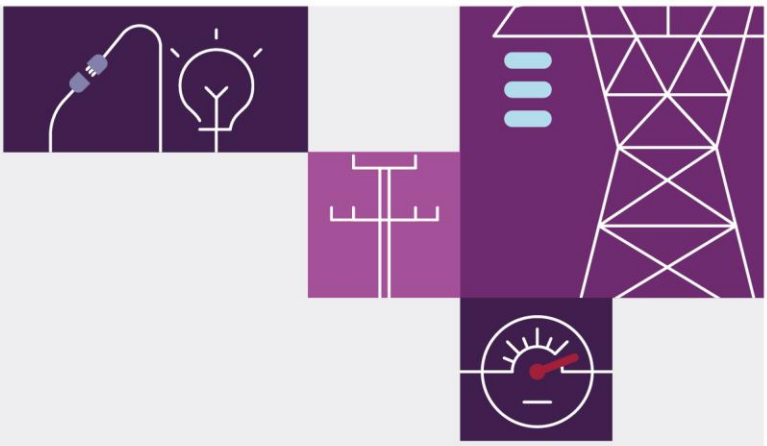
Victorian Transfer Limit Advice – Outages

April 2025

A report for the National Electricity Market on transfer limits in the Victorian region.



Important notice

Purpose

This publication has been prepared by AEMO to provide information about the transfer limit equations for flows to, from and inside Victoria for voltage stability, transient stability, voltage oscillation and voltage unbalance limits or constraint equation performance and related issues, as at the date of publication.

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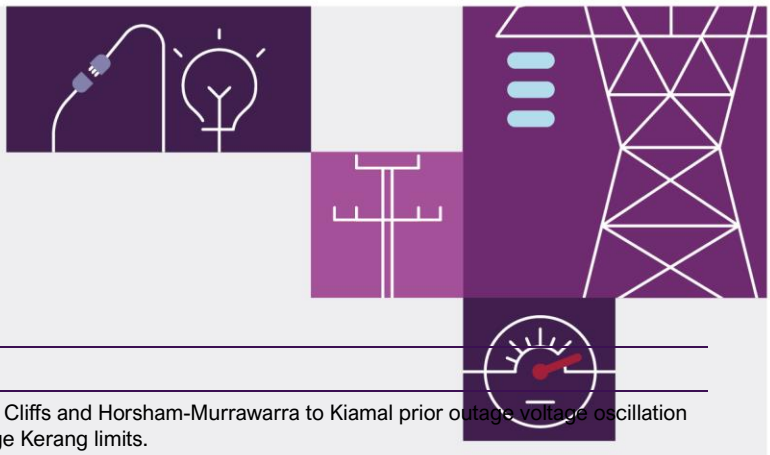
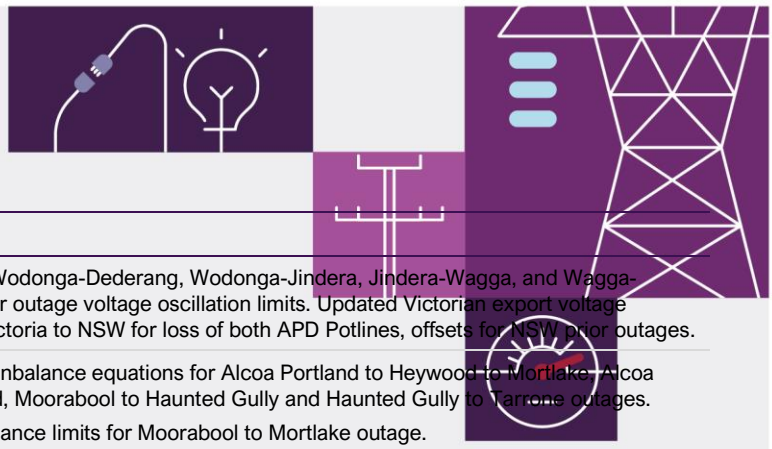


