0.06125	0.01375	0.136	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_006_FL5591_X2R12.04_P0.05_Q1_V1.06	0.06125	0.01125	0.19925	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_102_FL5591_X2R12.04_P0.05_Q1_V1.06	0.06	0.01	0.12725	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_126_FL5591_X2R12.04_P0.05_Q1_V1.06	0.06	0.01	0.108	TRUE	Compliant
CSR_5255_CSRBalancedFaults_027_FL5591_X2R12.04_P1_Q1_V1.06	0.05875	0.015	0.13725	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_042_FL3185_X2R11.24_P0.05_Q1_V1.06	0.05875	0.01	0.2205	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_114_FL3185_X2R11.24_P0.05_Q1_V1.06	0.05875	0.01	0.12975	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_138_FL3185_X2R11.24_P0.05_Q1_V1.06	0.05875	0.01	0.2205	TRUE	Compliant
CSR_5255_CSRBalancedFaults_039_FL3185_X2R11.24_P1_Q1_V1.06	0.0575	0.01375	0.1425	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_054_FL5591_X2R12.04_P0.05_Q1_V1.06	0.0575	0.01125	0.10825	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_078_FL5591_X2R12.04_P0.05_Q1_V1.06	0.0575	0.01125	0.10825	TRUE	Compliant
CSR_5255_CSRBalancedFaults_016_FL3185_X2R11.24_P0.05_Q0_V1.06	0.05625	0.01375	0.15975	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_052_FL5591_X2R12.04_P0.05_Q0_V1.06	0.05625	0.0125	0.1945	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_076_FL5591_X2R12.04_P0.05_Q0_V1.06	0.05625	0.0125	0.1945	TRUE	Compliant
CSR_5255_CSRBalancedFaults_042_FL3185_X2R11.24_P0.05_Q1_V1.06	0.05625	0.01125	0.167	TRUE	Compliant
CSR_5255_CSRBalancedFaults_004_FL5591_X2R12.04_P0.05_Q0_V1.06	0.055	0.0125	0.156	TRUE	Compliant
CSR_5255_CSRBalancedFaults_030_FL5591_X2R12.04_P0.05_Q1_V1.06	0.055	0.01125	0.16575	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_051_FL5591_X2R12.04_P1_Q1_V1.06	0.05375	0.0125	0.13725	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_075_FL5591_X2R12.04_P1_Q1_V1.06	0.05375	0.0125	0.13725	TRUE	Compliant
CSR_5255_CSRBalancedFaults_002_FL5591_X2R12.04_P1_Q-1_V1.06	0.0525	0.01375	0.1355	TRUE	Compliant
CSR_5255_CSRBalancedFaults_014_FL3185_X2R11.24_P1_Q-1_V1.06	0.0525	0.01375	0.1395	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_013_FL3185_X2R11.24_P1_Q0_V1.06	0.05125	0.0125	0.14125	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_112_FL3185_X2R11.24_P0.05_Q0_V1.06	0.05125	0.01125	0.12225	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_124_FL5591_X2R12.04_P0.05_Q0_V1.06	0.05125	0.01125	0.18525	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_136_FL3185_X2R11.24_P0.05_Q0_V1.06	0.05125	0.01125	0.1875	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_030_FL5591_X2R12.04_P0.05_Q1_V1.06	0.05125	0.01	0.1165	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_049_FL5591_X2R12.04_P1_Q0_V1.06	0.05	0.01375	0.137	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_073_FL5591_X2R12.04_P1_Q0_V1.06	0.05	0.01375	0.137	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_109_FL3185_X2R11.24_P1_Q0_V1.06	0.05	0.01375	0.10125	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_133_FL3185_X2R11.24_P1_Q0_V1.06	0.05	0.01375	0.141	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_001_FL5591_X2R12.04_P1_Q0_V1.06	0.05	0.0125	0.13625	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_016_FL3185_X2R11.24_P0.05_Q0_V1.06	0.05	0.0125	0.1775	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_101_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.05	0.0125	0.1105	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_113_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.05	0.0125	0.11375	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_121_FL5591_X2R12.04_P1_Q0_V1.06	0.05	0.0125	0.13575	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_125_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.05	0.0125	0.16425	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_137_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.05	0.0125	0.171	TRUE	Compliant
CSR_5255_CSRBalancedFaults_075_FL5591_X2R12.04_P1_Q1_V1.06	0.04875	0.01625	0.1345	TRUE	Compliant
CSR_5255_CSRBalancedFaults_005_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.04875	0.01375	0.15525	TRUE	Compliant
CSR_5255_CSRBalancedFaults_017_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.04875	0.01375	0.15825	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_004_FL5591_X2R12.04_P0.05_Q0_V1.06	0.04875	0.01125	0.17525	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_028_FL5591_X2R12.04_P0.05_Q0_V1.06	0.04875	0.01125	0.10825	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_040_FL3185_X2R11.24_P0.05_Q0_V1.06	0.04875	0.01125	0.19775	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_122_FL5591_X2R12.04_P1_Q-1_V1.06	0.0475	0.015	0.1355	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_039_FL3185_X2R11.24_P1_Q1_V1.06	0.0475	0.0125	0.1415	TRUE	Compliant
CSR_5255_CSRBalancedFaults_054_FL5591_X2R12.04_P0.05_Q1_V1.06	0.0475	0.01125	0.201	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_027_FL5591_X2R12.04_P1_Q1_V1.06	0.0475	0.01	0.09125	TRUE	Compliant
CSR_5255_CSRBalancedFaults_051_FL5591_X2R12.04_P1_Q1_V1.06	0.04625	0.0125	0.13725	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_005_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.04625	0.0125	0.16325	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_017_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.04625	0.0125	0.17175	TRUE	Compliant
CSR_5255_CSRBalancedFaults_066_FL3185_X2R11.24_P0.05_Q1_V1.06	0.04625	0.01125	0.19025	TRUE	Compliant
CSR_5255_CSRBalancedFaults_028_FL5591_X2R12.04_P0.05_Q0_V1.06	0.045	0.0125	0.1615	TRUE	Compliant
CSR_5255_CSRBalancedFaults_040_FL3185_X2R11.24_P0.05_Q0_V1.06	0.045	0.0125	0.1645	TRUE	Compliant
CSR_5255_CSRBalancedFaults_052_FL5591_X2R12.04_P0.05_Q0_V1.06	0.0425	0.01375	0.21325	TRUE	Compliant
CSR_5255_CSRBalancedFaults_064_FL3185_X2R11.24_P0.05_Q0_V1.06	0.04125	0.0125	0.201	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_029_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.04	0.0125	0.10625	TRUE	Compliant
CSR_5255_CSRBalancedFaults_029_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.03875	0.01375	0.1585	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_025_FL5591_X2R12.04_P1_Q0_V1.06	0.03875	0.01375	0.09425	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_053_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.03875	0.01375	0.093	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_077_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.03875	0.01375	0.093	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_041_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.03875	0.0125	0.19175	TRUE	Compliant
CSR_5255_CSRBalancedFaults_041_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.0375	0.01375	0.1615	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_002_FL5591_X2R12.04_P1_Q-1_V1.06	0.0375	0.01375	0.136	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_037_FL3185_X2R11.24_P1_Q0_V1.06	0.0375	0.01375	0.1415	TRUE	Compliant
CSR_5255_CSRBalancedFaults_050_FL5591_X2R12.04_P1_Q-1_V1.06	0.03375	0.01625	0.1355	TRUE	Compliant
CSR_5255_CSRBalancedFaults_062_FL3185_X2R11.24_P1_Q-1_V1.06	0.03375	0.01625	0.13975	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_050_FL5591_X2R12.04_P1_Q-1_V1.06	0.03375	0.01375	0.1365	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_074_FL5591_X2R12.04_P1_Q-1_V1.06	0.03375	0.01375	0.1365	TRUE	Compliant
CSR_5255_CSRBalancedFaults_038_FL3185_X2R11.24_P1_Q-1_V1.06	0.0325	0.015	0.141	TRUE	Compliant
CSR_5255_CSRBalancedFaults_049_FL5591_X2R12.04_P1_Q0_V1.06	0.0325	0.015	0.1365	TRUE	Compliant
CSR_5255_CSRBalancedFaults_087_FL3185_X2R11.24_P1_Q1_V1.06	0.0325	0.015	0.1335	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_038_FL3185_X2R11.24_P1_Q-1_V1.06	0.0325	0.015	0.14	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_097_FL5591_X2R12.04_P1_Q0_V1.06	0.0325	0.015	0.13675	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_110_FL3185_X2R11.24_P1_Q-1_V1.06	0.0325	0.015	0.1005	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_134_FL3185_X2R11.24_P1_Q-1_V1.06	0.0325	0.015	0.14	TRUE	Compliant
CSR_5255_CSRBalancedFaults_025_FL5591_X2R12.04_P1_Q0_V1.06	0.03125	0.01375	0.137	TRUE	Compliant
CSR_5255_CSRBalancedFaults_026_FL5591_X2R12.04_P1_Q-1_V1.06	0.03125	0.01375	0.13625	TRUE	Compliant
CSR_5255_CSRBalancedFaults_037_FL3185_X2R11.24_P1_Q0_V1.06	0.03125	0.01375	0.142	TRUE	Compliant
CSR_5255_CSRBalancedFaults_053_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.03125	0.01375	0.09775	TRUE	Compliant
CSR_5255_CSRBalancedFaults_061_FL3185_X2R11.24_P1_Q0_V1.06	0.03125	0.01375	0.1415	TRUE	Compliant
CSR_5255_CSRBalancedFaults_063_FL3185_X2R11.24_P1_Q1_V1.06	0.03125	0.01375	0.14275	TRUE	Compliant
CSR_5255_CSRBalancedFaults_065_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.03125	0.01375	0.196	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_014_FL3185_X2R11.24_P1_Q-1_V1.06	0.03125	0.01375	0.1405	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_026_FL5591_X2R12.04_P1_Q-1_V1.06	0.03125	0.01375	0.09325	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_099_FL5591_X2R12.04_P1_Q1_V1.06	0.03125	0.0125	0.1355	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_103_FL5591_X2R12.04_P-1_Q0_V1.06	0.07	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_127_FL5591_X2R12.04_P-1_Q0_V1.06	0.07	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_033_FL5591_X2R12.04_P-1_Q1_V1.06	0.07	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_007_FL5591_X2R12.04_P-1_Q0_V1.06	0.06875	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_019_FL3185_X2R11.24_P-1_Q0_V1.06	0.06875	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_105_FL5591_X2R12.04_P-1_Q1_V1.06	0.06875	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_129_FL5591_X2R12.04_P-1_Q1_V1.06	0.06875	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_116_FL3185_X2R11.24_P-1_Q-1_V1.06	0.06625	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_069_FL3185_X2R11.24_P-1_Q1_V1.06	0.06625	0.005	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_140_FL3185_X2R11.24_P-1_Q-1_V1.06	0.065	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_019_FL3185_X2R11.24_P-1_Q0_V1.06	0.0625	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_012_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.0625	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_074_FL5591_X2R12.04_P1_Q-1_V1.06	0.0625	0.00875	0.02	TRUE	Compliant

