1. Connection Application Studies Assumptions

AEMO’s Victorian Planning and Connections team encourages early engagement confirming any study assumptions to ensure when an application is submitted it aligns with our expectations.

Key assumptions for connection studies when connecting to the Victorian Declared Transmission System are described below.

In this Appendix, the term “committed” is taken to have the definition given in the SSIAG.

S5.2.5.4 Continuous Uninterrupted Operation (CUO) Test Assumptions

For testing the CUO capability of the plant in the normal operation range (90%-110% of normal voltage) the following tests should be applied at the plant’s Pmax and Pmin:

* Initially operating at Qmax and 1.0pu voltage at the Connection Point, step the Connection Point voltage down to 0.9pu with an infinite grid at the Connection Point
* Initially operating at Qmin and 1.0pu voltage at the Connection Point, step the Connection Point voltage up to 1.1pu with an infinite grid at Connection Point

Under these tests, the plant should be able to recover its initial reactive power dynamically without relying on tap changers or switching of static reactive plant.

Active power at the Connection Point may change due to increased losses inside the balance of plant, however generating units should not reduce their active power output in these tests.

While voltage is only required to step by 10% for this test, poor performance for larger steps (for example, dumping of active power or withdrawing of reactive power support) may still be unacceptable if it occurs during network fault studies in S5.2.5.5 (such as in a scenario where the far end of a line has not cleared but Connection Point voltage recovers close to 0.9pu).

This test may trigger fault ride through mode (where applicable) if applied as a step due to the sharp change in voltage. If this occurs, using a fast ramped change in voltage for the test may be more appropriate to demonstrate compliance.

S5.2.5.5 OPDMS Study Cases

AEMO’s Victorian Planning and Connections team requires at minimum (in either the Victorian region or the whole NEM):

* one PSS/E OPDMS case with highest load; and
* one PSS/E OPDMS case with lowest load.

At the time you submit your Connection Application, the OPDMS case should not be more than 12 months old.

All committed generators in Victoria need to be considered irrespective of their location and size. Generators connected deep in the distribution network should be connected to the nearest transmission network point if the network is not modelled in the snapshot.

If the Connection Point is close to the state border, nearby committed generators in the neighbouring state should also be considered. Please note that Finley Synchronous Condenser and the two Darlington Point synchronous condensers should be in service at all times (both are connected at Buronga Terminal Station) in any cases that do not include Project EnergyConnect.

Project EnergyConnect must be included for your project’s connection application studies, please discuss with AEMO prior to commencing studies. Project EnergyConnect models are available through AEMO data request.

The target output of Static VAR Compensators (SVCs) is to be less than 30% of rated output for both reactive power injection and absorption.

In setting up the cases, please aim to maintain sufficient reactive reserves (one third of capability) for the prevailing system conditions to provide system stability.

Highest Load Cases

The Highest Load Case should fulfill the following requirements:

* Solar or wind generation should both be dispatched with high output.

BESS should be dispatched as close to Pmax as possible.

* The following interconnector flow cases should be created alone or in combination:
  + 1. VIC - NSW (High Import from NSW to VIC) for projects which are connecting near or impact on the Victoria to NSW Interconnector (VNI)
    2. Heywood Importing from South Australia

Project EnergyConnect flows should not be circular when interconnector loading is high on both Heywood and VNI. This means if VNI is flowing towards NSW and Heywood is flowing towards Victoria, Project EnergyConnect should be flowing towards NSW. Similarly, if VNI is flowing towards Victoria and Heywood is flowing towards South Australia, then Project EnergyConnect should be flowing towards South Australia.

Lowest Load Cases

The Lowest Load Case should fulfill the following requirements:

* Lowest Fault Level (synchronous) case needs to be created. You may select any minimum combination of synchronous generators to operate in Victoria and South Australia, as described in AEMO’s [Transfer limit advice: System strength in SA and Victoria](https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/congestion-information/transfer-limit-advice-system-strength.pdf?la=en) document. However, the VIC\_2 case is preferable, which operates with 4 Loy Yang units and 1 Newport generator.
* Generally, solar generation should be dispatched with high output and wind generation should be dispatched with low output where constraints prevent all plant being at high output simultaneously.

BESS should be dispatched at zero output in cases where the DC coupled BESS is assumed at 0 generation. The new BESS’ Pmax case should also assume nearby BESS are dispatched at high generation.

* If the plant under assessment is a solar farm, generally solar generation should be dispatched with high output and wind generation should be dispatched with low output where constraints prevent all plant being at high output simultaneously.

BESS should be dispatched at zero output when assessing a new wind or solar connection.