Version control

Version	Release date	Changes
50	11 April 2025	Updated Kiamal-Red Cliffs and Horsham-Murrawarra to Kiamal prior outage voltage oscillation limits and prior outage Kerang limits.
49	28 March 2025	Updated Horsham to Murrawarra to Kiamal 220 kV line prior outage limit.
48	21 March 2025	Updated Dederang-Murray 330 kV line outage NSW-Vic limit and update of Horsham to Murrawarra to Kiamal 220 kV line prior outage islanding limits.
47	19 December 2024	Added definitions of inverter and turbine limits, removed Buronga – Red Cliffs outage.
46	30 October 2024	MLTS-SYTS outage limit and other limits.
45	23 August 2024	Updated 0x1 prior outage limit and other limits.
44	02 May 2024	Updated several outage limits.
43	30 Oct 2023	Updated Kerang voltage collapse limit for Murraylink outage w.r.t Murraylink VFRB changes, document review, moved voltage oscillation/islanding limits into tables.
42	10 April 2022	Updated to new AEMO template.
41	28 March 2022	Update system strength combo for outage of Moorabool – Sydenham 500 kV line. Update Voltage Oscillation Limit and Murraylink voltage stability limit for outage of Bendigo – Shepparton 220 kV line.
40	04 March 2022	Update voltage stability import limits for outage of Dederang to South Morang 330 kV line for the trip of the largest generator in Victoria or Basslink or the trip of the remaining line, and update of voltage stability export limit for the trip of APD.
39	15 January 2022	Update system strength combo for outage of Moorabool – Sydenham 500 kV line and Hazelwood – Loy Yang 500kV line. Updated Kerang voltage collapse limit for Murraylink outage. Updated NSW to VIC voltage stability limits for Murraylink outage.
38	01 October 2021	Updated voltage oscillation limits for the outage of Horsham SVC.
37	23 June 2021	Updated Murraylink voltage stability limits for Bendigo - Kerang 220 kV lines outage. New voltage oscillation limits for the outage of Ballarat – Bendigo 220 kV line.
36	31 May 2021	Updated Murraylink voltage stability limits for Ararat – Waubra – Ballarat, Ararat – Waubra, Ballarat to Waubra 220 kV lines outages.
35	20 May 2021	Updated voltage oscillation limits and update to offsets to Vic to NSW voltage stability export and import limits for Buronga-Red Cliffs 220 kV lines outages.
34	07 April 2021	Updated voltage oscillation limits for Red Cliffs-Wemen-Kerang 220 kV lines outages.
33	22 March 2021	Updated voltage oscillation limits for Kiamal to Red Cliffs outage.
32	25 February 2021	Added system strength requirement for outage of Hazelwood – Loy Yang 500 kV line and Moorabool – Sydenham 500 kV line.
31	19 February 2021	New voltage oscillation limits for outage of Moorabool – Sydenham 500 kV line.
30	5 February 2021	Updated Murraylink voltage stability limits for Ararat – Waubra – Ballarat, Ararat – Waubra, Ballarat to Waubra 220 kV lines outages. Updated table of Parameter Definitions.
29	19 January 2021	Updated voltage oscillation limits for Ararat – Waubra – Ballarat, Ararat – Waubra, Ballarat to Waubra and Ararat - Crowlands 220 kV lines outages. Merge outage section of Ararat to Waubra 220 kV line and Ballarat to Waubra 220 kV line into outage section of Ararat to Waubra to Ballarat 220 kV line.
28	9 December 2020	Updated voltage oscillation limits for Bulgana WF, Bulgana battery and Gannawarra battery for the Bendigo to Kerang outage.
27	24 November 2020	Updated voltage oscillation limits for Horsham and Kerang SVC outages.
26	2 November 2020	Moved outages in NSW and SA to new limits advice doc, added voltage oscillation and islanding limits for Bendigo to Kerang outage.



Version	Release date	Changes
25	15 October 2020	Updates to X3, X5, Wodonga-Dederang, Wodonga-Jindera, Jindera-Wagga, and Wagga-Darlington Point prior outage voltage oscillation limits. Updated Victorian export voltage stability limit from Victoria to NSW for loss of both APD Potlines, offsets for NSW prior outages.
24	1 September 2020	Updates to voltage unbalance equations for Alcoa Portland to Heywood to Mortlake, Alcoa Portland to Heywood, Moorabool to Haunted Gully and Haunted Gully to Tarrone outages. Added voltage unbalance limits for Moorabool to Mortlake outage. Updated Kiamal limits for Ararat to Waubra to Ballarat and Horsham to Murra Warra to Kiamal. Changed all inverter limit text from “on-line” to “connected”. Added notes on all TransGrid line outages to indicate TransGrid provide outage advice for these.
23	21 August 2020	Updates to the Kerang to Wemen to Red Cliffs outage limits.
22	31 July 2020	Updates to voltage oscillation and islanding limits for Kiamal to Red Cliffs and Horsham to Murra Warra to Kiamal outages.
21	1 May 2020	Removed the references to the system normal output and inverter limits of Broken Hill, Bannerton, Gannawarra, Karadoc and Wemen solar farms. Corrected minor typos.
20	20 April 2020	Added Ballarat – Bendigo voltage oscillation limits for the condition Bulgana WF is constrained to 5 MW.
19	8 January 2020	Added Buronga – Red Cliffs (0X1) voltage oscillation limits. Added information on when Balranald to Darlington Point (X5) is switched out with other line outages.
18	8 November 2019	Added new limits for Horsham SVC outage.
17	4 October 2019	Added new limits for Kerang SVC outage, updated voltage oscillation limits for 220 kV outages between Horsham and Red Cliffs, updated islanding limits for wind farms for north-west Vic outages.
16	13 September 2019	Added voltage oscillation limits for Buronga – Darlington Point (X5 and X3), Buronga – Red Cliffs (OX1) and Bendigo – Kerang outages, updated limits for Ararat – Waubra – Ballarat. Added limits for solar farms for north-west Vic outages.
15	9 August 2019	Added voltage oscillation limits for Bulgana to Crowlands line, updated information on operating Horsham SVC for north-west Vic outages. Updated Murra Warra limits for Crowlands to Bulgana to Horsham, Horsham to Murra Warra and Kerang to Wemen to Red Cliffs outages. Change inverters to maximum on-line instead of off. Removed voltage unbalance limits for APD-Heywood-Tarrone outage with one Mortlake in service. Added notes to north-west Vic outages that are being reviewed for voltage oscillation limits.
14	29 May 2019	Added voltage oscillation limits for Kerang to Wemen to Red Cliffs lines and changed to have all these line outages into one section in the doc. Added Murraylink voltage collapse limits for outages of Bendigo to Kerang, Ararat to Waubra and Ararat to Waubra to Ballarat lines.
13	14 May 2019	Added voltage oscillation limits for Horsham to Murra Warra line and Red Cliffs to Wemen lines.
12	1 May 2019	Added islanding limits for Ararat to Crowlands, Ararat to Waubra and Crowlands to Bulgana to Horsham outages. Further clean-up of section titles. Updated voltage oscillation limits for Bulgana to Horsham outage.
11	5/4/2019	Updated Murraylink limit for Ballarat to Waubra outage.
10	2/4/2019	Updated voltage oscillation limits for Ballarat to Waubra outage. Changed some section titles.
9	20/3/2019	Updated voltage oscillation limits for Horsham to Red Cliffs, editing and formatting fixes.
8	15/2/2019	Added voltage oscillation limits for Ballarat to Waubra, Horsham to Red Cliffs, Kerang to Wemen to Red Cliffs and Crowlands to Horsham outages.
7	23/11/2018	Updated Voltage stability limit equations, additional prior outage offsets and application of new template.
6	23/072018	Updated Voltage stability limit equations.
5	01/08/2017	Updated for Heywood Upgrade post series caps (system normal). Full document review. Updated to new AEMO template. Split multiple outages into separate document. Added voltage unbalance limits.
4	31/03/2015	Added further Victorian import and export limit equations.