Name	Iq Settling Time (s)	Iq Rise Time (s)	Ppoc Recovery Time (s)	Enters FRT	Assessment
CSR_5255_CSRBalancedFaults_086_FL3185_X2R11.24_P1_Q-1_V1.06	0.06125	0.00875	0.01975	TRUE	Compliant
CSR_5255_CSRBalancedFaults_007_FL5591_X2R12.04_P-1_Q0_V1.06	0.06	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_009_FL5591_X2R12.04_P-1_Q1_V1.06	0.06	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_021_FL3185_X2R11.24_P-1_Q1_V1.06	0.06	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_108_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.06	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_120_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.06	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_132_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.06	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_144_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.06	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_036_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.05875	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_048_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.05875	0.01	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_080_FL5591_X2R12.04_P-1_Q-1_V1.06	0.05875	0.00875	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_092_FL3185_X2R11.24_P-1_Q-1_V1.06	0.05875	0.00875	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_036_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.0575	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_072_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.0575	0.01125	0.00075	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_084_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.0575	0.01125	0.00125	TRUE	Compliant
CSR_5255_CSRBalancedFaults_022_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.05625	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_070_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.05625	0.0125	0.0005	TRUE	Compliant
CSR_5255_CSRBalancedFaults_048_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.05625	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_010_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.055	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_082_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.055	0.0125	0.00125	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_081_FL5591_X2R12.04_P-1_Q1_V1.06	0.0525	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_020_FL3185_X2R11.24_P-1_Q-1_V1.06	0.05125	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_079_FL5591_X2R12.04_P-1_Q0_V1.06	0.05125	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_033_FL5591_X2R12.04_P-1_Q1_V1.06	0.05125	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_106_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.05125	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_118_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.05125	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_130_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.05125	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_142_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.05125	0.01	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_008_FL5591_X2R12.04_P-1_Q-1_V1.06	0.05	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_107_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.05	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_131_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.05	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_072_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.05	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_045_FL3185_X2R11.24_P-1_Q1_V1.06	0.05	0.01	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_011_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.04875	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_023_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.04875	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_119_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.04875	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_143_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.04875	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_010_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.04875	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_022_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.04875	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_034_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.04875	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_104_FL5591_X2R12.04_P-1_Q-1_V1.06	0.0475	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_128_FL5591_X2R12.04_P-1_Q-1_V1.06	0.0475	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_046_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.0475	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_060_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.0475	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_069_FL3185_X2R11.24_P-1_Q1_V1.06	0.0475	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_046_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.0475	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_057_FL5591_X2R12.04_P-1_Q1_V1.06	0.0475	0.01	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_034_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.04625	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_011_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.04625	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_023_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.04625	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_031_FL5591_X2R12.04_P-1_Q0_V1.06	0.04625	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_043_FL3185_X2R11.24_P-1_Q0_V1.06	0.04625	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_081_FL5591_X2R12.04_P-1_Q1_V1.06	0.045	0.01625	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_093_FL3185_X2R11.24_P-1_Q1_V1.06	0.045	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_020_FL3185_X2R11.24_P-1_Q-1_V1.06	0.045	0.01125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_031_FL5591_X2R12.04_P-1_Q0_V1.06	0.045	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_043_FL3185_X2R11.24_P-1_Q0_V1.06	0.04375	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_032_FL5591_X2R12.04_P-1_Q-1_V1.06	0.0425	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_055_FL5591_X2R12.04_P-1_Q0_V1.06	0.0425	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_008_FL5591_X2R12.04_P-1_Q-1_V1.06	0.0425	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_091_FL3185_X2R11.24_P-1_Q0_V1.06	0.0425	0.00875	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_047_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.04125	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_070_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.04125	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_076_FL5591_X2R12.04_P0.05_Q0_V1.06	0.04125	0.01	0.036	TRUE	Compliant
CSR_5255_CSRBalancedFaults_077_FL5591_X2R12.04_P0.05_Q-1_V1.06	0.04125	0.01	0.03575	TRUE	Compliant
CSR_5255_CSRBalancedFaults_082_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.04125	0.01	0.04275	TRUE	Compliant
CSR_5255_CSRBalancedFaults_083_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.04125	0.01	0.041	TRUE	Compliant
CSR_5255_CSRBalancedFaults_089_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.04125	0.01	0.03725	TRUE	Compliant
CSR_5255_CSRBalancedFaults_095_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.04125	0.01	0.04775	TRUE	Compliant
CSR_5255_CSRBalancedFaults_067_FL3185_X2R11.24_P-1_Q0_V1.06	0.04	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_044_FL3185_X2R11.24_P-1_Q-1_V1.06	0.04	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_058_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.04	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_080_FL5591_X2R12.04_P-1_Q-1_V1.06	0.04	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_032_FL5591_X2R12.04_P-1_Q-1_V1.06	0.04	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_088_FL3185_X2R11.24_P0.05_Q0_V1.06	0.04	0.01	0.03775	TRUE	Compliant
CSR_5255_CSRBalancedFaults_090_FL3185_X2R11.24_P0.05_Q1_V1.06	0.04	0.01	0.0385	TRUE	Compliant
CSR_5255_CSRBalancedFaults_094_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.04	0.01	0.05	TRUE	Compliant
CSR_5255_CSRBalancedFaults_096_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.04	0.01	0.05175	TRUE	Compliant
CSR_5255_CSRBalancedFaults_035_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.03875	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_071_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.03875	0.01375	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_083_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.03875	0.01375	0.001	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_035_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.03875	0.0125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_079_FL5591_X2R12.04_P-1_Q0_V1.06	0.03875	0.00875	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_047_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.0375	0.0125	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_044_FL3185_X2R11.24_P-1_Q-1_V1.06	0.0375	0.01125	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_073_FL5591_X2R12.04_P1_Q0_V1.06	0.0375	0.01	0.025	TRUE	Compliant
CSR_5255_CSRBalancedFaults_085_FL3185_X2R11.24_P1_Q0_V1.06	0.0375	0.00875	0.02175	TRUE	Compliant
CSR_5255_CSRBalancedFaults_068_FL3185_X2R11.24_P-1_Q-1_V1.06	0.0325	0.015	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_056_FL5591_X2R12.04_P-1_Q-1_V1.06	0.03125	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_059_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.03125	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_071_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.03125	0.01375	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_078_FL5591_X2R12.04_P0.05_Q1_V1.06	0.0275	0.01	0	TRUE	Compliant
CSR_5255_CSRBalancedFaults_084_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.0275	0.01	0	TRUE	Compliant
CSR_5255_CSRUnbalancedFaults_055_FL5591_X2R12.04_P-1_Q0_V1.06	0.2275	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_056_FL5591_X2R12.04_P-1_Q-1_V1.06	0.12125	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_057_FL5591_X2R12.04_P-1_Q1_V1.06	0.3875	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_058_FL5591_X2R12.04_P-0.05_Q0_V1.06	0.225	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_059_FL5591_X2R12.04_P-0.05_Q-1_V1.06	0.25375	0.00375	0	FALSE	N/A

Name	Iq Settling Time (s)	Iq Rise Time (s)	Ppoc Recovery Time (s)	Enters FRT	Assessment
CSR_5255_CSRUnbalancedFaults_060_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.38125	0.0025	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_061_FL3185_X2R11.24_P1_Q0_V1.06	0.2175	0.00875	0.03325	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_062_FL3185_X2R11.24_P1_Q-1_V1.06	0.1775	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_063_FL3185_X2R11.24_P1_Q1_V1.06	0.385	0.00875	0.141	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_064_FL3185_X2R11.24_P0.05_Q0_V1.06	0.30125	0.0025	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_065_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.22375	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_066_FL3185_X2R11.24_P0.05_Q1_V1.06	0.38	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_067_FL3185_X2R11.24_P-1_Q0_V1.06	0.2225	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_068_FL3185_X2R11.24_P-1_Q-1_V1.06	0.22875	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_085_FL3185_X2R11.24_P1_Q0_V1.06	0.2175	0.00875	0.03325	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_086_FL3185_X2R11.24_P1_Q-1_V1.06	0.1775	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_087_FL3185_X2R11.24_P1_Q1_V1.06	0.385	0.00875	0.141	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_088_FL3185_X2R11.24_P0.05_Q0_V1.06	0.30125	0.0025	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_089_FL3185_X2R11.24_P0.05_Q-1_V1.06	0.22375	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_090_FL3185_X2R11.24_P0.05_Q1_V1.06	0.38	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_091_FL3185_X2R11.24_P-1_Q0_V1.06	0.2225	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_092_FL3185_X2R11.24_P-1_Q-1_V1.06	0.22875	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_093_FL3185_X2R11.24_P-1_Q1_V1.06	0.38625	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_094_FL3185_X2R11.24_P-0.05_Q0_V1.06	0.30125	0.0025	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_095_FL3185_X2R11.24_P-0.05_Q-1_V1.06	0.22375	0.00375	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_096_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.38	0.0025	0	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_098_FL5591_X2R12.04_P1_Q-1_V1.06	0.1375	0.01375	0.13425	FALSE	N/A
CSR_5255_CSRUnbalancedFaults_123_FL5591_X2R12.04_P1_Q1_V1.06	0.10875	0.0125	0.13625	TRUE	See Discussion
CSR_5255_CSRBalancedFaults_018_FL3185_X2R11.24_P0.05_Q1_V1.06	0.10375	0.0125	0.162	TRUE	See Discussion
CSR_5255_CSRBalancedFaults_015_FL3185_X2R11.24_P1_Q1_V1.06	0.0725	0.01375	0.1415	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_015_FL3185_X2R11.24_P1_Q1_V1.06	0.07125	0.0125	0.142	TRUE	See Discussion
CSR_5255_CSRBalancedFaults_021_FL3185_X2R11.24_P-1_Q1_V1.06	0.1325	0	0	TRUE	See Discussion
CSR_5255_CSRBalancedFaults_009_FL5591_X2R12.04_P-1_Q1_V1.06	0.11625	0	0	TRUE	See Discussion
CSR_5255_CSRBalancedFaults_024_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.10875	0	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_024_FL3185_X2R11.24_P-0.05_Q1_V1.06	0.1	0.01125	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_100_FL5591_X2R12.04_P0.05_Q0_V1.06	0.0775	0.01125	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_115_FL3185_X2R11.24_P-1_Q0_V1.06	0.07125	0.01125	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_139_FL3185_X2R11.24_P-1_Q0_V1.06	0.07125	0.01125	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_117_FL3185_X2R11.24_P-1_Q1_V1.06	0.07125	0.01	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_141_FL3185_X2R11.24_P-1_Q1_V1.06	0.07125	0.01	0	TRUE	See Discussion
CSR_5255_CSRUnbalancedFaults_045_FL3185_X2R11.24_P-1_Q1_V1.06	0.07125	0.00875	0	TRUE	See Discussion
CSR_5255_CSRBalancedFaults_012_FL5591_X2R12.04_P-0.05_Q1_V1.06	0.07125	0	0	TRUE	See Discussion

Multiple fault disturbances

Compliance to the MFRT requirements of this clause have been demonstrated in PSCAD SMIB. The test suite defined in Section 3.2.6 of the PSCAD Dynamic Model Acceptance Test Guideline (DMAT) [**?**] was performed and supporting results have been provided with the pscad dmat report [**?**]. All tests demonstrate that HEYWOOD BESS was capable of riding through all applied successive faults. Additionally, please refer to the provided letter of NER compliance [**?**] provided by SMA which confirms the ride through capability of the inverters for successive faults.

WAN studies

The list of faults evaluated in WAN studies was limited to those studied as part of R0 - as directed by ElectraNet. The 3phg faults,2phg faults with circuit breaker failure (CBF) timings (as per NER Table S5.1a.2), and 1phg faults with auto-reclose to nearby fault contingencies considered for the wide area network assessment are summarised in the table below. 3.9. Please note that for contingencies 37–43, which are trip tests, faults are applied to trip transformers or generators in order to assess their impact on the system.

Table 3.9: Wide area studies test suite (PSSE) - Line Contingencies

Test No	From	To	Fault at	Fault Type	Duration [s]
1	HEYWOOD275	SOUTHEAST275	HEYWOOD275	3PHG	0.1
2	HEYWOOD500	TARRONE500	HEYWOOD500	3PHG	0.08
3	HEYWOOD500	MORTLAKE500	HEYWOOD500	3PHG	0.08
4	SOUTHEAST275	TAILEMBEND275	SOUTHEAST275	3PHG	0.1
5	HAZELWOOD500	SOUTHMORANG500	HAZELWOOD500	3PHG	0.08
6	CRESSY500	MOORABOOL500	CRESSY500	3PHG	0.08
7	TARRONE500	MORTLAKE500	TARRONE500	3PHG	0.08
8	MORTLAKE500	CRESSY500	MORTLAKE500	3PHG	0.08
9	MORTLAKE500	HAUNTED500	MORTLAKE500	3PHG	0.08
10	HAUNTED500	CRESSY500	HAUNTED500	3PHG	0.08
11	MOORABOOL220	BALLARAT220	MOORABOOL220	3PHG	0.12
12	MOORABOOL220	TERANG220	MOORABOOL220	3PHG	0.12
13	HEYWOOD275	SOUTHEAST275	HEYWOOD275	2PHG	0.25
14	HEYWOOD500	TARRONE500	HEYWOOD275	2PHG	0.175

Test No	From	To	Fault at	Fault Type	Duration [s]
15	HEYWOOD500	MORTLAKE500	HEYWOOD275	2PHG	0.175
16	SOUTHEAST275	TAILEMBEND275	SOUTHEAST275	2PHG	0.25
17	HAZELWOOD500	SOUTHMORANG500	HAZELWOOD500	2PHG	0.175
18	CRESSY500	MOORABOOL500	CRESSY500	2PHG	0.175
19	TARRONE500	MORTLAKE500	TARRONE500	2PHG	0.175
20	MORTLAKE500	CRESSY500	MORTLAKE500	2PHG	0.175
21	MORTLAKE500	HAUNTED500	MORTLAKE500	2PHG	0.175
22	HAUNTED500	CRESSY500	HAUNTED500	2PHG	0.175
23	MOORABOOL220	BALLARAT220	MOORABOOL220	2PHG	0.43
24	MOORABOOL220	TERANG220	MOORABOOL220	2PHG	0.43
25	HEYWOOD275	SOUTHEAST275	HEYWOOD275	1PHG	0.1
26	HEYWOOD500	TARRONE500	HEYWOOD275	1PHG	0.08
27	HEYWOOD500	MORTLAKE500	HEYWOOD275	1PHG	0.08
28	SOUTHEAST275	TAILEMBEND275	SOUTHEAST275	1PHG	0.1
29	HAZELWOOD500	SOUTHMORANG500	HAZELWOOD500	1PHG	0.08
30	CRESSY500	MOORABOOL500	CRESSY500	1PHG	0.08
31	TARRONE500	MORTLAKE500	TARRONE500	1PHG	0.08
32	MORTLAKE500	CRESSY500	MORTLAKE500	1PHG	0.08
33	MORTLAKE500	HAUNTED500	MORTLAKE500	1PHG	0.08
34	HAUNTED500	CRESSY500	HAUNTED500	1PHG	0.08
35	MOORABOOL220	BALLARAT220	MOORABOOL220	1PHG	0.12
36	MOORABOOL220	TERANG220	MOORABOOL220	1PHG	0.12

The trip contingencies are summarised in Tables 3.10.

Table 3.10: Wide area studies test suite (PSSE) - Other Contingencies

Case	Trip contingency
1	Trip HEYWOOD275M3DUM_HEYWOOD500 TX
2	Trip HEYWOOD275M1DUM_HEYWOOD500 TX
3	TRIP SWITCHED_SHUNT 'HEYWOOD275CAP
4	TRIP MACHINE SOUTHEASTSVC
5	"TRIP MACHINE GOLDENPLAINSWF1
6	TRIP LOAD APDPOTLINE
7	TRIP MACHINE LOYYANGUNIT1

As these faults were tested on the wide area network, they were generally less severe than the most severe faults tested in the SMIB environment, which left no retained voltage at the point of connection. These faults have been analysed to determine the stability of the model, and the network, including the ability to recover to a stable operating point following the contingency.

The integrated resource system performed well in all disturbances tested, with the network voltage control not being negatively impacted by the presence of Heywood BESS. The results for each case have been prepared in Appendices G through J.

3.6 [S5.2.5.6] Quality of Electricity Generated and Continuous Uninterrupted Operation

3.6.1 Negotiated Access Standard

The integrated resource system and each of its operating production units and reactive plant, will not disconnect from the power system for voltage fluctuation, harmonic voltage distortion and voltage unbalance at the Connection Point within the levels specified:

1. For voltage fluctuations at the Connection Point, in the "compatibility levels" set out in Table 1 of AS/NZS 61000.3.7:2001.
2. For harmonic voltage distortion at the Connection Point, in the "compatibility levels" defined in Table 1 of AS/NZS 61000.3.6:2001.

3. For a negative sequence voltage at the Connection Point, in Table S5.1a.1 of the NER and shown in Table 2.8:

Nominal Supply Voltage (kV)	No Contingency Event	Credible Contingency Event		General
	30-Minute Average	30-Minute Average	10-Minute Average	1-Minute Average
> 100	0.5%	0.7%	1.0%	2.0%

Table 2.8: Negative Sequence Voltages

3.6.2 Assessment

S5.2.5.6 is not assessed through simulation software. Compliance to this clause is confirmed through a letter supplied by the inverter OEM. SMA have prepared a NER compliance report which covers the ability of their inverters to meet the automatic access standard for S5.2.5.6. [**?**]

3.7 [S5.2.5.7] Partial Load Rejection

3.7.1 Automatic Access Standard

For the purposes of this performance standard:

- **Minimum generation** means the minimum sent-out generation for continuous stable operation, $P_{\text{MIN}} = 0$ MW.