* The following interconnector flow cases should be created alone or in combination:
  + 1. VIC - NSW (High Import from NSW to VIC)
    2. VIC - NSW (High Export to NSW from VIC)
    3. Heywood Exporting to SA
    4. Heywood Importing from SA

These can be summed into two cases i.e. (1) and (3) can be represented in the same case and likewise (2) and (4) can be represented in the same case. If representing (1) and (3) together with Project EnergyConnect included, Project EnergyConnect should be transferring power from NSW to SA. Similarly if representing (2) and (4) together with Project EnergyConnect included, then Project EnergyConnect should be transferring power from SA to NSW

Interconnectors

Interconnector limits are available in Table 40 of AEMO’s [Inputs Assumptions and Scenarios Report](https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf?la=en). All interconnectors need to be monitored with varying import and export scenarios. Up to 70- 80% interconnector capability should be achieved

**Interconnectors with the Victorian Declared Shared (Transmission) Network**

* Jindera Wodonga
* Upper Tumut- Murray
* Lower Tumut – Murray
* Red Cliffs – Buronga
* Murray-link DC
* Basslink DC
* Heywood

Assumptions to be applied in PSS/E OPDMS

* Basslink/Murray-link flows can be set as either import or export.
* None of the voltages in the system should be above 1.1 per unit or below 0.90 per unit.
* Thermal Loadings of lines should not be violated. AEMO can provide line ratings for lines at 40ºC and 5ºC however this does not include the impact of wind monitoring equipment.
* Transformer loadings need to be monitored.
* AEMO can provide details of runback/trip schemes for generators, DC Links or loads, as well as any key local constraints to be considered in the OPDMS case.
* All generators/SVCs should not be hitting the reactive power limit (apart from generators in power factor mode).
* All shunts/reactors in the system need to be operating as per their scheme.
* No additional equipment/augmentations (e.g. reactors, capacitors or load augmentation) should be added onto the NEM system to support voltages
* AEMO can provide protection clearance times including auto-reclosure (AR) time.
* Where actual settings are not available, please use the NER default fault clearance timings.
* AEMO can provide information on any new network augmentations, models of considered projects are available through AEMO data request.
* If the synchronous condensers connected in Buronga, Kiamal, or Murra Warra are considered for PSS/E studies, their respective NSW farms should also be augmented in the studies.
* For NER S5.2.5.12 studies, any control methodology (Voltage Droop, PF, Q control) for the new generator and nearby generators should be implemented via Python scripting to show the change in network voltages for different contingencies.
* Irrespective of the location and size of the project, all interconnectors need to be monitored.
* Irrespective of the location and size of the plant, voltage across the Victorian network needs to be monitored. The following buses must be monitored for any project:
* Red Cliffs 220kV
* Wodonga 330kV
* Ballarat 220kV
* Heywood 500kV
* Glenrowan 220kV
* Hazelwood 500kV

S5.2.5.12 Study Requirements

Assessment of Thermal Limits

The OPDMS cases will include a snapshot of equipment ratings by default, however the ratings used for your assessment should be the temperature ratings corresponding to your maximum operating temperature.

Where a high temperature rating is exceeded, it should be investigated what temperature rating would be sufficient to accommodate the extra generation.

Please note the temperature dependent ratings are static and do not account for the increased operational ratings from wind monitoring equipment.

The system will be dispatched such that:

* Pre-contingent transmission element loading must not exceed continuous ratings.
* Short term N-1 post-contingent loading must not exceed short term ratings - continuous ratings apply where no short-term ratings are available
* Steady state N-1 post-contingent loading does not exceed continuous ratings.

If any of the above conditions are breached in static studies, constraints should be expected to apply under some scenarios.

Assessment of Dynamic Voltage Limits

* After the switching of a network element but before the action of on-line tap changers and switched shunts, the total change in voltage at a bus should not exceed 0.1pu.
* Static modelling of voltages after switching out an element must account for changes in reactive power output of nearby plants using a voltage droop control strategy.
* Steady state N-1 reactive margin must be ≥1% of the maximum three phase bus fault level.

The voltage change assessment is summarised in the below table:

|  |  |
| --- | --- |
| Assessment | Criteria |
| Bus voltage | 0.9 pu <= Bus voltage <= 1.1 pu |
| Voltage below 0.9 pu and voltage above 1.1 pu is defined as outside the normal operating range |
| Step change in voltage due to regular Plant output variations | Less than requirements in Table 7, AS 61000-3-7 (2001) |
| Step change in voltage due to sudden loss of P (e.g. cloud cover) | < 0.05pu |
| Step change in voltage due to tripping of major network elements | < 0.10pu |