Version	Release date	Changes
3	21/08/2014	Added Victorian import limit equations and updated to new AEMO template.
2	14/11/2013	Updated initial equations, with term for Mount Mercer Wind Farm (MMWF) MW output, added additional prior outage equations.
1	12/03/2012	Initial version.

Contents

Tables

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1 Introduction

AEMO is responsible for calculating the maximum transient and voltage stability limits into and out of Victoria (National Electricity Rules (NER) S5.1.2.3) in accordance with Power System Stability Guidelines[1]. This document describes the values for these transfer limits for system normal conditions (that is, when all transmission elements are in service) in Victoria.

This limits advice document also describes the methodology used by AEMO to determine the transient and voltage stability limits.

The limit equations for Victoria for cases are described in this document and the following separate documents[2]:

- Victorian Transient Limit Advice – System Normal.
- Victorian Transient Limit Advice – Outages in Adjacent Regions.
- Victorian Transfer Limit Advice – Multiple Outages.

1.1 Other AEMO publications

Other limit advice documents are located at https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource/limits-advice.

1.2 Calculating transient and voltage stability limits

Transfer limit equations are developed for power transfers into and out of Victoria (known as import and export limits respectively). Maximum export is limited by transient stability, whereas maximum import is determined by voltage stability.

Transient stability limit equations are derived from a large number of transient stability studies. Stability studies are based on the application of a 2-phase to ground fault at the most critical fault location.

Voltage stability limit equations are derived from a large number of load flow studies. Studies consider the trip of a large generator, the loss of Basslink when exporting from Tasmania (Tas) to Victoria (Vic), and where appropriate the fault and trip of a critical transmission line or transformer.

1.2.1 Methodology

The methodology for calculating voltage and transient stability limits is given below:

1. Generate a set of Power System Simulator for Engineering (PSS/E) cases to represent a wide range of operating conditions.

[1] AEMO, *Power System Stability Guidelines*, Available at: https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource, Viewed on: 6 October 2020.

[2] Available at: https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource/limits-advice.

2. Execute a binary search algorithm to search for limiting interconnector power transfer.
3. Linear regression and statistical limit determination.

1.3 Calculating voltage unbalance limits

Voltage unbalance is based on the levels of negative sequence voltage. As specified in S5.1a.1 of the NER, the negative sequence voltage needs to be limited to 0.5% of nominal voltage for busbars greater than 100 kV. With the introduction of generation in the southwest of Victoria, AEMO has determined that under specific outage conditions, the voltage unbalance at the Portland smelter (APD) 500 kV busbar can exceed these levels.

The limit equations are defined such that the simulated negative sequence voltage on the APD 500 kV bus does not exceed 0.4 % of nominal voltage[3] for system normal and prior circuit outage conditions. This allows for a margin of 0.1%, which is considered a minimum requirement to account for the following:

- Other sources of unbalance, including effect of loads and generation that were not represented. The simulation results only represent unbalance associated with the transmission network.
- Sufficient measurements of voltage unbalance in the APD area that are not presently available to enable verification or calibration of the simulation model.