The integrated resource system is capable of continuous uninterrupted operation during and following a power system load reduction of 30% from its pre-disturbance level or equivalent impact from separation of part of the power system in less than 10 s, provided that the loading level remains above P_{MIN}.

3.7.2 Assessment Methodology

To assess the integrated resource system's performance under a Partial Load Rejection scenario, a resistive load was applied at the point of connection (POC). The performance of the plant was monitored before and after this disturbance to identify any loss of synchronization or voltage stability.

3.7.3 Results

This clause was assessed using resistive load applying at the connection point, shown in Table 3.11.

Table 3.11: Partial Load Rejection Test Summary

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Load Rejection [MW]	Appendix Reference
Test 1 p1	19.61754386	12.04	1.06	0.3	1.072	1	-85.5	Appendix G PLR
Test 1 p2	11.1754386	11.24	1.06	0.3	1.072	1	-85.5	Appendix G PLR
Test 2 p1	19.61754386	12.04	1.06	-0.3	1.048	1	-85.5	Appendix G PLR
Test 2 p2	11.1754386	11.24	1.06	-0.3	1.048	1	-85.5	Appendix G PLR

The integrated resource system performed well in all disturbances tested, with the network voltage control not being negatively impacted by the partial load rejection. The results have been prepared in Appendices **??**.

3.8 [S5.2.5.8] Protection of Generating Systems from Power System Disturbances

3.8.1 Minimum Access Standard

(a) Subject to paragraphs (b) and (e) where the integrated resource system or any of its production units that is required by the NSP, Generator or Integrated Resource Provider to be automatically disconnected from the power system in response to abnormal conditions arising from the power system, the relevant protection system or control system does not disconnect the integrated resource system for:
  (i) conditions for which it must remain in continuous uninterrupted operation; or
  (ii) conditions it must withstand under the NER.

(b) The integrated resource system has facilities to automatically and rapidly reduce its generation:
  (i) in proportion to the difference between the frequency at the Connection Point and a level nominated by AEMO (not less than the upper limit of the operational frequency tolerance band) such that the generation is reduced, by at least half, within 3 s of the frequency reaching the upper limit of the extreme frequency excursion tolerance limits.

(c) The integrated resource system must be automatically disconnected by a local or remote control scheme whenever the part of the network to which it is connected has been disconnected from the national grid and has formed an island that supplies load.

(d) The conditions for which the integrated resource system must trip and must not trip are: TBC.

(e) Notwithstanding the performance standards under clauses S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.6 and S5.2.5.7 of the NER the integrated resource system may be automatically disconnected from the power system under any of the following conditions s:
  (1) in accordance with the ancillary services agreement dated [insert date] between the Integrated Resource Provider and AEMO for the provision o
  (2) where the integrated resource system is automatically disconnected under paragraphs (a), (b), or the performance standard under clause S5.2.5.9 of the NER;
  (3) where the integrated resource system is automatically disconnected under the performance standard under clause S5.2.5.10 of the NER; or
  (4) in accordance with an agreement between the Integrated Resource Provider and the NSP (including an agreement in relation to an emergency control scheme under clause S5.1.8 of the NER) to provide a service that AEMO agrees is necessary to maintain or restore power system security in the event of a specified contingency event.
  (5) Where the integrated resource system is automatically disconnected from the power system via an emergency frequency control scheme (EFCS) in accordance with an EFCS settings schedule as maintained by AEMO and notified to the Integrated Resource Provider from time to time.

3.8.2 Assessment Methodology

Active Power Reduction by Half [S5.2.5.8(b)]

This clause was assessed using the test suite from section 3.11 [S5.2.5.11] where a grid frequency disturbance was applied and the change in active power output of the generating system was monitored. As demonstrated in 3.11, a frequency droop percentage of 5% has been configured for Heywood BESS. As a result, depending on the pre-disturbance active power output of the generating system, the reduction in active power when exposed to a system frequency $\geq$ 51.0 Hz may not always be $\leq$ 0.5 pu.

As such compliance to this clause will be achieve through the implementation of a SCADA solution. This frequency control scheme will become active when the generating system experiences a frequency above 51 Hz for an extended period of time. Through interfacing with the Power Plant Manager, this scheme will ensure that the generating system's active power output is reduced by half within 3 seconds. This proposed SCADA solution will not be assessed as part of this report.

Frequency and Voltage Protection [S5.2.5.8(d)]

The generating systems ability to trip off for over-voltage voltage and over-frequency disturbances has been assessed for this clause. Frequency disturbances were applied in accordance with the methodology discussed in 3.11.2. Voltage disturbances were applied in accordance with the methodology described in 3.4.2. In order to test the response of the inverter protection, the impedances between the inverter terminals and the point of connection were reduced significantly to ensure that the voltage seen by the inverter approximates that of the point of connection.

3.8.3 Results

Active Power Reduction by Half [S5.2.5.8(b)]

With a frequency droop of 5% a reduction in active power of at least 50% in active power is not observed when in certain operating conditions. For evidence of this response, please refer to section 3.11 [S5.2.5.11] Frequency Control. A full set of results is available in Appendix N.

Frequency and Voltage Protection [S5.2.5.8(d)]

A summary of whether the generating system successfully tripped when exposed to voltage and frequency disturbances has been summarised in Tables **??** and **??**. The results for this section have been provided in Appendix L and M.

3.9 [S5.2.5.9] Protection Systems that Impact on Power System Security

3.9.1 Automatic Access Standard

(a) The integrated resource system has primary protection systems to disconnect from the power system any faulted element within the integrated resource system and in the protection zones that include the Connection Point, within the fault clearance times specified in Table 2.9
(b) Each primary protection system has sufficient redundancy to ensure that a faulted element within its protection zone is disconnected from the power system within the applicable fault clearance time with any single protection element (including any communications facility on which that protection system depends) out of service.

(c) Breaker fail protection systems are provided to clear faults that are not cleared by the circuit breakers controlled by the primary protection system, within the fault clearance times in Table 2.9:

Voltage Level	Primary Protection Systems	Breaker Fail Protection Systems
275 kV	100 ms	250 ms

Table 2.9: Protection and Breaker Fail System Fault Clearance Times

(d) The protection system design will be coordinated with other protection systems, avoid consequential disconnection of other Network Users' facilities and take into account the NSP's existing obligations under their connection agreements with other Network Users.

3.9.2 Assessment

Note that compliance with this clause is subject to detailed design, which is not available at the R0 stage.

3.10 [S5.2.5.10] Protection to Trip Plant for Unstable Operation

3.10.1 Automatic Access Standard

(a) The generating system will not cause a voltage disturbance at the connection point due to sustained unstable behaviour of more than the maximum level specified in Table 7 or the compatibility levels in Table 2 of the Australian Standard AS/NZS 61000.3.7:2001.
(b) The generating system has a quality of supply monitoring unit connected via the facility's SCADA system, and via an established operating protocol, able to provide an alarm to AusNet and AEMO if the voltage flicker levels exceed the maximum level specified in Table 7 of Australian Standard AS/NZS 61000.3.7:2001.

3.10.2 Assessment

Note that compliance with this clause is subject to detailed design, which is not available at the R0 stage.

3.11 [S5.2.5.11] Frequency Control

3.11.1 Automatic Access Standard

For the purposes of this performance standard:
- *'Maximum operating level'* = 285 MW.
- *'Minimum operating level'* = -285 MW.
- *'Droop'* means, in relation to frequency response mode, the percentage change in power system frequency as measured at the Connection Point, divided by the percentage change

in power transfer of the integrated resource system, expressed as a percentage of the maximum operating level of the integrated resource system. Droop must be measured at frequencies that are outside the deadband and within the limits of power transfer.

- Power system frequency is measured at the Connection Point.

(1) an integrated resource system, to the extent it comprises production units, must be capable of operating in frequency response mode such that it automatically provides a proportional:
  (i) decrease in power transfer to the power system, with a continuous shift from one to the other mode, in response to a rise in the frequency of the power system as measured at the connection point accompanied by a smooth change in bidirectional unit operating mode between production and consumption; and
  (ii) 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 accompanied by a smooth change in bidirectional unit operating mode between production and consumption,

sufficiently rapidly and sustained for a sufficient period for the Integrated Resource Provider (as relevant) to be in a position to offer measurable amounts of all market ancillary services for the provision of power system frequency control.

(2) Nothing in paragraph (2) or (3) requires the integrated resource system to operate below its minimum operating level in response to a rise in power system frequency, or above its maximum operating level in response to a fall in power system frequency.

(3) The change in power transfer to the power system will occur with no delay beyond that required for stable operation, or inherent in the plant controls, once power system frequency leaves a deadband around 50 Hz.

(4) The integrated resource system's:
  (i) deadband can be set within the range of 0 to ± 1.0 Hz ; and
  (ii) droop can be set within the range of 2% to 10%, droop has been set to 5%.

(5) Each control system used to satisfy this performance standard is adequately damped.

(6) The amount of relevant market ancillary service for which the plant is registered will not exceed the amount that would be consistent with this performance standard.

3.11.2 Assessment Methodology

To test the frequency droop controller, F_{grid} is driven with a time-series signal $F_{\text{grid}_1}, F_{\text{grid}_2}, F_{\text{grid}_3}, \ldots, F_{\text{grid}_n}$, as shown in Figure 3.11. The active power through the connection point is expected to change by an amount that is proportional to the change in frequency, subject to active power limits and available input power[5], in line with the agreed droop gain.

[5] Note that while not addressed in this document, the Dynamic Model Acceptance Test (DMAT) reports show the behaviour of the frequency controller when limited by available input power.

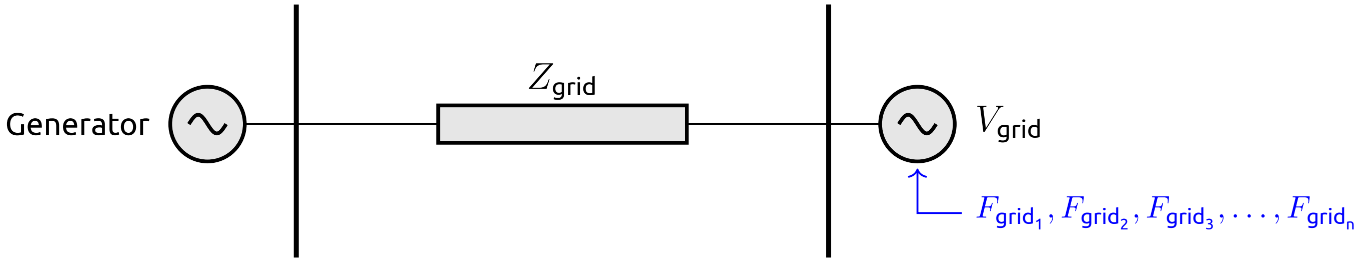

Figure 3.11: Frequency droop controller testing methodology

All assessments for this clause have been performed in PSCAD and PSSE.

3.11.3 FCAS Assessment Methodology

To assess compliance with AEMO's requirements for BESSes providing FCAS the generating system's response to a selection of frequency disturbances was compared to the expected behaviour outlined in section 3.3 of Battery Energy Storage System requirements for contingency FCAS registration [**?**].

3.11.4 Results

The tests performed for this clause have been presented in Table 3.12 and have been provided in Appendix N. For completeness these tests were also performed in PSSE and have been provided in Appendix O. To confirm the compliance of the generating system to the configured droop characteristic, the steady-state change in active power has been plotted against the associated change in frequency in Figure 3.12 for all simulations that were run for this clause. The markers on the plot can be understood as follows:

- Grey circles indicate that the active power controller reached saturation (either due to it already being saturated or by supplying/reducing so much active power that it reached saturation), which automatically fulfills the GPS requirement for frequency control.
- Red markers indicate the amount of active power transfer increase or decrease for a particular frequency disturbance. For compliance, the marker should be on the access standard characteristic.

The results provided demonstrate that Heywood BESS is configured with a frequency droop percentage of 4.97%. Additionally, we see that the plant does not increase its active power in response to an increase in frequency. Conversely, we see that the plant does not reduce active power for a reduction in frequency.

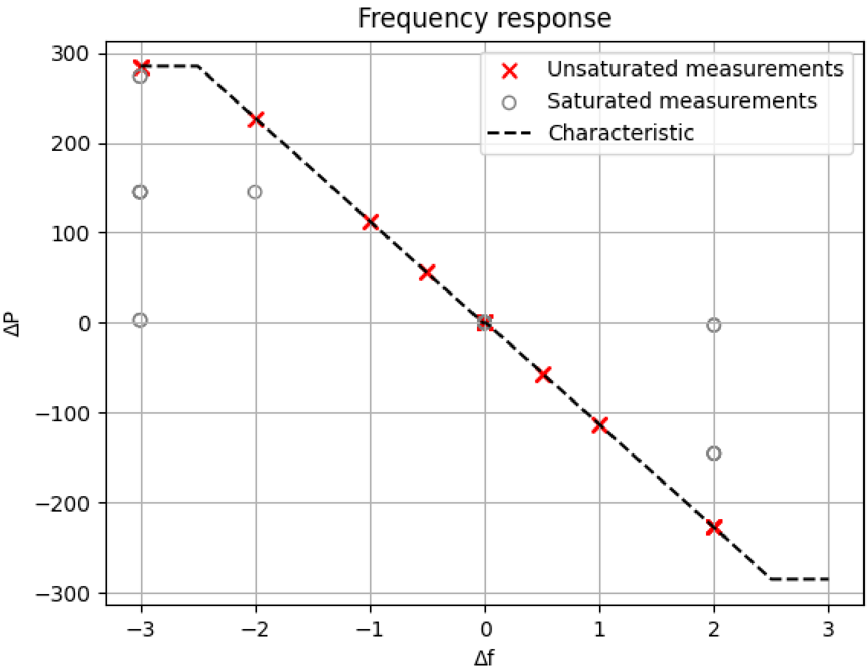

Figure 3.12: s5.2.5.11 frequency droop characteristic validation (PSCAD)

Table 3.12: s5.2.5.11 frequency droop controller test suite (PSCAD)

