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Batch Process Technical Requirements

Hunter Central Coast Renewable Energy Zone

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Ausgrid

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Introduction

To support the efficient and effective connection of generation within the HCC REZ, Ausgrid has specifically targeted the Connection Application and Registration stages of the generator connections processes for improvement.

Under the existing Chapter 5 process, projects normally don't take each other into account until the Application stage has been completed with the issuing of the 5.3.4A letter. This can cause risks to system security and performance and may require the re-running of complex studies and result in impacts to timelines. Using a Batched Assessment Process (considering multiple generation proponents at once) allows parallel projects to take each other into account at an earlier stage, helping to reduce these risks.

Ausgrid will check the wide area impacts of the combined effects of the generation in a Batched Assessment Process. This process includes undertaking system strength and system stability assessments as well as assessing and coordinating the tuning of the individual generators within the batch as required to manage wide area performance.

This allows projects to be developed and progressed through the connections process by Ausgrid as distinct batches aligned to the delivery of HCC REZ components.

Delivering this solution requires the Batch Process to be well defined and understood so that proponents can effectively engage with the process and derive its intended benefits. Supporting the Batch Process are several critical documents, which detail its operation and implementation in more detail. These are:

- Batch Process - General Framework
- Batch Process - Technical Requirements (this document)
- Batch Process - Commercial and Contractual Documentation

This document describes the technical requirements that a proponent must meet if they intend on participating in the Batch Process. Proponents who are unable to meet these requirements may be deemed ineligible to participate in an individual Batch Round. In this case, a proponent will either need to progress under the existing Chapter 5 connection process or continue to develop their connection application package to participate in a future Batch Round.

The technical requirements that must be met include a sub-set of Generator Performance Standards (GPS) clauses, a specified level of Single Machine Infinite Bus (SMIB) model performance and the submission of supporting documentation and reports.

Technical Standards and References

A selection of technical references, standards and guidelines that will support proponents through the connection process are listed below in Table 1 and Table 2. This list is not exhaustive, and proponents should seek further information as required.

Table 1: Ausgrid Technical Standards and References

Ausgrid Documentation	
Network Standards and Technical Requirements	
NS 194 Protection Requirements of Embedded Generators > 30kW	NS 194B Guidelines for Rotating machines connected to the Ausgrid Network
NS 195 High Voltage Customer Connections	NS 238 Supply Quality
NS 143 Easements, Leases and Rights of Way	NS 178 Secondary Systems Requirements for Major Substations
Sample protection schematic	ES3 Metering Installation Requirements Part A

Ausgrid Documentation	
Network standards	
Process Information	
Connecting large registered embedded generators	HCC REZ Batch Process – Participation Technical Requirements
HCC REZ Batch Process – Commercial and Contractual Documentation	HCC REZ Negotiated Access Standards Guideline

Table 2: Third Party Technical Standards and References

External Documentation	
AEMO Documentation	
Generator Connection Application Checklist	Generator Performance Standards (GPS) Template
Modelling requirements (website)	Power System Model Guidelines
Guidelines for Assessment of Generator Performance Standards	System Strength Impact Assessment Guidelines (website)
Dynamic Model Acceptance Test Guideline	System Strength Withstand SCR Methodology Review
Power System Stability Guidelines	
Other References	
National Electricity Rules	

Abbreviations

AAS Automatic Access Standard

AEMO Australian Energy Market Operator

CB Circuit Breaker

CT Current Transformer

GPS Generator Performance Standard

MAS Minimum Access Standard

NAS Negotiated Access Standard

NEM National Electricity Market

NER National Electricity Rules

NSP Network Service Provider

VT Voltage Transformer

Batched Wide Area Assessments

The Wide Area Assessment ensures that system strength, network performance and stability are thoroughly evaluated for a generating system connecting to the NEM. This process is jointly conducted by Ausgrid and AEMO in collaboration with the proponents. The static and dynamic performance of a proponent's plant is evaluated, considering the established system (i.e., network and generation) and the committed system (i.e., future network and generation). Changes to the network or generation can result in the repetition of wide area studies to account for newly committed assets, as system performance will be different.