As well, the maximum simulated voltage unbalance at APD without the additional generation in the south west of Victoria is 0.4%.

The voltage unbalance levels at APD are influenced by a combination of:

- Voltage balancing effect (or reduction of negative sequence voltage) at Mortlake caused by the Mortlake generators.
- Power flow and associated negative sequence voltage across the Mortlake (MOPS) to Moorabool (MLTS), and Mortlake (MOPS) to Heywood (HYTS) to APD No. 2 500 kV lines (which are not fully transposed).
- Power flow on the Moorabool (MLTS) to Tarrone (TRTS) to Heywood (HYTS) to APD No. 1 500 kV line and mutual coupling with the MOPS-MLTS and MOPS-HYTS-APD No. 2 500 kV lines.

These factors can produce additive or counteractive effects on negative sequence voltage at APD, depending on the direction of power flow in the MOPS-MLTS and MOPS-HYTS-APD No. 2 500 kV lines and adjacent MLTS-TRTS-HYTS-APD No. 1 500 kV line.

1.3.1 Methodology

A number of voltage unbalance simulations were performed using a Power Systems Computer Aided Design (PSCAD) model of the 500 kV network. From these results, limit equations were produced to keep the level of voltage unbalance at APD at or below 0.4% during specific outages on the 500 kV network. These equations quantify the relationship between generation, Vic to SA transfer (via Heywood), and where relevant, APD load, such that the simulated voltage unbalance at APD will not exceed 0.4%.

[3] Line to Line = 2 kV and Line to Neutral = 1.15 kV

It is assumed that the net APD load can vary between 405 MW to 615 MW, and Portland wind farm is capable of generating up to 100 MW.

1.4 Calculating voltage oscillation limits

Voltage oscillations and associated instability can occur in parts of the power system that have low system strength, especially during prior outage conditions. To mitigate such oscillations in Western Victoria power system, voltage oscillatory stability limits are determined for low system strength conditions including prior outage conditions. Simulations of large disturbances such as two-phase to ground fault and trip of critical lines are undertaken using PSCAD to determine if the voltage oscillations occur in the power system post-contingency.

Large disturbance simulations of several operating conditions are undertaken to determine the limiting operating conditions of the power system which prevent voltage oscillations from occurring.

1.4.1 Methodology

Voltage oscillation stability limits were determined by performing electromagnetic-transient simulations using PSCAD on a model of the north-west Victorian and south-west NSW networks. Several possible power system scenarios including Murraylink power import and export conditions, wind farm and solar farm operating conditions, battery operating conditions and special protection schemes were considered in the simulations.

1.5 Inverter and Turbine limits

The following terminology is used by AEMO for limitations on plant with turbines and inverters.

Disconnected – The inverters or turbines are physically disconnected from the power system through the opening of a circuit breaker or through the participant advising AEMO that the inverters are physically disconnected from the power system via some other means.

Blocked – The inverters or turbines enter a state where they will not respond to any power system changes and are essentially no longer operating/online. For the avoidance of doubt when an inverter or turbine is blocked it will provide no MWs or MVARs and will be prevented from firing and therefore does not impact system strength. When “Blocked” the inverter or turbine may remain physically connected to the power system. In the past AEMO has referred to this in the limits advice as “Pause Mode”

Constrained to Zero – The inverter or turbines are constrained to 0 MW output via the local plant controller, or constraints and NEMDE.

1.6 Conversion to constraint equations

This document does not describe how AEMO implements these limit equations as constraint equations in the National Electricity Market (NEM) market systems. That is covered in the Constraint Formulation Guidelines, Constraint Naming Guidelines and Constraint Implementation Guidelines. These documents are located in the Congestion Information Resource on the AEMO website, at: https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource.

2 Alcoa Portland to Heywood to Mortlake 500 kV line

The following limit equations are enabled during an outage of the Alcoa Portland to Heywood to Mortlake 500 kV line and associated line reactor.

2.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 1 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-100
Offset to the system normal equation NIL_O	-100

2.2 Voltage Unbalance

The following limit equation should be applied to manage the voltage unbalance at APD 500kV and Heywood 275kV buses:

Mortlake + Dundonnell generation – 3.1488 x Macarthur generation + 1.9538 x Vic to SA (Heywood) ≤ 324

2.3 Islanding

Limitation to prevent islanding of local load following the next credible contingency.

Table 2 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Macarthur Wind Farm	*≤ 0 MW*	

3 Alcoa Portland to Heywood 500 kV line

The following limit only applies to the Alcoa Portland to Heywood No.1 500 kV line. No limits are applied to the No.2 line.

3.1 Voltage Unbalance

The following voltage unbalance limit should be applied to manage the voltage unbalance at APD 500kV and Heywood 275kV buses:

1.85 x APD Net Load + Mortlake + Dundonnell generation ≤ 1535

4 Alcoa Portland to Heywood to Tarrone 500 kV line

The following limit equations are enabled during an outage of the Alcoa Portland to Heywood to Tarrone 500 kV line.