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Test Details	Appendix Reference
1	11.1754386	11.24	1.06	0	1.06	1	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
2	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
3	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
4	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
5	11.1754386	11.24	1.06	0	1.06	1	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
6	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
7	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
8	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
9	19.61754386	12.04	1.06	0	1.06	1	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
10	19.61754386	12.04	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
11	19.61754386	12.04	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
12	19.61754386	12.04	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
13	19.61754386	12.04	1.06	0	1.06	1	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
14	19.61754386	12.04	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
15	19.61754386	12.04	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
16	19.61754386	12.04	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
17	11.1754386	11.24	1.06	0	1.06	-1	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
18	11.1754386	11.24	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
19	11.1754386	11.24	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
20	11.1754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
21	11.1754386	11.24	1.06	0	1.06	-1	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
22	11.1754386	11.24	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
23	11.1754386	11.24	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
24	11.1754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
25	19.61754386	12.04	1.06	0	1.06	-1	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
26	19.61754386	12.04	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
27	19.61754386	12.04	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
28	19.61754386	12.04	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 52 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
29	19.61754386	12.04	1.06	0	1.06	-1	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
30	19.61754386	12.04	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
31	19.61754386	12.04	1.06	0	1.06	-0.5	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
32	19.61754386	12.04	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 47 FROM 15s TO 18s change to 50	Appendix change to CSR Fgrid Steps
33	19.61754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 50.5	Appendix change to CSR Fgrid Steps
34	19.61754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 49.5	Appendix change to CSR Fgrid Steps
35	19.61754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 49	Appendix change to CSR Fgrid Steps
36	19.61754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 48	Appendix change to CSR Fgrid Steps
37	19.61754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 51	Appendix change to CSR Fgrid Steps
38	19.61754386	11.24	1.06	0	1.06	-0.05	50 FROM 5s TO 8s change to 52	Appendix change to CSR Fgrid Steps
39	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 50.5	Appendix change to CSR Fgrid Steps
40	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 49.5	Appendix change to CSR Fgrid Steps
41	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 49	Appendix change to CSR Fgrid Steps
42	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 48	Appendix change to CSR Fgrid Steps
43	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 51	Appendix change to CSR Fgrid Steps
44	11.1754386	11.24	1.06	0	1.06	0.05	50 FROM 5s TO 8s change to 52	Appendix change to CSR Fgrid Steps
45	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 50.5	Appendix change to CSR Fgrid Steps
46	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 49.5	Appendix change to CSR Fgrid Steps
47	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 49	Appendix change to CSR Fgrid Steps
48	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 48	Appendix change to CSR Fgrid Steps
49	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 51	Appendix change to CSR Fgrid Steps
50	11.1754386	11.24	1.06	0	1.06	0.5	50 FROM 5s TO 8s change to 52	Appendix change to CSR Fgrid Steps
51	11.1754386	11.24	1.06	0	1.06	0	50 FROM 5s TO 8s change to 50.5	Appendix change to CSR Fgrid Steps

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Test Details	Appendix Reference
52	11.1754386	11.24	1.06	0	1.06	0	50 FROM 5s TO 8s change to 49.5	Appendix change to CSR Fgrid Steps
53	11.1754386	11.24	1.06	0	1.06	0	50 FROM 5s TO 8s change to 49	Appendix change to CSR Fgrid Steps
54	11.1754386	11.24	1.06	0	1.06	0	50 FROM 5s TO 8s change to 48	Appendix change to CSR Fgrid Steps
55	11.1754386	11.24	1.06	0	1.06	0	50 FROM 5s TO 8s change to 51	Appendix change to CSR Fgrid Steps
56	11.1754386	11.24	1.06	0	1.06	0	50 FROM 5s TO 8s change to 52	Appendix change to CSR Fgrid Steps

3.11.5 FCAS Results

The tests performed for this clause have been presented in Table 3.13 and have been provided in AK. For all tests, we see the response of the generating system aligns with the expectations outlined in [**?**].

Table 3.13: s5.2.5.11 FCAS test suite (PSCAD)

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Frequency target [Hz]	Test Type	Appendix Reference
Test 1	17.8	4.01518	1.0227	0	1.0227	0.195	50.5	Lower FCAS Test (Starting pos 1) Fast Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 2	17.8	4.01518	1.0227	0	1.0227	0	50.5	Lower FCAS Test (Starting pos 2) Fast Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 3	17.8	4.01518	1.0227	0	1.0227	0.0975	50.5	Lower FCAS Test (Starting pos 3) Fast Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 4	17.8	4.01518	1.0227	0	1.0227	0.195	50.5	Lower FCAS Test (Starting pos 1) Slow Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 5	17.8	4.01518	1.0227	0	1.0227	0	50.5	Lower FCAS Test (Starting pos 2) Slow Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 6	17.8	4.01518	1.0227	0	1.0227	0.0975	50.5	Lower FCAS Test (Starting pos 3) Slow Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 7	17.8	4.01518	1.0227	0	1.0227	0	49.5	Raise FCAS Test (Starting pos 2) Fast Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 8	17.8	4.01518	1.0227	0	1.0227	-0.195	49.5	Raise FCAS Test (Starting pos 1) Fast Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 9	17.8	4.01518	1.0227	0	1.0227	-0.0975	49.5	Raise FCAS Test (Starting pos 3) Fast Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 10	17.8	4.01518	1.0227	0	1.0227	0	49.5	Raise FCAS Test (Starting pos 2) Slow Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 11	17.8	4.01518	1.0227	0	1.0227	-0.195	49.5	Raise FCAS Test (Starting pos 1) Slow Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11
Test 12	17.8	4.01518	1.0227	0	1.0227	-0.0975	49.5	Raise FCAS Test (Starting pos 3) Slow Ramp	Appendix AL Grid frequency disturbance step tests S5.2.5.11

3.12 [S5.2.5.12] Impact on Network Capability

3.12.1 Automatic Access Standard

The integrated resource system has plant capabilities and control systems that are sufficient so that when connected to the power system it does not reduce any inter-regional or intra-regional power transfer capability below the level that would apply if the integrated resource system were not connected.

3.12.2 Assessment Methodology

This clause is assessed through analysis of the WAN contingency test results available in the WAN studies section on page 25 of this report. To ensure compliance with this clause, the contingencies are applied with the generating system out of service and in service, and the results are overlayed and compared.

In order to assess the impact of the project on the South Australian electrical network, four wide area cases were prepared based on recommendations provided by ElectraNet.

For each case, the interconnector flows are characterised by the below.

1. SA light load - Interconnectors exporting 850 MW. Barker Inlet and Snapper Point in service.
2. SA light-medium load - Interconnectors exporting 850 MW. Barker Inlet, Snapper Point, and QPS 5 in service.
3. SA medium-high load - Interconnectors importing 750 MW. Barker Inlet, Snapper Point, Pelican unit #1, and QPS 5 in service.

4. SA high load - Interconnectors importing 1,300 MW. Barker Inlet, Snapper Point, Pelican units #1 and #2, and QPS 5 in service.

The interconnectors and corresponding limits applicable to this project have been prepared below.

Interconnector	Flow direction	Nominal Capacity (MW)
Heywood (VIC-SA)	Towards VIC	550
Heywood (VIC-SA)	Towards SA	600
PEC (SA-VIC-NSW)	Towards NSW	800
PEC (SA-VIC-NSW)	Towards SA	800
Murraylink (VIC-SA)	Towards Vic	200
Murraylink (VIC-SA)	Towards SA	220

Table 3.14: Interconnector flows applicable to this project

The list of faults evaluated in WAN studies was limited to those studied as part of R0 - as directed by ElectraNet.

Faults were carried out using AEMO's OPDMS snapshots, which incorporated nearby generation and the generator SMIB model, and evaluated performance of the generator for disturbances on the wide area network. A variety of faults were tested, including:

- Three-phase-to-ground faults with circuit breaker failure clearance times
- Two-phase-to-ground faults

The contingencies considered for wide are network assessment are presented in Table 3.9.

3.12.3 Results

The generating system was found not to reduce any inter-regional or intra-regional power transfer capability below the level that would apply with the generating system out of service. The results of the contingencies with the generating system in and out of service are available in Appendices P through S.

3.13 [S5.2.5.13] Voltage and Reactive Power Control

3.13.1 Automatic Access Standard

Voltage 'droop' = 4% on 112.575 MVAr base

1. The integrated resource system has plant capabilities and control systems sufficient to ensure that:
   (a) power system oscillations, for the frequencies of oscillation of the production unit against any other production unit or system, are adequately damped;
   (b) operation of the integrated resource system does not degrade the damping of any critical mode of oscillation of the power system; and
   (c) operation of the integrated resource system does not cause instability (including

hunting of tap-changing transformer control systems) that would adversely impact other Registered Participants.

2. The control systems used with this integrated resource system have:
   (a) for the purposes of disturbance monitoring and testing, permanently installed and operational, monitoring and recording facilities for key variables including each input and output; and
   (b) facilities for testing the control system sufficient to establish its dynamic operational characteristics.
3. The integrated resource system has facilities with a control system to regulate voltage, reactive power and power factor, with the ability to operate in any control mode and to switch between control modes, as shown in the plant voltage control strategy document
4. The integrated resource system has a voltage control system that:
   (a) regulates voltage at the Connection Point to within 0.5% of the setpoin;
   (b) regulates voltage in a manner that helps to support network voltages during faults and does not prevent the NSP from achieving the requirements under clause S5.1a.3 and S5.1a.4 of the NER;
   (c) allows the voltage setpoint to be continuously controllable in the range of at least 95% to 105% of the target voltage at [the Connection Point (as recorded in the connection agreement), without reliance on a tap-changing transformer and subject to the reactive power capability referred to in the performance standard under clause S5.2.5.1;
   (d) has limiting devices to ensure that a voltage disturbance does not cause the production unit to trip at the limits of its operating capability. The limiting devices:
      i. do not detract from the performance of any power system stabiliser or power oscillation damping capability; and
      ii. are co-ordinated with all protection systems.
5. The integrated resource system has a voltage control system that:
   (a) with the integrated resource system connected to the power system, has settling times for active power, reactive power and voltage due to a step change of voltage setpoint or voltage at the connection point, of less than:
      i. 5.0 s for a 5% voltage disturbance with the integrated resource system connected to the power system, from an operating point where the voltage disturbance would not cause any limiting device to operate; and
      ii. 7.5 s for a 5% voltage disturbance with the integrated resource system connected to the power system, when operating into any limiting device from an operating point where a voltage disturbance of 2.5% would just cause the limiting device to operate;
   (b) for a 5% step change in the voltage setpoint, has reactive power rise time, of less than 2 s;
   (c) has power oscillation damping capability with sufficient flexibility to enable damping performance to be maximised with characteristics as described in paragraph (7).
6. A reactive power or power factor control system provided under paragraph (3) will:
   (a) regulate reactive power or power factor at the Connection Point, to within:
      i. for a integrated resource system operating in reactive power mode, 2% of the generating system's rating (expressed in MVAr);
      ii. for a integrated resource system operating in power factor mode, a power factor equivalent to 2% of the integrated resource system's rating (expressed in MVAr);
   (b) allow the reactive power or power factor setpoint to be continuously controllable

across the reactive power capability range established under the performance standard under clause S5.2.5.1; and

(c) with the integrated resource system connected to the power system, and for a step change in setpoint of at least 50% of the reactive power capability agreed with AEMO and the NSP under clause S5.2.5.1 of the NER, or a 5% voltage disturbance at the location agreed under subparagraph (i):
   i. have settling times for active power, reactive power and voltage of less than 5.0 s from an operating point where the voltage disturbance would not cause any limiting device to operate; and
   ii. have settling times for active power, reactive power and voltage of less than 7.5 s when operating into any limiting device from an operating point where a voltage disturbance of 2.5% would just cause the limiting device to operate.

3.13.2 Assessment Methodology

Reactive controller stability tests assess the ability of the generator to provide stable reactive response to a perturbed Connection Point voltage or controller state (i.e. a reference change). In VAr and power factor control modes, this is just about P_{POC} and Q_{POC} settling to their pre-disturbance values. However, in voltage droop control modes, a changing V_{POC} will result in a changing calculated Q_{ref}, so the generator will need to track to a new reactive power target at the same time as rejecting the disturbance.

To implement these tests in Single Machine, Infinite Bus (SMIB) modelling, the appropriate V_{grid_1} is first identified to achieve V_{POC_1} given the required initial P_{POC}, Q_{POC}, SCR and X/R conditions. Subsequent V_{grid} values $V_{\text{grid}_2}, V_{\text{grid}_3}, \ldots, V_{\text{grid}_n}$ can then be calculated to achieve the desired V_{POC} values $V_{\text{POC}_2}, V_{\text{POC}_3}, \ldots, V_{\text{POC}_n}$.

With all $V_{\text{grid,i}}$ calculated, a simulation is performed with V_{grid} stepped or ramped as required to implement the desired disturbance, as shown in Figure 3.13.

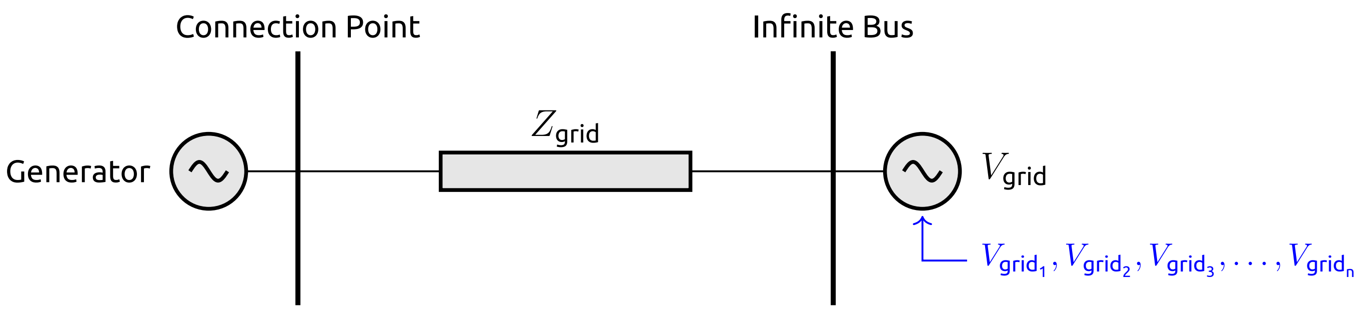

Figure 3.13: Reactive power controller disturbance assessment methodology

To assess the stability of the control system response to a stepped V_{ref}, Q_{ref}, PF_{ref} signal, reference steps are applied as per Figure 3.14. To perform this test, the generator is first initialised to the initial V_{POC}, P_{POC}, Q_{POC}, SCR and X/R conditions, where Q_{POC} is the target reactive output of the generator for the associated $V_{\text{err}} = V_{\text{ref}_1} - V_{\text{POC}}$ per the droop characteristic.