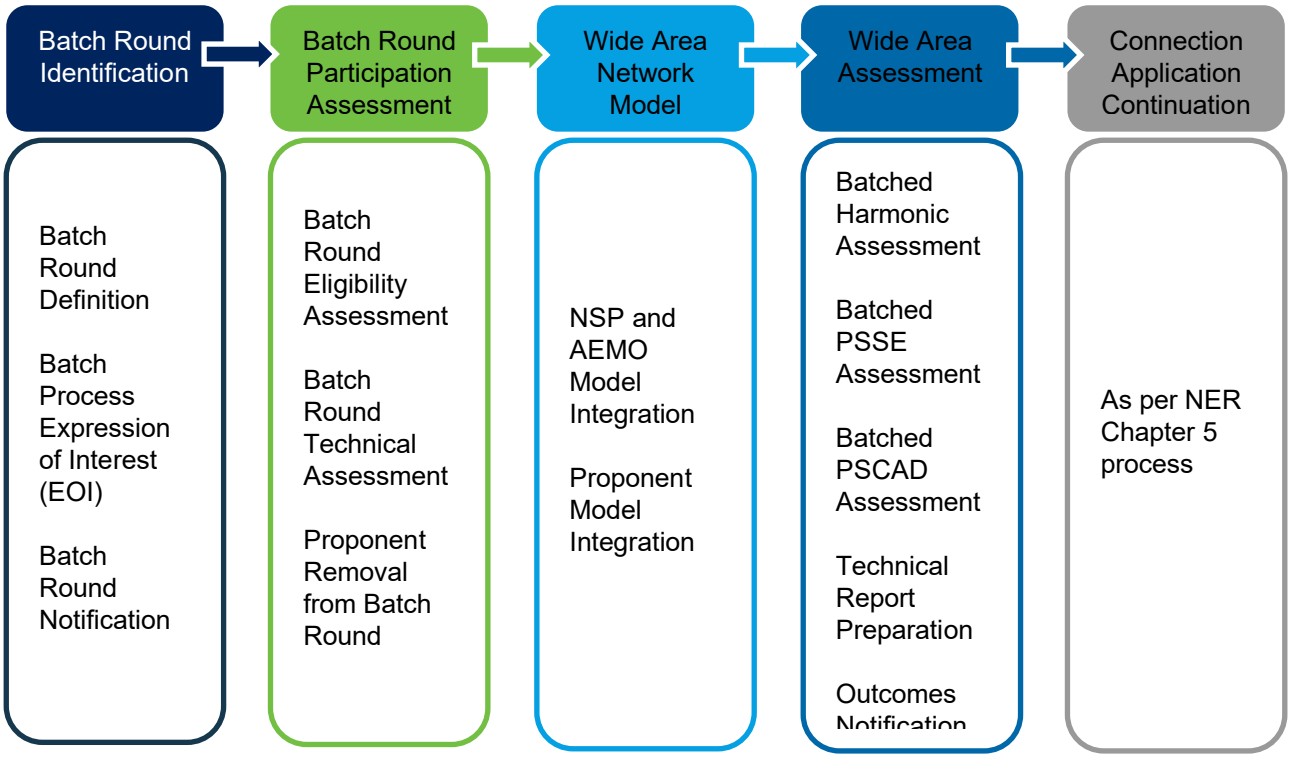
This is particularly problematic in grid locations where multiple generators are engaged in the connection process, each seeking to achieve the 5.3.4A letter. As each proponent reaches committed status, other generators will now need to consider this generation in their own assessments, causing multiple iterations of Wide Area Assessment for both Network Service Providers (**NSPs**), AEMO and proponents.

By assessing multiple generation proponents together (as part of a batch process), combined with a known development pathway for the HCC REZ, the Wide Area Assessment process can be streamlined. This will accelerate the grid connection process by accelerating the connection application and registration model finalisation, reducing the need for multiple iterations and rework. This contrasts with the traditional approach where individual proponents must incorporate others' models into their studies, leading to delays as updates and changes are identified. The traditional approach also potentially produces an adversarial environment as proponents race to achieve the 5.3.4A letter first.

Ausgrid will review the combined impact of the generation systems on system stability, network performance and system strength, and tuning as required before consulting with AEMO. This process allows for coordinated management of wide area performance, ensuring the overall stability of the power system, while removing the risk of repeated studies and rework to account for multiple generation developments.

Batch Process – General Framework

The *Batch Process – General Framework* (this document) describes the overall, end-to-end process that enables Batched Wide Area Assessments to be undertaken. It describes each step of the batch process, including:



The various inputs, outputs, timelines and guidance for each step is provided to aid proponents in effectively engaging in the Batch Process.

Batch Process – Technical Requirements

To participate in the Batch Process, proponents must meet a series of technical requirements. They are described in detail in the *Batch Process – Technical Requirements* document.