4.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 3 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-80
Offset to the system normal equation NIL_O	-80

4.2 Voltage Unbalance

Note: for this outage, all three Heywood transformers remain on load.

For one Mortlake generator in service only:

No MW limit for a single unit in service. For two Mortlake generators in service:

These limits are under review based on measurements made during the outage with only a single Mortlake generator in service,

Mortlake generation + 0.353 x Vic. to SA (Heywood) ≤ 60 - 1.28 x (APD load – Portland WF – 485)

Note: in actual outage conditions, it was revealed that the National Electricity Network Dispatch Engine (NEMDE) produced unfeasible market results with the above limit equations (such as exporting more generation from SA than was available with contingency frequency control ancillary services). As a result, the above limit equations have been replaced by constraining Mortlake generation to zero MW.

Mortlake generation = 0

5 Ararat to Crowlands 220 kV line

The following limit equations are enabled during an outage of the Ararat to Crowlands 220 kV line.

5.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 4 V::N ARTS-HOTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-80
Offset to system normal equation NILQ	-40
Offset to system normal equation NILS	-80
Offset to system normal equation NILS_decel	-80

5.2 Islanding

Limitation to prevent islanding of local load following the trip of the Kiamal to Red Cliffs 220 kV line.

Table 5 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Bulgana Wind Farm	*≤ 0 MW*	
Bulgana Battery	*=0 MW*	*0 and disconnected*
Crowlands Wind Farm	*≤ 0 MW*	
Kiata Wind Farm	*≤ 0 MW*	
Kiamal Solar Farm	*≤ 0 MW*	*0 and disconnected*

Kiamal SynCon switched off

5.3 Voltage Oscillation

To prevent voltage oscillations for trip of a Bendigo to Kerang 220 kV line the following limits are applied:

Table 6 Voltage oscillation limits

Generator	MW Limit
Ararat Wind Farm	≤ 60 MW
Bannerton Solar Farm	≤ 20 MW

Generator	MW Limit
Broken Hill Solar Farm	≤ 25 MW
Coleambally Solar Farm	≤ 60 MW
Darlington Point Solar Farm	≤ 110 MW
Finley Solar Farm	≤ 55 MW
Gannawarra Solar Farm	≤ 15 MW
Karadoc Solar Farm	≤ 20 MW
Limondale 1 Solar Farm	≤ 85 MW
Limondale 2 Solar Farm	≤ 15 MW
Murra Warra 1+2 Wind Farm	≤ 60 MW
Murraylink (SA to Vic)	≤ 150 MW
Murraylink (Vic to SA)	≤ 150 MW
Silverton Wind Farm	≤ 80 MW
Sunraysia Solar Farm	≤ 80 MW
Waubra Wind Farm	≤ 0 MW and 0 MVAr
Wemen Solar Farm	≤ 20 MW
Yatpool Solar Farm	≤ 20 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

6 Ararat to Waubra to Ballarat 220 kV line

The following limit equations are enabled during an outage of the Ararat to Waubra to Ballarat 220 kV line, or Ararat to Waubra 220 kV line or Ballarat to Waubra 220 kV line unless indicated.

6.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 7 V::N ARTS-WBTS-BATS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-100
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-100
Offset to system normal equation NILS_decel	-100

6.2 Voltage Stability – Murraylink

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Bendigo to Kerang 220 kV line, apply the following prior outage limit equations. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 8 V^S [MRLK] ARTS-WBTS-BATS

Term	Coefficient
Intercept	243
RCTS-MLK_MVAR	-0.7445
WETS Load	-2.126
BETS Load	-0.7796
DARL_PT_3WTX_MW	0.253
HOTS-66CAP	1.565
Confidence Level (95%) offset	-53.6

6.3 Islanding

Limitation to prevent islanding of local load following the trip of the Kiamal to Red Cliffs 220 kV line.

Table 9 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Ararat Wind Farm	*≤ 0 MW*	
Bulgana Wind Farm	*≤ 0 MW*	
Bulgana Battery	*= 0 MW*	*0 and disconnected*
Crowlands Wind Farm	*≤ 0 MW*	
Kiata Wind Farm	*≤ 0 MW*	
Kiamal Solar Farm	*≤ 0 MW*	*0 and disconnected*

Kiamal SynCon switched off

6.4 Voltage Oscillation

To prevent voltage oscillations for trip of a Bendigo to Kerang 220 kV line the following limits are applied:

Table 10 Voltage oscillation limits

Generator	MW Limit
Bannerton Solar Farm	≤ 20 MW
Broken Hill Solar Farm	≤ 25 MW
Coleambally Solar Farm	≤ 60 MW
Darlington Point Solar Farm	≤ 110 MW
Finley Solar Farm	≤ 55 MW
Gannawarra Solar Farm	≤ 15 MW
Karadoc Solar Farm	≤ 20 MW
Limondale 1 Solar Farm	≤ 85 MW
Limondale 2 Solar Farm	≤ 15 MW
Murra Warra 1+2 Wind Farm	≤ 60 MW
Murraylink (SA to Vic)	≤ 150 MW
Murraylink (Vic to SA)	≤ 150 MW
Silverton Wind Farm	≤ 80 MW
Sunraysia Solar Farm	≤ 80 MW
Waubra Wind Farm	≤ 0 MW and ≤ 0 MVAr
Wemen Solar Farm	≤ 20 MW
Yatpool Solar Farm	≤ 20 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

7 Ballarat to Bendigo 220 kV line

The following limit equations are enabled during an outage of the Ballarat to Bendigo 220 kV line.