Once the generator has been initialised, the series of voltage references $V_{\text{ref}_2}, V_{\text{ref}_3}, \ldots, V_{\text{ref}_n}$ are applied to the PPC, as shown in Figure 3.14. Tests where the reactive power reference is constrained by a reactive power limit, will be identified as "Saturating".

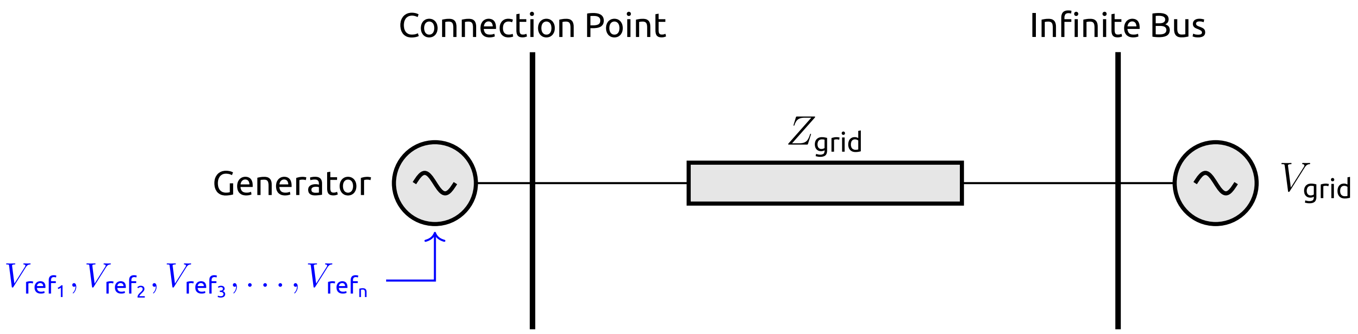

Figure 3.14: Reactive power controller disturbance assessment methodology (shown for voltage droop control)

In wide area studies, only reference step tests are applied, since actual voltage disturbances are best assessed through the application of real faults, machine trips and TOV shunt application, all of which is assessed under s5.2.5.5.

All SMIB assessments for this clause have been performed in PSCAD and all wide-area assessments have been performed in PSS/E. All tests undertaken as part of this clause have been characterised as either "Saturated" or "Un-saturated". Saturating tests are those for which the reference step is limited by the reactive power controller. Unsaturated tests are those for which the reference step stays within the reactive power limits of the reactive power controller. Please note that as the voltage droop configured for this plant is 2% on a base of 23.7 MVAr, all voltage steps applied result in operation of the reactive power controllers limits.

3.13.3 SMIB study results

Oscillation Rejection

Oscillation rejection analysis has been performed to ensure that the generating system acts to adequately damp oscillations seen at the connection point in accordance with section (1) of this GPS clause. Please refer to the results in Appendix AL which demonstrate the generators response to oscillations of varying frequency.

Connection point voltage disturbance tests (droop mode)

The connection point voltage disturbance tests performed for this clause have been presented in Table 3.15. Figure 3.15 shows the active power, reactive power and connection point voltages along with the distribution of rise and settling times (as applicable). The results show compliance to the GPS requirements for all tests.

Figure 3.16 presents a summary of all Q_{POC} measurements against V_{POC} measurements at the end of each connection point voltage disturbance tests after the controllers have settled. It can be seen from this chart that the controller always accurately regulates to the intended voltage droop characteristic.

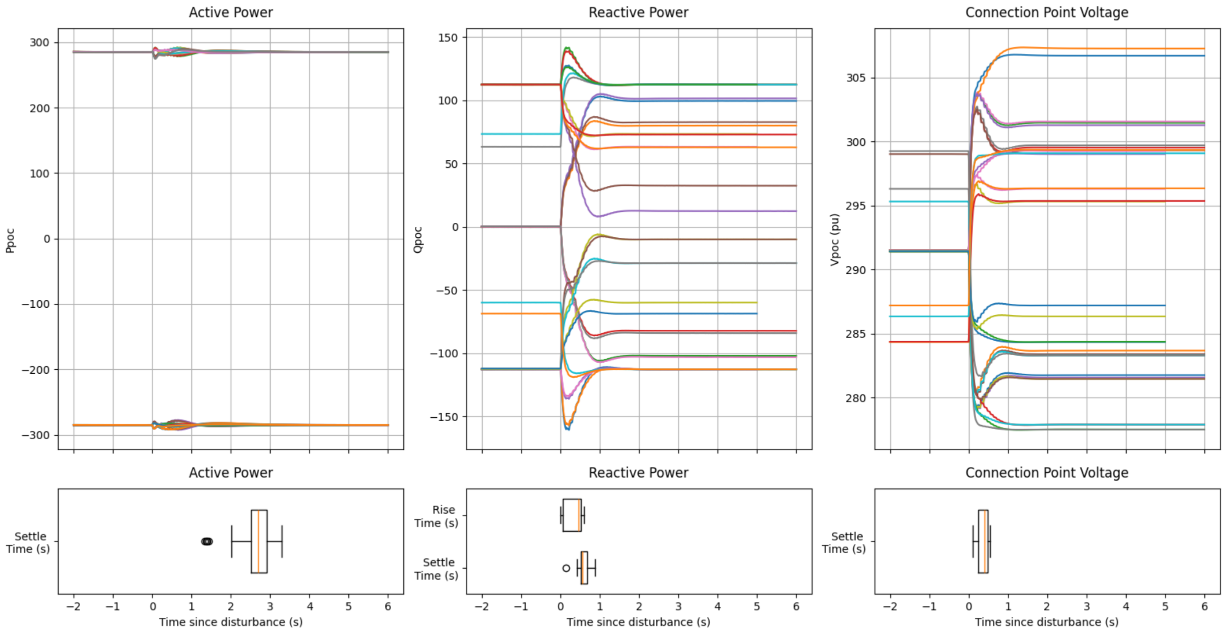

Figure 3.15: s5.2.5.13 Connection point voltage disturbance step test performance summary (droop mode)

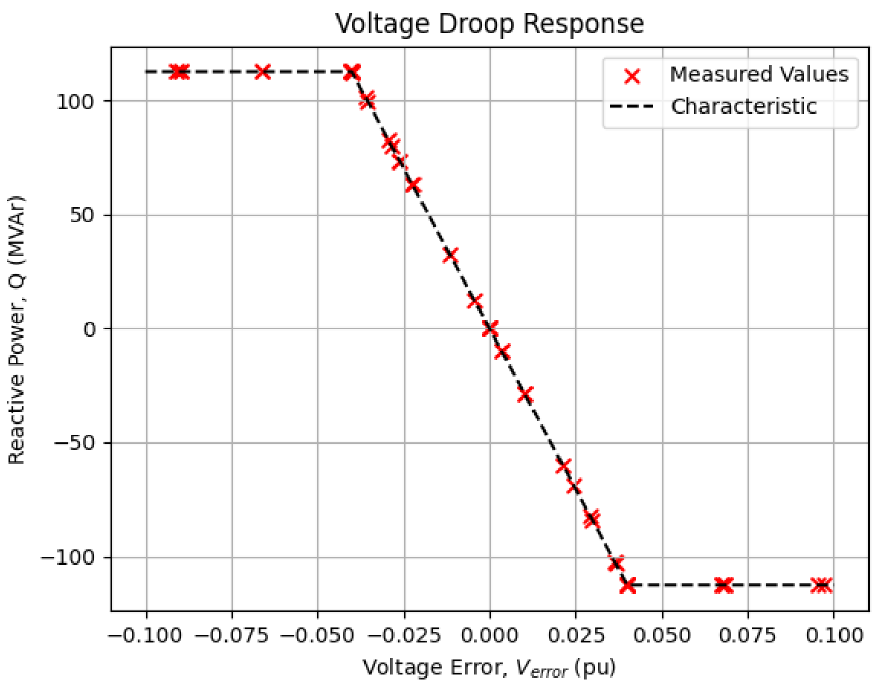

Figure 3.16: Voltage droop controller characteristic accuracy

Table 3.15: s5.2.5.13 Connection point voltage disturbance step test suite (droop mode)

Test Num	Test Type	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
Test 1 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	0	1.06	1	Appendix I CSR Vgrid Steps
Test 1 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	0	1.06	1	Appendix I CSR Vgrid Steps
Test 2 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	0	1.06	1	Appendix I CSR Vgrid Steps

Test Num	Test Type	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
Test 2 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	0	1.06	1	Appendix I CSR Vgrid Steps
Test 3 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	0	1.06	-1	Appendix I CSR Vgrid Steps
Test 3 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	0	1.06	-1	Appendix I CSR Vgrid Steps
Test 4 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	0	1.06	-1	Appendix I CSR Vgrid Steps
Test 4 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	0	1.06	-1	Appendix I CSR Vgrid Steps
Test 5 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	-1	1.02	1	Appendix I CSR Vgrid Steps
Test 5 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	-1	1.02	1	Appendix I CSR Vgrid Steps
Test 6 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	-1	1.02	-1	Appendix I CSR Vgrid Steps
Test 6 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	-1	1.02	-1	Appendix I CSR Vgrid Steps
Test 7 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	1	1.1	1	Appendix I CSR Vgrid Steps
Test 7 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	1	1.1	1	Appendix I CSR Vgrid Steps
Test 8 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	1	1.1	-1	Appendix I CSR Vgrid Steps
Test 8 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	1	1.1	-1	Appendix I CSR Vgrid Steps
Test 9 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	1	1.1	1	Appendix I CSR Vgrid Steps
Test 9 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	1	1.1	1	Appendix I CSR Vgrid Steps
Test 10 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	1	1.1	-1	Appendix I CSR Vgrid Steps
Test 10 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	1	1.1	-1	Appendix I CSR Vgrid Steps
Test 11 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	-1	1.02	1	Appendix I CSR Vgrid Steps
Test 11 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	-1	1.02	1	Appendix I CSR Vgrid Steps
Test 12 p1	CSR Vgrid Steps	19.61754386	12.04	1.06	-1	1.02	-1	Appendix I CSR Vgrid Steps
Test 12 p2	CSR Vgrid Steps	11.1754386	11.24	1.06	-1	1.02	-1	Appendix I CSR Vgrid Steps

Table 3.16 shows the rise and settling times for each test performed. Please note that tests 9-12 are limiter tests, while tests 1 through 8 are non-limiter tests. As seen from the table below the generating system has settling time for reactive power and voltage of less than 5.0s for all cases considered. Please note that active power settle time has not been assessed for any tests in which the change in active power is $\leq$ 0.1pu. Reactive power rise time remains below 2 seconds for all non-limiter tests.

Table 3.16: s5.2.5.13 Voltage grid disturbance step test results (droop mode)

Name	Ppoc Settling Time (sec)	Qpoc Settling Time (sec)	Vpoc Settling TIme (sec)	Ppoc Rise Time (sec)	Qpoc Rise Time (sec)	Vpoc Rise Time (sec)
Test 1 p1	2.8775	0.6325	0.5265	0	0.603	0.058
Test 1 p2	2.63775	0.5465	0.4995	0	0.51975	0.04725
Test 2 p1	2.8125	0.62775	0.479	0	0.5985	0.06075
Test 2 p2	2.57325	0.534	0.48	0	0.507	0.04925
Test 3 p1	2.82375	0.635	0.5455	0	0.6055	0.0585
Test 3 p2	2.645	0.5465	0.53875	0	0.5195	0.048
Test 4 p1	2.8605	0.62825	0.4875	0	0.59875	0.061
Test 4 p2	2.64075	0.534	0.4975	0.0005	0.50675	0.04975
Test 5 p1	2.7095	0.59175	0.47625	0.00025	0.56575	0.06125
Test 5 p2	2.4965	0.53025	0.48175	0.00025	0.50625	0.0505
Test 6 p1	3.16425	0.733	0.38225	0	0.0025	0.36575
Test 6 p2	3.266	0.82475	0.5435	0	0.004	0.52575
Test 7 p1	2.8935	0.8085	0.23125	0	0.00125	0.21525
Test 7 p2	2.9335	0.87075	0.39675	0	0.00325	0.38
Test 8 p1	2.78	0.62325	0.49725	0	0.58925	0.05775
Test 8 p2	2.6405	0.5475	0.52675	0	0.51675	0.0475
Test 9 p1	2.813	0.5145	0.39625	0	0.48075	0.0575
Test 9 p2	1.8645	0.11475	0.12925	0	0.09875	0.11425
Test 10 p1	2.614	0.468	0.4185	0	0.4375	0.046
Test 10 p2	2.073	0.60825	0.14625	0	0.07625	0.131
Test 11 p1	2.9995	0.817	0.23125	0	0.0005	0.21525
Test 11 p2	1.31325	0.525	0.1055	0	0.504	0.09075
Test 12 p1	3.0385	0.87975	0.43925	0	0.0005	0.4225
Test 12 p2	1.30725	0.43325	0.107	0	0.41375	0.09225

Voltage reference step tests

The connection point voltage reference step tests performed for this clause have been presented in Table 3.17. Figure 3.17 shows the active power, reactive power and connection point voltages along with the distribution of rise and settling times (as applicable) The results show compliance to the GPS requirements for all tests.