These technical requirements reflect the minimum levels of connection application development that are required to support the integration of the proponent's plant into a wide area network model, complete the necessary batch assessments, and provide sufficiently meaningful and accurate results. These technical requirements have been set at a level that balances the need for accuracy and reliability of the Wide Area Assessment results without being excessively onerous on proponents, allowing as many participants in a batch round as possible. In summary, proponents are required to:

Agree a subset of Generator Performance Standards (GPS)	Meet a minimum set of modelling requirements	Submit a partial connection application package
S5.2.5.1 Reactive power capability S5.2.5.2 Quality of electricity generated S5.2.5.3 Generating system response to frequency disturbances S5.2.5.4 Generating system response to voltage disturbances S5.2.5.5 Generating system response to disturbances following contingency events S5.2.5.13 Voltage and reactive power control S5.2.5.15 Short circuit ratio	Site-specific PSCAD/EMTDC and PSS®E dynamic models Model Releasable User Guides (RUGs) Dynamic Model Assessment Tests (DMATs) Benchmarking Report	Proposed GPS (for the specified clauses) Connection Studies Report (including relevant project information and specified GPS clauses) Voltage Control Strategy (VCS) Single Line Diagram (SLD) Harmonic Assessment Report

Ausgrid will work collaboratively with proponents to assess proponents' submissions, reach agreement on performance (where required) and to progress submissions to a point where they are able to comply with the technical requirements and participate in the Batch Process.

Batch Process – Commercial and Contractual Requirements

Participation in the Batch Process will require proponents and Ausgrid to agree and adhere to certain contractual requirements. This is to ensure that the Batch Process can function as intended for the benefit of all participants, Ausgrid and AEMO. These commercial and contractual requirements are in addition to those associated with the existing Chapter 5 connection process. These requirements are detailed in the *Batch Process – General Framework* document.

Generator Performance Standards

Ausgrid has identified the specific GPS under Clause S5.2 that must be agreed prior to undertaking a Batched Wide Area Assessment. This is a subset of the full range of GPS clauses that must ultimately be agreed between the proponent, Ausgrid and AEMO (where applicable). The GPS clauses that must be agreed are those that have the potential to impact a proponent's plant's performance once it is integrated into the Wide Area model. Future changes to these settings may result in undesirable behaviours that would need to be re-assessed and may delay a proponent's progress towards connection.

These clauses are to be agreed above the Minimum Access Standard (MAS) and include the "General Requirements". These clauses are not expected to be above the Automatic Access Standard (AAS) and the established 5.3.4A process will be followed for agreeing to a Negotiated Access Standard (NAS). Ausgrid has provided separate guidance for negotiated access standards related specifically to the HCC REZ in the *HCC REZ Negotiated Access Standards Guideline*.

During the Wide Area Assessment, some tuning changes may be identified that support overall system performance. If required these changes will be reflected into the previously agreed performance standards. Table 3 lists the GPS clauses that must be agreed for a proponent to participate in a Batch Process. It also indicates the elements of performance that may be modified as part of the batch tuning process.

Table 3: Performance Standards to be agreed for participation in a Batch Process

NER Clause	Technical Requirement	Potential changes following Wide Area Assessment
S5.2.5.1	Reactive Power Capability	Capability may be increased, but unlikely to decrease
S5.2.5.2	Quality of electricity generated	Nil
S5.2.5.3	Generating system response to frequency disturbances	Nil
S5.2.5.4	Generating system response to voltage disturbances	Voltage ranges may be extended, but not contracted
S5.2.5.5	Generating system response to disturbances following contingency events	Fault clearance times are unlikely to change as they are based on network needs MFRT is unlikely to change as it is based on the OEM control implementations (e.g., fault counters and timers) and limits of the physical plant (e.g., multiple faults causing plant elements to hit their thermal limits, i.e., IGBTs) Current injection amount, rise time and settling time are likely to change. Based on de-tuning to prevent oscillations and unstable operation in a low SCR network Coordination of response with other nearby units may be required, e.g., stagger different plant responses to prevent all plant responding at the same time, exacerbating the event rather than assisting in the recovery of the event.
S5.2.5.13	Voltage and reactive power control	Units will most likely continue to primarily be in voltage droop control mode with options of PF and Q control also likely required Settling times for active power, reactive power and voltage may be increased or reduced based on Wide Area studies results. This reflects coordinating tuning with other units, network needs and to consider low fault level, weak network sections PSS and POD requirements may be assessed on small signal studies.
S5.2.5.15	Short circuit ratio	Withstand SCR may be decreased, but not increased

NER Clause	Technical Requirement	Potential changes following Wide Area Assessment
S5.2.8	Fault level	Maximum expected fault contribution. Fault level may be decreased but not increased.