7.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 11 V::N BATS-BETS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-60
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-60
Offset to system normal equation NILS_decel	-60

7.2 Voltage Stability – Murraylink

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Buronga to Balranald to Darlington point 220 kV line, apply the following prior outage limit equations. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 12 V^S [MRLK] BATS-BETS_X5

Term	Coefficient
Intercept	497.4
RCTS Load	-1.003
KGTS Load	-2.599
HOTS Load	-1.978
BATS TX MW	-0.2051
BKNH TX MW	-0.5091
BHSS220 Load	-1.122
HOTS SVC Out of Service	-14.20
KGTS SVC Out of Service	-18.67
VIC to NSW	0.01021

Term	Coefficient
Confidence Level (95%) offset	-33

7.3 Voltage Oscillation

To prevent voltage oscillations for trip of Bendigo to Shepparton 220kV line the following limits applied:

Table 13 Voltage oscillation limits

Generator	MW Limit
Ararat wind farm	≤ 120 MW
Bannerton Solar Farm	≤ 25 MW
Bulgana Wind Farm	≤ 50 MW
Broken Hill Solar Farm	≤ 25 MW
Coleambally Solar Farm	≤ 40 MW
Crowlands Wind Farm	≤ 40 MW
Darlington Point Solar Farm	≤ 60 MW
Finley Solar Farm	≤ 40 MW
Gannawarra Solar Farm	≤ 25 MW
Karadoc Solar Farm	≤ 25 MW
Kiamal Solar Farm	≤ 50 MW
Limondale 1 Solar Farm	≤ 50 MW
Limondale 2 Solar Farm	≤ 10 MW
Murra Warra 1+2 Wind Farm	≤ 60 MW
Murraylink (SA to Vic)	≤ 150 MW
Murraylink (Vic to SA)	≤ 150 MW
Silverton Wind Farm	≤ 50 MW
Sunraysia Solar Farm	≤ 60 MW
Wemen Solar Farm	≤ 25 MW
Yatpool Solar Farm	≤ 25 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

Kerang SVC switched off or set to manual mode with a fixed Q setpoint

8 Bendigo to Kerang 220 kV line

The following limit equations are enabled during an outage of the Bendigo to Kerang 220 kV line.

8.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 14 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-60
Offset to the system normal equation NIL_O	-60

8.2 Voltage Stability – Murraylink

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Ararat to Waubra to Ballarat 220 kV line, apply the following prior outage limit equations. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 15 V^S [MRLK] BETS-KGTS

Term	Coefficient
Intercept	269.3
RCTS Load	-0.4457
WETS Load	-1.828
KGTS Load	-2.276
RCTS-MLK_MVAR	-0.7164
Q3-REDCLF 220	0.6137
Q2-BURNGA 220	0.5999
HOTS_TX1_TX2 MW	-0.5086
HOTS_TX1_TX2 MVAR	-0.2575
Confidence Level (95%) offset	-45

8.3 Islanding

Limitation to prevent islanding of local load following the trip of the Kerang to Wemen to Red Cliffs 220 kV line.

Table 16 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Cohuna Solar Farm	*≤ 0 MW*	*0 and disconnected*
Gannawarra Solar Farm	*≤ 0 MW*	*0 and disconnected*
Gannawarra Battery	*= 0 MW*	*0 and disconnected*

8.4 Voltage Oscillation

To prevent voltage oscillations for trip of Ararat to Waubra to Ballarat 220 kV line the following limits applied:

Table 17 Voltage oscillation limits

Generator	MW Limit
Bannerton Solar Farm	≤ 25 MW
Broken Hill Solar Farm	≤ 25 MW
Coleambally Solar Farm	≤ 45 MW
Darlington Point Solar Farm	≤ 80 MW
Finley Solar Farm	≤ 45 MW
Karadoc Solar Farm	≤ 25 MW
Kiamal Solar Farm	≤ 50 MW
Kiata Wind Farm	≤ 0 MW (can be operated Blocked)
Limondale 1 Solar Farm	≤ 60 MW
Limondale 2 Solar Farm	≤ 25 MW
Murra Warra 1+2 Wind Farm	≤ 0 MW (can be operated Blocked)
Murraylink (SA to Vic)	≤ 150 MW
Murraylink (Vic to SA)	≤ 150 MW
Sunraysia Solar Farm	≤ 60 MW
Wemen Solar Farm	≤ 25 MW
Yatpool Solar Farm	≤ 25 MW

9 Bendigo to Shepparton 220 kV line

The following limit equations are enabled during an outage of the Bendigo to Shepparton 220 kV line.