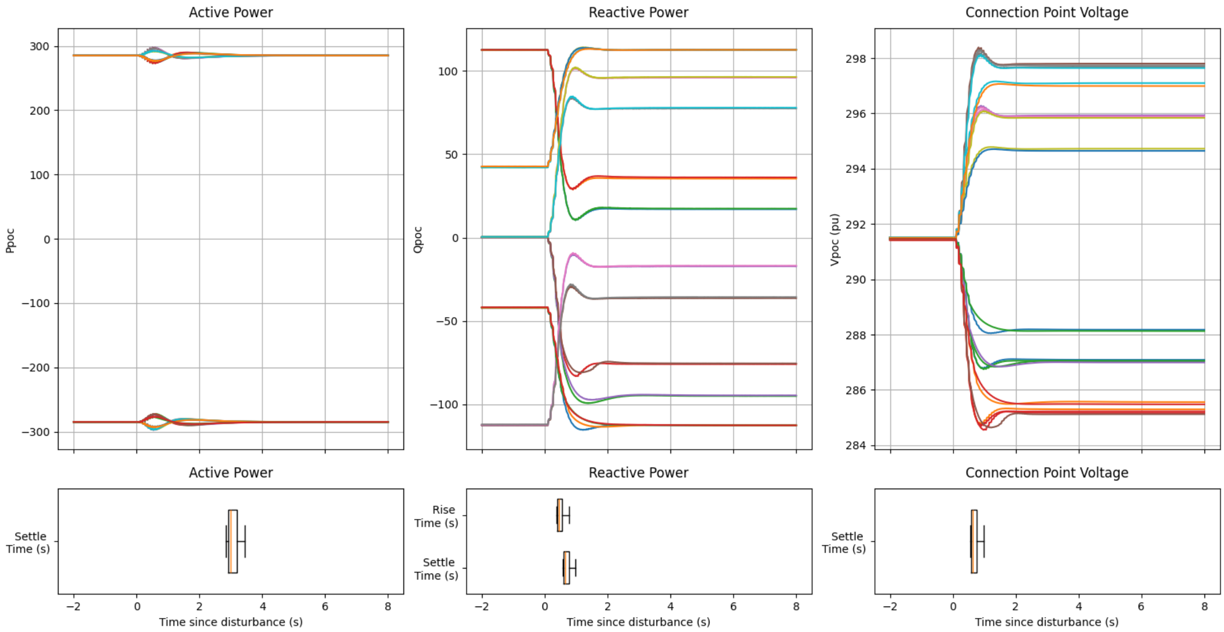

Figure 3.17: s5.2.5.13 Voltage reference step test performance summary

Table 3.17: s5.2.5.13 Voltage reference step test suite

Test Num	Test Type	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Ppoc [pu]	Appendix Reference
Test 1 p1	CSR Vref Steps	19.61754386	12.04	1.06	1	1	Appendix J CSR Vref Steps
Test 2 p1	CSR Vref Steps	19.61754386	12.04	1.06	0	1	Appendix J CSR Vref Steps
Test 3 p1	CSR Vref Steps	19.61754386	12.04	1.06	-1	1	Appendix J CSR Vref Steps
Test 4 p1	CSR Vref Steps	19.61754386	12.04	1.06	0	1	Appendix J CSR Vref Steps
Test 5 p1	CSR Vref Steps	19.61754386	12.04	1.06	0.375	1	Appendix J CSR Vref Steps
Test 6 p1	CSR Vref Steps	19.61754386	12.04	1.06	-0.375	1	Appendix J CSR Vref Steps
Test 1 p2	CSR Vref Steps	11.1754386	11.24	1.06	1	1	Appendix J CSR Vref Steps
Test 2 p2	CSR Vref Steps	11.1754386	11.24	1.06	0	1	Appendix J CSR Vref Steps
Test 3 p2	CSR Vref Steps	11.1754386	11.24	1.06	-1	1	Appendix J CSR Vref Steps
Test 4 p2	CSR Vref Steps	11.1754386	11.24	1.06	0	1	Appendix J CSR Vref Steps
Test 5 p2	CSR Vref Steps	11.1754386	11.24	1.06	0.375	1	Appendix J CSR Vref Steps
Test 6 p2	CSR Vref Steps	11.1754386	11.24	1.06	-0.375	1	Appendix J CSR Vref Steps
Test 7 p1	CSR Vref Steps	19.61754386	12.04	1.06	1	-1	Appendix J CSR Vref Steps
Test 8 p1	CSR Vref Steps	19.61754386	12.04	1.06	0	-1	Appendix J CSR Vref Steps
Test 9 p1	CSR Vref Steps	19.61754386	12.04	1.06	-1	-1	Appendix J CSR Vref Steps
Test 10 p1	CSR Vref Steps	19.61754386	12.04	1.06	0	-1	Appendix J CSR Vref Steps
Test 11 p1	CSR Vref Steps	19.61754386	12.04	1.06	0.375	-1	Appendix J CSR Vref Steps
Test 12 p1	CSR Vref Steps	19.61754386	12.04	1.06	-0.375	-1	Appendix J CSR Vref Steps
Test 7 p2	CSR Vref Steps	11.1754386	11.24	1.06	1	-1	Appendix J CSR Vref Steps
Test 8 p2	CSR Vref Steps	11.1754386	11.24	1.06	0	-1	Appendix J CSR Vref Steps
Test 9 p2	CSR Vref Steps	11.1754386	11.24	1.06	-1	-1	Appendix J CSR Vref Steps
Test 10 p2	CSR Vref Steps	11.1754386	11.24	1.06	0	-1	Appendix J CSR Vref Steps
Test 11 p2	CSR Vref Steps	11.1754386	11.24	1.06	0.375	-1	Appendix J CSR Vref Steps
Test 12 p2	CSR Vref Steps	11.1754386	11.24	1.06	-0.375	-1	Appendix J CSR Vref Steps

Table 3.18 shows the rise and settling times for each test performed. Please note that active power settling times were not assessed as the change in active power was found to be $\leq$ 0.1 pu for all tests performed.

Table 3.18: s5.2.5.13 Voltage reference step test results

Name	Ppoc Settling Time (s)	Qpoc Settling Time (s)	Vpoc Settling TIme (s)	Ppoc Rise Time (s)	Qpoc Rise Time (s)	Vpoc Rise Time (s)
CSR_52513_CSRVrefSteps_001p1	3.0538	0.6395	0.6205	0.0005	0.4325	0.4255
CSR_52513_CSRVrefSteps_001p2	2.9745	0.5908	0.5863	0.0008	0.3965	0.394

Name	Ppoc Settling Time (s)	Qpoc Settling Time (s)	Vpoc Settling TIme (s)	Ppoc Rise Time (s)	Qpoc Rise Time (s)	Vpoc Rise Time (s)
CSR_52513_CSRVrefSteps_002p1	3.1335	0.7173	0.702	0.0008	0.5103	0.5073
CSR_52513_CSRVrefSteps_002p2	2.914	0.593	0.5888	0.001	0.3988	0.3963
CSR_52513_CSRVrefSteps_003p1	2.8975	0.609	0.5948	0.0003	0.4118	0.401
CSR_52513_CSRVrefSteps_003p2	2.8375	0.577	0.5595	0.0005	0.383	0.3678
CSR_52513_CSRVrefSteps_004p1	3.0165	0.6628	0.6405	0.0003	0.4563	0.4463
CSR_52513_CSRVrefSteps_004p2	2.916	0.5905	0.5848	0.0003	0.3963	0.3928
CSR_52513_CSRVrefSteps_005p1	3.192	0.748	0.7408	0.0005	0.5565	0.552
CSR_52513_CSRVrefSteps_005p2	3.2768	0.81	0.7903	0.0008	0.6173	0.6
CSR_52513_CSRVrefSteps_006p1	3.1338	0.7358	0.7158	0.0003	0.5443	0.527
CSR_52513_CSRVrefSteps_006p2	3.354	0.8203	0.8133	0.0005	0.6273	0.6223
CSR_52513_CSRVrefSteps_007p1	2.9603	0.6375	0.6488	0	0.43	0.453
CSR_52513_CSRVrefSteps_007p2	2.8605	0.5883	0.5923	0	0.3953	0.3993
CSR_52513_CSRVrefSteps_008p1	3.1805	0.7773	0.7865	0	0.5703	0.591
CSR_52513_CSRVrefSteps_008p2	2.8818	0.6125	0.6305	0	0.4195	0.4375
CSR_52513_CSRVrefSteps_009p1	2.9448	0.607	0.5993	0	0.4108	0.4045
CSR_52513_CSRVrefSteps_009p2	2.8655	0.8275	0.582	0	0.3783	0.3895
CSR_52513_CSRVrefSteps_010p1	2.9853	0.6638	0.6643	0	0.457	0.4693
CSR_52513_CSRVrefSteps_010p2	2.8653	0.5888	0.5913	0	0.3958	0.3988
CSR_52513_CSRVrefSteps_011p1	3.144	0.7485	0.7508	0	0.558	0.5615
CSR_52513_CSRVrefSteps_011p2	3.244	0.8205	0.8265	0	0.629	0.6358
CSR_52513_CSRVrefSteps_012p1	3.3598	0.9753	0.9775	0	0.7848	0.788
CSR_52513_CSRVrefSteps_012p2	3.4405	0.9568	0.9783	0	0.765	0.7868

Reactive power reference step tests

The connection point reactive power reference step tests performed for this clause have been presented in Table 3.19. Figure 3.18 shows the active power, reactive power and connection point voltages along with the distribution of rise and settling times (as applicable). The results show compliance to the GPS requirements for all tests.

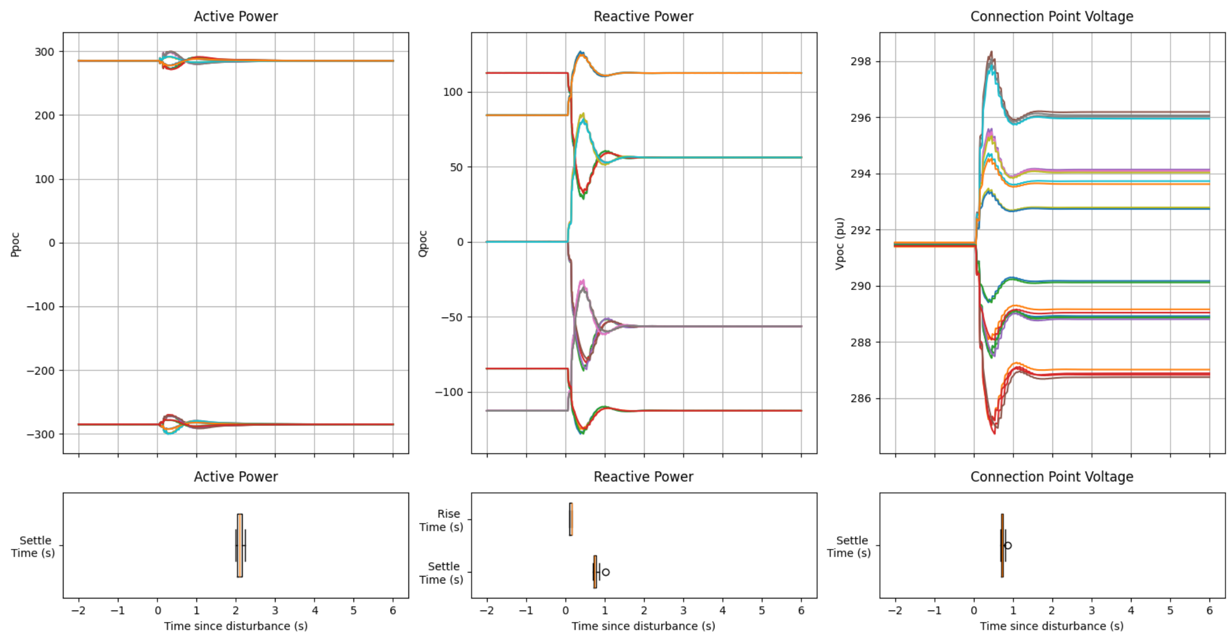

Figure 3.18: s5.2.5.13 VAr reference step test performance summary

Table 3.19: s5.2.5.13 VAr reference step test suite

Test Num	Test Type	SCR	X/R	Vpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
Test 1 p1	Qref 0.5p.u at 2s	19.61754386	12.04	1.06	1.1	1	Appendix K CSR Qref Steps
Test 2 p1	Qref -0.5p.u at 2s	19.61754386	12.04	1.06	1.06	1	Appendix K CSR Qref Steps
Test 3 p1	Qref -0.5p.u at 2s	19.61754386	12.04	1.06	1.02	1	Appendix K CSR Qref Steps
Test 4 p1	Qref 0.5p.u at 2s	19.61754386	12.04	1.06	1.06	1	Appendix K CSR Qref Steps
Test 5 p1	Qref 1.25p.u at 2s (limiter)	19.61754386	12.04	1.06	1.09	1	Appendix K CSR Qref Steps
Test 6 p1	Qref -1.25p.u at 2s (limiter)	19.61754386	12.04	1.06	1.03	1	Appendix K CSR Qref Steps
Test 1 p2	Qref 0.5p.u at 2s	11.1754386	11.24	1.06	1.1	1	Appendix K CSR Qref Steps
Test 2 p2	Qref -0.5p.u at 2s	11.1754386	11.24	1.06	1.06	1	Appendix K CSR Qref Steps
Test 3 p2	Qref -0.5p.u at 2s	11.1754386	11.24	1.06	1.02	1	Appendix K CSR Qref Steps
Test 4 p2	Qref 0.5p.u at 2s	11.1754386	11.24	1.06	1.06	1	Appendix K CSR Qref Steps
Test 5 p2	Qref 1.25pu at 2s (limiter)	11.1754386	11.24	1.06	1.09	1	Appendix K CSR Qref Steps
Test 6 p2	Qref -1.25pu at 2s (limiter)	11.1754386	11.24	1.06	1.03	1	Appendix K CSR Qref Steps
Test 7 p1	Qref 0.5p.u at 2s	19.61754386	12.04	1.06	1.1	-1	Appendix K CSR Qref Steps
Test 8 p1	Qref -0.5p.u at 2s	19.61754386	12.04	1.06	1.06	-1	Appendix K CSR Qref Steps
Test 9 p1	Qref -0.5p.u at 2s	19.61754386	12.04	1.06	1.02	-1	Appendix K CSR Qref Steps
Test 10 p1	Qref 0.5p.u at 2s	19.61754386	12.04	1.06	1.06	-1	Appendix K CSR Qref Steps
Test 11 p1	Qref 1.25p.u at 2s (limiter)	19.61754386	12.04	1.06	1.09	-1	Appendix K CSR Qref Steps
Test 12 p1	Qref -1.25p.u at 2s (limiter)	19.61754386	12.04	1.06	1.03	-1	Appendix K CSR Qref Steps
Test 7 p2	Qref 0.5p.u at 2s	11.1754386	11.24	1.06	1.1	-1	Appendix K CSR Qref Steps
Test 8 p2	Qref -0.5p.u at 2s	11.1754386	11.24	1.06	1.06	-1	Appendix K CSR Qref Steps
Test 9 p2	Qref -0.5p.u at 2s	11.1754386	11.24	1.06	1.02	-1	Appendix K CSR Qref Steps
Test 10 p2	Qref 0.5p.u at 2s	11.1754386	11.24	1.06	1.06	-1	Appendix K CSR Qref Steps
Test 11 p2	Qref 1.25p.u at 2s (limiter)	11.1754386	11.24	1.06	1.09	-1	Appendix K CSR Qref Steps
Test 12 p2	Qref -1.25p.u at 2s (limiter)	11.1754386	11.24	1.06	1.03	-1	Appendix K CSR Qref Steps

Table 3.20 shows the rise and settling times for each test performed. Please note that active power settling time was not assessed for this clause as the change in active power for all tests was negligible. The table below demonstrates compliance for all reactive power reference steps performed.