S5.2.5.1 Reactive power capability

This clause focuses on the capability of a generating system or integrated resource system to deliver reactive power at its connection point. Supply or absorption of reactive power is essential for maintaining a suitable voltage profile in the power system and helps support the system under a range of operating conditions.

The capability of the generating system or integrated resource system to deliver reactive power overlaps with many other clauses as it expresses the expected operational conditions for P, Q and V that frames all other clauses.

By agreeing this capability before Batched Wide Area studies, Ausgrid can ensure consistent generating system size for studies, and sufficient reactive power is available for voltage control.

S5.2.5.2 Quality of electricity generated

This clause sets out the requirements for the quality of the electricity that a generating system or integrated resource system injects into the network. The primary aim is to ensure that electricity generation does not degrade the power quality of the grid, specifically concerning factors such as voltage waveform distortion, flicker, harmonics, and unbalanced voltage conditions.

Early detection of harmonic emission problems allows proponents to modify their design or install necessary filters to mitigate these effects. This is relevant as the installation of harmonic filters generally involves the inclusion of capacitive and reactive elements that can change the plant's reactive power performance at its connection point (i.e. impact S5.2.5.1 performance).

Confirming S5.2.5.2 performance, including the need for harmonic filtering, is critical to finalising S5.2.5.1 performance.

Harmonic allocations for each generating system or integrated resource system and network harmonic polygons will be made available to proponents at Connection Enquiry stage to ensure the generating system or integrated resource system is designed to meet the S5.2.5.2 requirements.

S5.2.5.3 Generating system response to frequency disturbances

This clause specifies the expected frequency withstand range for generating systems or integrated resource systems. The generating system or integrated resource systems must remain online during frequency disturbances outlined in this clause, without tripping, under any operational conditions defined in S5.2.5.1. All units are expected to comply with the AAS. Applicants should ensure they select an OEM that meets this requirement. This clause is generally not impacted by wide area studies, which can be verified using an SMIB model in PSS/E or PSCAD.

If a generating system or integrated resource system requires auxiliary loads (such as yaw motors and auxiliary supply systems) to maintain operation, evidence must be provided that these auxiliary loads can withstand the frequency disturbance.

S5.2.5.4 Generating system response to voltage disturbances

This clause outlines the technical requirements for how a generating system or integrated resource system should remain connected during voltage disturbances at their connection point. The focus of this clause is to ensure that the generating system or integrated resource system remains connected and operational during such disturbances, which could occur following power system contingency events such as network voltage deviations. The generating system or integrated resource system should remain in continuous uninterrupted operation for these voltage disturbances and under any operational conditions defined in S5.2.5.1.

Any auxiliary plant that supports the generating system or integrated resource system's continuous uninterrupted operation must also demonstrate the capability to withstand voltage disturbances.

S5.2.5.5 Generating system response to disturbances following contingency events

This clause outlines the requirements for a generating system or integrated resource system's ability to respond to disturbances in the power system. The primary purpose is to ensure that generating units remain connected and stable during credible contingencies and the ability of connected systems to withstand and recover from faults.

Coordination of generating unit response with other nearby units may be required, e.g., stagger different plant responses to prevent all plants responding at the same time, exacerbating the event rather than assisting in its recovery. A coordinated response can be obtained for the overall benefit of the power system.

As a result of Batched Wide Area Assessment, current injection magnitude, rise time and settling time may change, based on de-tuning to prevent oscillations and unstable operation.

MFRT is unlikely to change as it is based on the OEM control implementations (e.g., fault counters and timers) and limits of the physical plant (e.g. multiple faults causing plant elements to hit their thermal limits, i.e., IGBTs).

If the generating system or integrated resource system fails to meet the requirements of S5.2.5.5, it may trip during contingencies, leading to underperformance or cascading issues across the grid. Having an agreed performance standard for this clause will enable an accurate assessment of a proponent's contribution to system performance during and after faults.

S5.2.5.13 Voltage and reactive power control

This clause outlines the requirements for voltage and reactive power control for a generating system or integrated resource system. It specifies that a generating system or integrated resource system must regulate voltage at its connection point by adjusting its reactive power output. Key points of the clause include:

- The generating system or integrated resource system must have automatic voltage control to manage voltage within agreed limits at the connection point.
- The generating system or integrated resource system must be able to absorb or supply reactive power to maintain voltage levels, especially during system disturbances.
- The system should maintain stable voltage control under various operating conditions and coordinate with other generating systems and network service providers.