9.1 Voltage Stability – Murraylink

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of Buronga to Balranald to Darlington point 220 kV line, apply the following prior outage limit equation. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid.

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 18 V^S [MRLK] BETS-SHTS_X5

Term	Coefficient
Intercept	376.5
RCTS Load	-1.151
KGTS Load	-2.486
BHSS220 Load	-2.267
BKNH TX MW	-0.5398
BATS TX MW	-0.8298
HOTS SVC out of service	-19.85
KGTS SVC out of service	-20.73
Confidence Level (95%) offset	-29.78

9.2 Voltage Oscillation

To prevent voltage oscillations the following limits applied:

Table 19 Voltage oscillation limits

Generator	MW Limit
Ararat Wind Farm	≤ 70 MW
Bannerton Solar Farm	≤ 25 MW
Broken Hill Solar Farm	≤ 25 MW
Bulgana Wind Farm	≤ 30 MW
Coleambally Solar Farm	≤ 90 MW
Crowlands Wind Farm	≤ 25 MW
Darlington Point Solar Farm	≤ 165 MW

Generator	MW Limit
Finley Solar Farm	≤ 90 MW
Gannawarra Solar Farm	≤ 15 MW
Karadoc Solar Farm	≤ 30 MW
Kiata Wind Farm	≤ 10 MW
Kiamal Solar Farm	≤ 60 MW
Limondale 1 Solar Farm	≤ 120 MW
Limondale 2 Solar Farm	≤ 15 MW
Murra Warra 1+2 Wind Farm	≤ 60 MW
Murraylink (SA to Vic)	≤ 150 MW
Silverton Wind Farm	≤ 100 MW
Sunraysia Solar Farm	≤ 120 MW
Wemen Solar Farm	≤ 25 MW
Yatpool Solar Farm	≤ 25 MW

10 Cranbourne to Hazelwood 500 kV line

The following limit equations are enabled during an outage of the Cranbourne to Hazelwood 500 kV line.

10.1 Transient stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 20 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-250
Offset to the system normal equation NIL_O	-250

11 Crowlands to Bulgana to Horsham 220 kV line

The following limit equations are enabled during an outage of the Crowlands to Bulgana, Bulgana to Horsham or Crowlands to Bulgana to Horsham 220 kV lines unless indicated.

11.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 21 V::N ARTS-HOTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-80
Offset to system normal equation NILQ	-40
Offset to system normal equation NILS	-80
Offset to system normal equation NILS_decel	-80

11.2 Islanding

Limitation to prevent islanding of local load following the trip of the Kiamal to Red Cliffs 220 kV line.

Table 22 Islanding limits

Generator	MW Limit	inverter
Kiata Wind Farm	*≤ 0 MW*	
Kiamal Solar Farm	≤ 0 MW	0 and disconnected

Kiamal SynCon switched off

For an outage of the Bulgana to Crowlands 220 kV line section the following islanding limit also applied:

Table 23 Islanding limit

Generator	MW Limit
Bulgana Wind Farm	*≤ 0 MW*

11.3 Voltage Oscillation

To prevent voltage oscillations for trip of a Bendigo to Kerang 220 kV line the following limits are applied:

Table 24 Voltage oscillation limits

Generator	MW Limit	Inverter / Turbine maximum
Bannerton Solar Farm	*≤ 45 MW*	*≤ 22 inverters connected, otherwise 0 MW*
Broken Hill Solar Farm	*≤ 30 MW*	*≤ 44 inverters connected, otherwise 0 MW*
Gannawarra Solar Farm	*≤ 30 MW*	*≤ 12 inverters connected, otherwise 0 MW*
Karadoc Solar Farm	*≤ 45 MW*	*≤ 21 inverters connected, otherwise 0 MW*
Murra Warra 1+2 Wind Farm	*≤ 15 MW*	*≤ 30 inverters connected, otherwise 0 MW*
Wemen Solar Farm	*≤ 45 MW*	*≤ 21 inverters connected, otherwise 0 MW*

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

Kerang SVC switched off or set to manual mode with a fixed Q setpoint

For the outage of the Bulgana to Horsham 220 kV line the following limit is also applied:

Table 25 Voltage oscillation limit

Generator	MW Limit
Bulgana Wind Farm	*≤ 130 MW*

12 Dederang to Mount Beauty 220 kV line

The current system normal limits are adequate to manage the prior-outage of one Dederang to Mount Beauty 220 kV line.

13 Dederang to Murray 330 kV line

The following limit equations are enabled during an outage of one Dederang to Murray 330 kV line.

Note: these limits are in addition to the limits provided by TransGrid for this outage.