Table 3.20: s5.2.5.13 VAr reference step test results (saturated)

Name	Ppoc Settling Time (s)	Qpoc Settling Time (s)	Vpoc Settling TIme (s)	Ppoc Rise Time (s)	Qpoc Rise Time (s)	Vpoc Rise Time (s)
CSR_52513_CSRQrefSteps_001p1	2.136	0.7315	0.717	0.0023	0.155	0.1518
CSR_52513_CSRQrefSteps_001p2	2.1755	0.786	0.781	0.0028	0.1593	0.158
CSR_52513_CSRQrefSteps_002p1	2.0945	0.755	0.7353	0.0068	0.155	0.151
CSR_52513_CSRQrefSteps_002p2	2.154	0.812	0.7978	0.0013	0.1615	0.1603
CSR_52513_CSRQrefSteps_003p1	2.018	0.714	0.71	0	0.1438	0.0963
CSR_52513_CSRQrefSteps_003p2	2.079	0.754	0.7253	0	0.1588	0.1568
CSR_52513_CSRQrefSteps_004p1	2.0973	0.7155	0.7113	0	0.152	0.0993
CSR_52513_CSRQrefSteps_004p2	2.1388	0.7498	0.72	0	0.1585	0.1568
CSR_52513_CSRQrefSteps_005p1	2.0575	0.7065	0.6913	0	0.101	0.0908
CSR_52513_CSRQrefSteps_005p2	2.1585	0.7145	0.7103	0	0.106	0.093
CSR_52513_CSRQrefSteps_006p1	1.993	0.7093	0.7043	0.0008	0.1008	0.0908
CSR_52513_CSRQrefSteps_006p2	2.0238	0.7465	0.7215	0.0008	0.109	0.094
CSR_52513_CSRQrefSteps_007p1	2.0088	0.731	0.7185	0	0.1563	0.1558
CSR_52513_CSRQrefSteps_007p2	2.082	0.7813	0.7828	0	0.16	0.1615
CSR_52513_CSRQrefSteps_008p1	2.1623	0.7878	0.7863	0	0.1568	0.1565
CSR_52513_CSRQrefSteps_008p2	2.2423	0.8635	0.865	0	0.169	0.1685
CSR_52513_CSRQrefSteps_009p1	2.0668	0.7113	0.7095	0.0003	0.148	0.1523
CSR_52513_CSRQrefSteps_009p2	2.1663	0.7348	0.72	0	0.159	0.1598
CSR_52513_CSRQrefSteps_010p1	2.0263	0.713	0.7115	0	0.1543	0.154
CSR_52513_CSRQrefSteps_010p2	2.106	0.734	0.7195	0	0.159	0.16
CSR_52513_CSRQrefSteps_011p1	2.005	0.7058	0.7023	0	0.1028	0.0923
CSR_52513_CSRQrefSteps_011p2	2.0655	0.7125	0.7113	0	0.1075	0.095
CSR_52513_CSRQrefSteps_012p1	2.0405	1.026	0.7105	0	0.1015	0.0915
CSR_52513_CSRQrefSteps_012p2	2.1605	0.7848	0.7848	0	0.11	0.0963

Power factor reference step tests

The connection point power factor power reference step tests performed for this clause have been presented in Table 3.21. Figure 3.19 shows the active power, reactive power and connection point voltages along with the distribution of rise and settling times (as applicable). The results show compliance to the GPS for all tests.

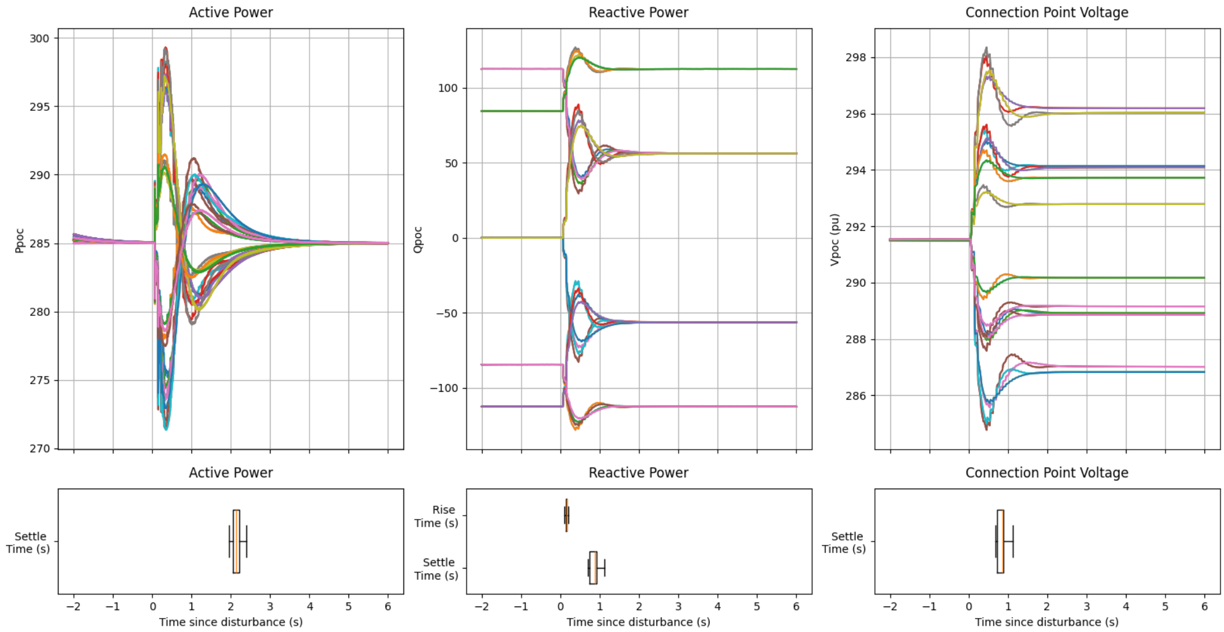

Figure 3.19: s5.2.5.13 PF reference step test performance summary

Table 3.21: s5.2.5.13 PF reference step test suite

Test Num	Test Type	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Ppoc [pu]	Appendix Reference
Test 1 p1	PFref 0.5pu at 5s	19.61754386	12.04	1.06	1	1.1	1	Appendix L CSR PFref Steps
Test 2 p1	PFref -0.5pu at 5s	19.61754386	12.04	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 3 p1	PFref -0.5pu at 5s	19.61754386	12.04	1.06	-1	1.02	1	Appendix L CSR PFref Steps
Test 4 p1	PFref 0.5pu at 5s	19.61754386	12.04	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 5 p1	Pfref - 0.5pu into upper limiter	19.61754386	12.04	1.06	0.75	1.09	1	Appendix L CSR PFref Steps
Test 6 p1	PFref 0.5pu into lower limtier	19.61754386	12.04	1.06	-0.75	1.03	1	Appendix L CSR PFref Steps
Test 7 p1	PFref 0.5pu at 5s	11.1754386	11.24	1.06	1	1.1	1	Appendix L CSR PFref Steps
Test 8 p1	PFref -0.5pu at 5s	11.1754386	11.24	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 9 p1	PFref -0.5pu at 5s	11.1754386	11.24	1.06	-1	1.02	1	Appendix L CSR PFref Steps
Test 10 p1	PFref 0.5pu at 5s	11.1754386	11.24	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 11 p1	Pfref - 0.5pu into upper limiter	11.1754386	11.24	1.06	0.75	1.09	1	Appendix L CSR PFref Steps
Test 12 p1	PFref 0.5pu into lower limtier	11.1754386	11.24	1.06	-0.75	1.03	1	Appendix L CSR PFref Steps
Test 1 p2	PFref 0.5pu at 5s	19.61754386	12.04	1.06	1	1.1	1	Appendix L CSR PFref Steps
Test 2 p2	PFref -0.5pu at 5s	19.61754386	12.04	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 3 p2	PFref -0.5pu at 5s	19.61754386	12.04	1.06	-1	1.02	1	Appendix L CSR PFref Steps
Test 4 p2	PFref 0.5pu at 5s	19.61754386	12.04	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 5 p2	Pfref - 0.5pu into upper limiter	19.61754386	12.04	1.06	0.75	1.09	1	Appendix L CSR PFref Steps
Test 6 p2	PFref 0.5pu into lower limtier	19.61754386	12.04	1.06	-0.75	1.03	1	Appendix L CSR PFref Steps
Test 7 p2	PFref 0.5pu at 5s	11.1754386	11.24	1.06	1	1.1	1	Appendix L CSR PFref Steps
Test 8 p2	PFref -0.5pu at 5s	11.1754386	11.24	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 9 p2	PFref -0.5pu at 5s	11.1754386	11.24	1.06	-1	1.02	1	Appendix L CSR PFref Steps
Test 10 p2	PFref 0.5pu at 5s	11.1754386	11.24	1.06	0	1.06	1	Appendix L CSR PFref Steps
Test 11 p2	Pfref - 0.5pu into upper limiter	11.1754386	11.24	1.06	0.75	1.09	1	Appendix L CSR PFref Steps
Test 12 p2	PFref 0.5pu into lower limtier	11.1754386	11.24	1.06	-0.75	1.03	1	Appendix L CSR PFref Steps

Table 3.22 shows the rise and settling times for each test performed. The results below show compliance to the GPS for all tests.

Table 3.22: s5.2.5.13 PF reference step test results

Name	Ppoc Settling Time (s)	Qpoc Settling Time (s)	Vpoc Settling TIme (s)	Ppoc Rise Time (s)	Qpoc Rise Time (s)	Vpoc Rise Time (s)
CSR_52513_CSRPFrefSteps_001p1	2.3348	0.8073	0.7945	0.001	0.2043	0.1835
CSR_52513_CSRPFrefSteps_001p1	2.1143	0.9095	0.8795	0.0008	0.163	0.1623
CSR_52513_CSRPFrefSteps_001p2	2.1143	0.9095	0.8795	0.0008	0.163	0.1623
CSR_52513_CSRPFrefSteps_002p1	2.1438	0.7285	0.7153	0.007	0.155	0.151
CSR_52513_CSRPFrefSteps_002p1	2.263	0.9335	0.91	0.0008	0.165	0.1635
CSR_52513_CSRPFrefSteps_002p2	2.1438	0.7285	0.7153	0.007	0.155	0.151
CSR_52513_CSRPFrefSteps_002p2	2.263	0.9335	0.91	0.0008	0.165	0.1635
CSR_52513_CSRPFrefSteps_003p1	2.079	0.709	0.7028	0	0.1438	0.0963

Name	Ppoc Settling Time (s)	Qpoc Settling Time (s)	Vpoc Settling TIme (s)	Ppoc Rise Time (s)	Qpoc Rise Time (s)	Vpoc Rise Time (s)
CSR_52513_CSRPFrefSteps_003p1	2.1978	0.8885	0.8718	0	0.1618	0.1608
CSR_52513_CSRPFrefSteps_003p2	2.079	0.709	0.7028	0	0.1438	0.0963
CSR_52513_CSRPFrefSteps_003p2	2.1978	0.8885	0.8718	0	0.1618	0.1608
CSR_52513_CSRPFrefSteps_004p1	1.9975	1.1268	1.117	0	0.152	0.0993
CSR_52513_CSRPFrefSteps_004p1	2.0588	0.8888	0.873	0	0.1618	0.161
CSR_52513_CSRPFrefSteps_004p2	1.9975	1.1268	1.117	0	0.152	0.0993
CSR_52513_CSRPFrefSteps_004p2	2.0588	0.8888	0.873	0	0.1618	0.161
CSR_52513_CSRPFrefSteps_005p1	2.0385	0.7065	0.6913	0	0.101	0.0908
CSR_52513_CSRPFrefSteps_005p1	2.1378	0.8685	0.8605	0	0.1248	0.095
CSR_52513_CSRPFrefSteps_005p2	2.0385	0.7065	0.6913	0	0.101	0.0908
CSR_52513_CSRPFrefSteps_005p2	2.1378	0.8685	0.8605	0	0.1248	0.095
CSR_52513_CSRPFrefSteps_006p1	1.9738	0.708	0.7025	0.0013	0.1005	0.0905
CSR_52513_CSRPFrefSteps_006p1	2.0648	0.873	0.8698	0.0015	0.122	0.0943
CSR_52513_CSRPFrefSteps_006p2	1.9738	0.708	0.7025	0.0013	0.1005	0.0905
CSR_52513_CSRPFrefSteps_006p2	2.0648	0.873	0.8698	0.0015	0.122	0.0943
CSR_52513_CSRPFrefSteps_007p1	1.954	0.792	0.7888	0.0005	0.159	0.1575
CSR_52513_CSRPFrefSteps_007p1	2.1833	0.9488	0.9448	0	0.1793	0.1673
CSR_52513_CSRPFrefSteps_007p2	1.954	0.792	0.7888	0.0005	0.159	0.1575
CSR_52513_CSRPFrefSteps_007p2	2.1833	0.9488	0.9448	0	0.1793	0.1673
CSR_52513_CSRPFrefSteps_008p1	2.2543	0.7885	0.7835	0.008	0.1615	0.1603
CSR_52513_CSRPFrefSteps_008p1	2.3935	0.9523	0.9505	0.008	0.1868	0.1713
CSR_52513_CSRPFrefSteps_008p2	2.2543	0.7885	0.7835	0.008	0.1615	0.1603
CSR_52513_CSRPFrefSteps_008p2	2.3935	0.9523	0.9505	0.008	0.1868	0.1713
CSR_52513_CSRPFrefSteps_009p1	2.1785	0.7295	0.7145	0	0.159	0.1573
CSR_52513_CSRPFrefSteps_009p1	2.3378	0.911	0.8773	0	0.1808	0.1683
CSR_52513_CSRPFrefSteps_009p2	2.1785	0.7295	0.7145	0	0.159	0.1573
CSR_52513_CSRPFrefSteps_009p2	2.3378	0.911	0.8773	0	0.1808	0.1683
CSR_52513_CSRPFrefSteps_010p1	1.9973	1.107	1.1063	0	0.1583	0.1563
CSR_52513_CSRPFrefSteps_010p1	2.1393	0.914	0.8798	0	0.1768	0.166
CSR_52513_CSRPFrefSteps_010p2	1.9973	1.107	1.1063	0	0.1583	0.1563
CSR_52513_CSRPFrefSteps_010p2	2.1393	0.914	0.8798	0	0.1768	0.166
CSR_52513_CSRPFrefSteps_011p1	2.1585	0.7145	0.7103	0	0.106	0.093
CSR_52513_CSRPFrefSteps_011p1	2.2588	0.872	0.8665	0	0.158	0.1545
CSR_52513_CSRPFrefSteps_011p2	2.1585	0.7145	0.7103	0	0.106	0.093
CSR_52513_CSRPFrefSteps_011p2	2.2588	0.872	0.8665	0	0.158	0.1545
CSR_52513_CSRPFrefSteps_012p1	2.0535	0.7348	0.7195	0.0015	0.108	0.0938
CSR_52513_CSRPFrefSteps_012p1	2.2138	0.925	0.9048	0.0013	0.16	0.1575
CSR_52513_CSRPFrefSteps_012p2	2.0535	0.7348	0.7195	0.0015	0.108	0.0938
CSR_52513_CSRPFrefSteps_012p2	2.2138	0.925	0.9048	0.0013	0.16	0.1575

3.13.4 Wide area study results

Voltage reference step tests

The connection point voltage reference step tests performed in the wide area PSSE network have been presented in Table 3.23. Please note that active power settle times were not assessed for these tests as the change in active power was found to be negligible. The results show compliance to the GPS requirements for all tests.