This clause significantly impacts the Batch Process, as voltage and reactive power control are key factors contributing to the stability and reliability of the power system. As part of the assessment, the following are evaluated:

- Whether the generating system or integrated resource system can consistently meet voltage control requirements across all operating scenarios.
- The generating system or integrated resource system's ability to provide sufficient reactive power to control voltage and its impact on overall grid voltage control.
- The coordination of the generating system or integrated resource system's voltage control systems with other generators and the network.

Successfully completing this evaluation requires the clause (as well as S5.2.5.1) to be fully agreed so Ausgrid can ensure voltage control will be effective under different grid conditions. Depending on the results of the Wide Area Assessment, further tuning may be required to support overall system performance.

S5.2.5.15 Short circuit ratio

This clause addresses the Short Circuit Ratio (SCR) requirements for asynchronous generating systems or integrated resource systems connected to the grid.

Withstand SCR is also used when considering System Strength as part of the System Strength Impact Assessment Guidelines (SSIAG). As part of this clause, proponents must demonstrate their minimum Withstand SCR (i.e., the lowest fault level for which the plant can operate stably).

This will allow Ausgrid to complete the minimum SCR stability checks and identify any proponent plant that is contributing to instability. Pre-agreeing this clause also ensures the generating system or integrated resource system aligns with the grid's established conditions, mitigating instability risks and enabling early detection of potential stability issues.

By understanding the minimum SCR expected from asynchronous generating systems or integrated resource systems, proponents can select an appropriate OEM that can meet it.

S5.2.8 Fault level

This clause addresses the fault current contribution generating system or integrated resource system to the network, as well as the fault current withstand of the generating system or integrated resource system and the fault current interrupting capacity of the circuit breakers that isolate it from the network.

Considering the fault current contribution of the generating system or integrated resource system is important in ensuring that the fault rating of existing equipment is not exceeded. Ausgrid will consider the fault current contributions of all proponents under the Batch Process, to check that the fault withstand capability of the network and proponents' sites is maintained under all conditions.

Model Requirements

To participate in the Batch Process the model is expected to meet relevant guidelines and requirements as indicated by the NER. This is important to allow Ausgrid to fully integrate the proponent models into the Wide Area Network and have a degree of confidence that the results obtained from Wide Area Assessments accurately reflect plant performance.

The applicant is expected to provide the relevant documentation as normal in their connection application. This would include the elements noted in the *AEMO Connection Application Checklist*. The models provided should be site-specific and tuned to meet the agreed performance standards.

Proponents are required to provide documentation that supports the use of the models i.e. PSS/E and PSCAD Releasable User Guides (RUGs), demonstrate an individual model's performance through the completion of the Dynamic Model Acceptance Test (DMAT) Guideline and the completion of Benchmarking Report between the PSS/E and PSCAD models. This demonstrates that the models can meet the relevant guidelines and requirements set by AEMO.

The models provided are expected to meet the relevant guidelines and requirements. These include the Power System Model Guidelines and DMAT.

Site-Specific Model Requirements

As part of the Batched Wide Area Assessment, the proponent must provide Ausgrid with site-specific PSCAD/EMTDC and PSS/E dynamic models to simulate the generating system's responses during disturbances, faults, and normal grid operations. These models must comply with *AEMO's Power System Models Guidelines* and accurately represent the generating system's responses to multiple and sequential disturbances, or as required for the specific assessment.

The model should be fully optimised and capable of demonstrating the plant's ability to meet performance criteria under the relevant NER clauses, outlined in Table 3. It must include detailed information on the generator's control systems, protection schemes[1] and equipment, including synchronous machines or inverters, transformers, and reactive power control systems.

The models should simulate the generating system's performance under a range of operating conditions, including maximum and minimum power output as specified by the S5.2.5.1 capability. They should assess the system's ability to maintain voltage stability under varying grid conditions. The model should also demonstrate dynamic stability for all required SCRs, including the minimum, maximum, and withstand SCRs specific to the site, as agreed with Ausgrid and AEMO.

Additionally, a model should be provided to assess the system's harmonic distortion contribution and power quality, including the potential for harmonic resonance, and ensure compliance with AS/NZS 61000 standards for electromagnetic compatibility (as applicable).