Table 3.23: s5.2.5.13 Voltage reference step test suite

Case	Test No	Vpoc [pu]	Qpoc [pu]	Ppoc [pu]	Test Type	
1	1	1.06	0	1	Vref change -5%	Appendix AC WANVref Steps
1	2	1.06	0	1	Vref change +5%	Appendix AC WANVref Steps

Reactive power reference step tests

The connection point reactive power reference step tests performed in the wide area PSSE network have been presented in Table 3.24. Please note that active power settle times were not assessed for these tests as the change in active power was found to be negligible.The results show compliance to the GPS requirements for all tests.

Table 3.24: s5.2.5.13 Reactive power reference step test suite

Case	Test No	Vpoc [pu]	Qpoc [pu]	Ppoc [pu]	Test Type	Appendix Reference
1	1	1.06	0	1	Qref change -50%	Appendix AA WANQref Steps

Case	Test No	Vpoc [pu]	Qpoc [pu]	Ppoc [pu]	Test Type	Appendix Reference
1	2	1.06	0.75	1	Qref change 50%	Appendix AA WANQref Steps

Power factor reference step tests

The connection point power factor reference step tests performed in the wide area PSSE network have been presented in Table 3.25. Please note that active power settle times were not assessed for these tests as the change in active power was found to be negligible. The results show compliance to the GPS requirements for all tests.

Table 3.25: s5.2.5.13 Power factor reference step test suite

Case	Test No	Vpoc [pu]	Qpoc [pu]	Ppoc [pu]	Appendix Reference
1	1	1.06	0	1	Appendix AB WANPFref Steps
1	2	1.06	-0.75	1	Appendix AB WANPFref Steps

3.14 [S5.2.5.14] Active Power Control

3.14.1 Automatic Access Standard

The integrated resource system has an active power control system that is adequately damped and capable of:

1. maintaining and changing its active power level in accordance with its dispatch instructions;
2. ramping its active power level linearly from one dispatch level to another; and
3. receiving and automatically responding to signals delivered from the automatic generation control system, as updated at a rate of once every 4 s

3.14.2 Assessment Methodology

Active power reference step tests assess the ability of the generator to provide a damped active (and reactive) power response to a change in the active power target applied to the PPC.

To perform this test, the generator is first initialised to the initial V_{POC}, P_{POC}, Q_{POC}, SCR and X/R conditions, where $P_{\text{POC}} = P_{\text{ref}_1}$. Once the generator has been initialised, the series of active power references $P_{\text{ref}_2}, P_{\text{ref}_3} \ldots, P_{\text{ref}_n}$ are applied to the PPC, as shown in Figure 3.20.

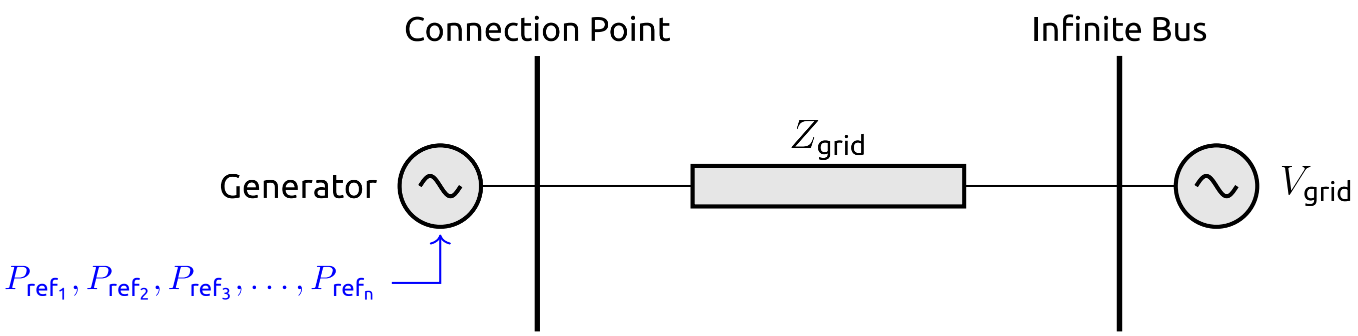

Figure 3.20: Active power reference change methodology

All assessments for this clause have been performed in PSCAD.

3.14.3 Results

The full suite of active power control tests are shown in Table 3.26. The results demonstrate that the generating system is capable of ramping stably without a defined ramp rate limit.The tests provided here demonstrate the ability for the generator to ramp linearly from setpoint to the next over a five minute interval.

Table 3.26: s5.2.5.14 active power control test suite

Test Num	SCR	X/R	Vpoc [pu]	Qpoc [pu]	Vref [pu]	Appendix Reference
Test 1	19.61754386	12.04	1.06	0	1.06	Appendix M Pref Steps
Test 2	11.1754386	11.24	1.06	0	1.06	Appendix M Pref Steps

3.15 [S5.2.8 and S5.3.2(b)] Fault Current

3.15.1 Agreed Access Standard

- The generating system limits its contribution to the fault current at the Connection Point to:
  - Three-phase fault current: 1.57 kA;
  - Single-phase-to-ground fault current: 4.7 kA;
  - Phase-to-phase-to-ground fault current: 2.71 kA.
- The generating system's connected plant is capable of withstanding fault current through the connection point up to 40 kA for 1000 ms.
- The circuit breaker provided to isolate the generating system from the network is capable of breaking, without damage or restrike, the maximum fault current of 40 kA, expected to flow through the circuit breaker for any fault in the network or in the generating system.

3.15.2 Assessment Methodology

As the vector group of the main transformer for this generating system is a wye-wye configuration with grounded neutrals, the only path for zero-sequence current to flow will be provided by the grid beyond the generators point of connection. A consequence of this is that the generators fault current contribution for earth faults will be dominated by the zero-sequence impedance seen by the POC.

In order to estimate a likely fault current contribution, the ASCC fault current simulation method was used in the PSS/E low and high load wide area network models to determine the three-phase-to-ground, single-phase-to-ground, and phase-to-phase-to-ground fault current contribution at the generating system's POC at a voltage of 1.0 pu.

In order to estimate an upper-bound on the generating systems fault current contribution the ASCC fault current simulation method was utilised in the SMIB model. For this assessment, the zero-sequence reactance of the grid impedance was reduced to 0.00001 pu.

In assessing the plants withstand capability, please refer to the protection study report which includes a summary of the maximum and minimum expected fault levels as well as equipment ratings [?].

3.15.3 Results

An estimate of the likely maximum fault current contribution by fault type - based on the wide area network grid impedances seen by the generating system, have been prepared in Table 3.27.

Table 3.27: Approximate Fault current contribution (WAN)

Case	3phg	1phg	ph-phg
Case 1 - Low Load	0.450 kA	0.224 kA	0.378 kA
Case 4 - High Load	0.450 kA	0.223 kA	0.378 kA

An estimate of the upper-bound on the maximum fault current contribution calculated for each type of fault is shown in Table 3.28.

Table 3.28: Upper-bound on fault current contribution (SMIB)

Fault Type	1.0pu voltage	1.1pu voltage
Three-phase fault	0.450 kA	0.496 kA
Single phase-to-ground fault	0.416 kA	0.457 kA
Phase-to-phase-to-ground fault	0.440 kA	0.484 kA

From the above analysis we see that the 3phg, 1Ph-g,and 1Ph-Ph-G fault current contribution exceeds that specified in the existing Generator Performance Standard. As such we would recommend that the Generator Performance Standard is revised to align with fault contributions set to at least those reflected in Table 3.28.

3.16 ESCOSA License Conditions

Assessment of compliance to the ESCOSA model license conditions [?] has been undertaken in the sections below.

3.16.1 Disturbance Ride Through Capability

The generating system must not include any vector shift or similar relay/protective function acting upon voltage phase angle which might operate for phase angle changes less than 20 degrees.

Compliance to this clause has been ensured as part of R1 detailed design. Please refer to the Protection Setting Report [?] which outlines protection functions for this generating system. Additionally, SMA has confirmed that the SCS3600 UP inverters do not trip on asymmetrical phase currents, voltage or angles - there is no such relay to facilitate this. As such the inverters are able to ride-through significant vector jumps. Please also refer to the SMA NER Compliance Report [?].

3.16.2 System Strength

Individual components of plant within a generating system, which includes but is not limited to generating units and dynamic reactive power plant, must be capable of operating down to the following levels at the high voltage terminals in relation to each component:

(a) minimum short circuit ratio of 1.5, and

(b) minimum positive sequence X/R ratio of 2

Please refer to the provided SMA technical note on Sunny Central (Storage) UP Operation at low SCR [**?**]. This note confirms the ability of the inverters to maintain stable operation at SCRs as low as 1.0. SMA has separately confirmed that ”there are no further limitations from an X/R perspective”.

Acronyms

Heywood BESS Heywood Battery Energy Storage System . . . 1

CUO Continuous Uninterrupted Operation . . . 11

DMAT Dynamic Model Acceptance Test . . . 31

GPS Generator Performance Standards . . . 1

OFRT Over-Frequency Ride-Through . . . 9

OVRT Over-Voltage Ride-Through . . . 11

SMIB Single Machine, Infinite Bus . . . 37

TOV Temporary Over-Voltage . . . 16

UFRT Under-Frequency Ride-Through . . . 9

UVRT Under-Voltage Ride-Through . . . 11

References

[1] TI_20220509_SC1725UD_LVRT_HVRT capability_V2_EN.pdf

[2] Harmonic_Assessment_Learmonth_BESS_rev1.pdf

[3] Clarification letter re_5.2.5.6_certification.pdf

[4] GESF-GR-RPT-007 Dynamic Model Acceptance Report (PSCAD).pdf

[5] Learmonth BESS - fault performance.docx

[6] Learmonth BESS - HVRT ride through.docx

[7] SCR Change fault assessment - technical memo.docx

[8] Technical Note - System Strength Withstand SCR Methodology Review V1.1

[9] TI_20230708_SC1200 1375 1575 1725UD_Short-Circuit.pdf

[10] Victorian Planning and Connections Pre-App Scope Two Provision of Location Specific Critical Network Information - Appendix A1

[11] Western Victorian Generation Inter-Trip, Murraylink VFRB and DBUSS Schemes

[12] Sungrow Technote_Learmonth.pdf

[13] Clarification letter re Multiple Fault Ride Through_SC1725UD.pdf

[14] Interconnector Capabilities April 2024 - AEMO

4. Appendices

A Grid Frequency Disturbance Withstand Tests [S5.2.5.3]

B Grid Voltage Disturbance Withstand Tests [S5.2.5.4]

C Continuous Uninterrupted Operation [S5.2.5.4]

D Balanced Faults [S5.2.5.5]

E Unbalanced Faults [S5.2.5.5]

F Temporary Over-Voltage Tests [S5.2.5.5]

G WAN Case 1 - Wide Area Network Contingency Results [S5.2.5.5]

H WAN Case 2 - Wide Area Network Contingency Results [S5.2.5.5]

I WAN Case 3 - Wide Area Network Contingency Results [S5.2.5.5]

J WAN Case 4 - Wide Area Network Contingency Results [S5.2.5.5]

K Partial Load Rejection Tests [S5.2.5.7]

L Frequency Protection Tests [S5.2.5.8]

M Voltage Protection Tests [S5.2.5.8]

N 1 Grid Frequency Disturbance Step Tests [S5.2.5.11] (PSCAD)

O 2 Grid Frequency Disturbance Step Tests [S5.2.5.11] (PSSE)

P WAN Case 1 - Wide Area Network Contingency Overlays [S5.2.5.12]

Q WAN Case 2 - Wide Area Network Contingency Overlays [S5.2.5.12]

R WAN Case 3 - Wide Area Network Contingency Overlays [S5.2.5.12]

S WAN Case 4 - Wide Area Network Contingency Overlays [S5.2.5.12]

T Grid Voltage Disturbance Step Tests [S5.2.5.13]

U Voltage Reference Step Tests (SMIB) [S5.2.5.13]

V WAN Case 1 - Voltage Reference Step Tests (WAN) [S5.2.5.13]

W WAN Case 2 - Voltage Reference Step Tests (WAN) [S5.2.5.13]

X WAN Case 3 - Voltage Reference Step Tests (WAN) [S5.2.5.13]

Y WAN Case 4 - Voltage Reference Step Tests (WAN) [S5.2.5.13]

Z Reactive Power Reference Step Tests (SMIB) [S5.2.5.13]

AA WAN Case 1 - Reactive Power Reference Step Tests (WAN) [S5.2.5.13]

AB WAN Case 2 - Reactive Power Reference Step Tests (WAN) [S5.2.5.13]

AC WAN Case 3 - Reactive Power Reference Step Tests (WAN) [S5.2.5.13]

AD WAN Case 4 - Reactive Power Reference Step Tests (WAN) [S5.2.5.13]

AE Power Factor Reference Step Tests (SMIB) [S5.2.5.13]

AF WAN Case 1 - Power Factor Reference Step Tests (WAN) [S5.2.5.13]

AG WAN Case 2 - Power Factor Reference Step Tests (WAN) [S5.2.5.13]

AH WAN Case 3 - Power Factor Reference Step Tests (WAN) [S5.2.5.13]

AI WAN Case 4 - Power Factor Reference Step Tests (WAN) [S5.2.5.13]

AJ Active Power Control Tests [S5.2.5.14]

AK FCAS Tests [S5.2.5.11]

AL Grid oscillation rejection tests [S5.2.5.13]