Model Releasable User Guides (RUGs)

Proponents must provide model RUGs in a format and with content consistent with AEMO's *Guideline for Preparation of a Releasable User Guide.* A separate RUG is required for both the PSCAD/EMTDC and PSS/E models. The provided RUG must contain sufficient information to enable Ausgrid (and AEMO and Transgrid as applicable) to use encrypted model source code provided to carry out power system studies and assess the proponent's plant for suitability for connection to the NEM.

It is accepted elements of the RUG may be changed and further updated when the balance of power systems studies required for a complete GPS and Connection Application Package are performed. The provided RUG

[1] As relevant to the NER Clauses listed in Table 3

must fully describe the model, plant configuration, its capabilities and operation to meet performance criteria under the relevant NER clauses, outlined in Table 3.

Where a section or sections of the RUG are incomplete at this stage of the proponent's Connection Application (and it is not related to these technical requirements), they are to be included as a placeholder, with a statement that "this information will be provided with the connection application submission."

Dynamic Model Assessment Tests (DMAT)

Proponents must complete DMATs for both the PSCAD/EMTDC and PSS/E models. This is necessary to demonstrate proponent models are usable, numerically robust and represent the installed plant under reasonably expected operating conditions. AEMO's *Dynamic Model Acceptance Test Guideline* explains how to assess the accuracy, consistency and robustness of computer models used for power system analysis.

Proponents are to complete all tests defined in this Guideline and provide suitable reports that demonstrate and discuss the results as required. In the event that tuning changes are required following the Wide Area Assessment, Ausgrid will work with the proponent to determine what (if any) tests are required to be repeated.

Benchmarking Report

Proponents must provide a Benchmarking Report, consistent with the requirements of both *the Dynamic Model Acceptance Test Guideline* and AEMO's *Power System Model Guidelines*. This includes benchmarking the response PSS/E and PSCAD for all balanced fault events and control actions for all tests listed in the DMAT Guideline. The Benchmarking Report must demonstrate the performance across the full range of required tests and discuss the results, especially any deviations or exceptions to compliance.

The PSS/E and PSCAD models are expected to provide consistent and accurate responses within the specified tolerance limits. In instances where this cannot be demonstrated, it should be adequately explained and documented. Depending on the magnitude and consequence of any performance deviations, as well as the adequacy of the provided explanations and potential resolution pathways, Ausgrid may elect to accept the model performance for the purpose of undertaking Wide Area Assessment. This will be discussed and agreed with proponents on a case-by-case basis as required.

Connection Package

The technical requirements for Batch Process participation are to be met and demonstrated with the submission and assessment of a partial Connection Package. The partial Connection Package must contain all the elements listed in Table 4.

The Connection Package will be assessed in a similar manner to a Clause 5.3.4A submission under the NER.

Table 4: Connection Package requirements

Document Requirements	Comment
Proposed GPS	Proposed GPS (in AEMO GPS template) with acceptable performance standards specified for clauses listed in Table 3.
Connection Studies Report (CSR)	A CSR that reflects the proposed GPS, containing enough information to support and evaluate the proposed performance. The CSR only needs to include relevant project information and consider performance standards specified for clauses listed in Table 3.
Voltage Control Strategy (VCS)	A VCS that explains how the plant meets the proposed S5.2.5.1 and S5.2.5.13 performance standards
Single Line Diagram (SLD)	Conceptual SLD of the plant, showing the detailed connection arrangement of the plant and connection point. This is required to be more detailed than the modelling SLDs and shows critical primary plant such as CBs, CT, VTs, Metering etc.
Harmonic Assessment Report and PowerFactory Model	A Harmonic Assessment Report (together with the PowerFactory model) to demonstrate compliance with clause S5.2.5.2. If any harmonic filtering is required, the size is to be specific to enable S5.2.5.1 assessment
PSS/E Model PSS/E RUG PSS/E DMAT	A validated PSS/E model, consistent with the requirements of section 0. A RUG, consistent with the requirements of section 0. Completed DMAT and associated report, consistent with the requirements of section 0.
PSCAD Model PSCAD RUG PSCAD DMAT	A validated PSCAD model, consistent with the requirements of section 0. A RUG, consistent with the requirements of section 0. Completed DMAT and associated report, consistent with the requirements of section 0.
PSS/E/ PSCAD Benchmarking	Benchmarking Report consistent with the requirements of section 0.
Tuning Indications	Details of any model tuning that may be completed by Ausgrid to meet overall system need. Includes the identification of tuneable parameters and any applicable tuning ranges or limitations