13.1 Transient Stability – Vic to NSW

13.1.1 V::N DDTS-MSS-V

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Dederang to Murray 330 kV line (where Victoria accelerates ahead of the other states), apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 26 V::N DDTS-MSS-V coefficients

Term	Coefficient
Intercept	994.7
Basslink	0.1248
Vic. to SA (Heywood)	0.07176
Vic. to SA (Heywood)^2	-2.59e-4
Vic. to SA (Murraylink)	-0.5758
LV 500 Inertia	1.439
EPS Inertia	3.446
MOPS Inertia	2.061
KIEWA Inertia	6.499
SNOWY Inertia	1.392
Murray Gen	0.8731
LV 220 Gen	0.09512
VIC Metro Gen	0.1612
State Grid Load North	-0.4595
Vic Wind & Solar	0.06173
VIC Demand - State Grid Load North	-0.4486
220 kV_Caps	-0.1013
Num. ROTS SVC	13.52
Confidence Level (95%) offset	-64

13.1.2 V::N DDTS-MSS-S

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Dederang to Murray 330 kV line (where South Australia accelerates ahead of the other states), apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 27 V::N DDTS-MSS-S coefficients

Term	Coefficient
Intercept	1036
Basslink	0.08914
Vic. to SA (Heywood)	-0.0383
Vic. to SA (Heywood)^2	-1.2e-4
Vic. to SA (Murraylink)	-0.5229
LV 500 Inertia	1.072
EPS Inertia	4.662
MOPS Inertia	1.288
LV 220 Inertia	-4.738
KIEWA Inertia	2.931
SNOWY Inertia	1.081
Murray Gen	0.8924
Kiewa Gen	0.206
LV 220 Gen	0.2181
VIC Metro Gen	0.149
State Grid Load North	-0.3608
APD Load	-0.07564
Vic Wind & Solar	0.07921
VIC Demand - State Grid Load North - APD Load	-0.04914
220 kV_Caps	-0.070
Num. ROTS SVC	15.68
Confidence Level (95%) offset	-67

13.2 Voltage Stability – NSW to Vic

13.2.1 Largest Vic generator or Basslink trip

To manage Victorian voltage stability import limit from NSW to Victoria for fault and trip of Basslink or the loss of the largest Victorian generator, apply the following limit equation. Studies monitor post-contingent voltages and reactive power margin in northern Victoria and southern NSW. The limit equation is of the form:

NSW to Victoria ≤ -1 * Sum [Term Values * Coefficients]

Table 28 V^N DDTS-MSS BLVG coefficients

Term	Coefficient
Intercept	-1535
Contingent_MW	0.9062
SW_NSW	0.7723
NSWd-SW_NSW	0.02759
STH_NSW_GEN	-0.07476

Term	Coefficient
UTUM1SC+UTUM2SC	-20.47
LTUM3SC	-67.3
MSS2SC	-52.63
DD330Cap	-0.2519
WAGGACap	-0.2607
MSSReac	-0.3413
YASSReac	-0.1853
U_TUMUT_Gen	-0.4923
L_TUMUT_Gen	-0.3274
MURRAY_Gen	0.61
UQT Gen	-0.516
BKNH_GEN	-1.038
Num. MSS1 on	-19.27
Confidence Level (95%) offset	+65.0

13.2.2 Dederang to Murray 330 kV line trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of the remaining Dederang to Murray 330 kV line, apply the following limit equation. Studies monitor post-contingent voltages and reactive power margin in northern Victoria and southern NSW. The limit equation is of the form:

NSW to Victoria ≤ -1 * Sum [Term Values * Coefficients]

Table 29 V^N DDTS-MSS DDMS coefficients

Term	Coefficient
Intercept	-886
SW_NSW	0.6468
UTUM1SC+UTUM2SC	-14.75
LTUM3SC	-32.13
MSS2SC	-19.60
WAGGACap	-0.1989
DLPTshnt	-0.4695
MSSReac	-0.1648
YASSReac	-0.09942
U_TUMUT_Gen	-0.1822
L_TUMUT_Gen	-0.04036
MURRAY_Gen	0.9568
UQT Gen	-0.4729
HUME VIC GEN	-1.819
BKNH GEN	-0.9831
Num. MSS1 on	-10.66
Confidence Level (95%) offset	+65

13.3 Voltage Stability – Vic to NSW

13.3.1 Trip of both APD Potlines or the trip of the remaining Dederang-Murray line

To manage the Vic to NSW voltage stability export limit from Victoria to NSW for loss of both APD Potlines or the trip of the remaining Dederang-Murray 330 kV line, apply the following prior outage offset to the system normal equation V^N_2xAPD. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * Coefficients] +Offset

Table 30 V^N_2xAPD offset

Term	Offset
Offset to system normal V^N_2xAPD	-170

14 Dederang to South Morang 330 kV line

The following limit equations are enabled during an outage of one Dederang to South Morang 330 kV line.

14.1 Transient Stability – Vic to NSW

14.1.1 V::N DDTS-SMTS-V

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the remaining Dederang to South Morang 330 kV line (where Victoria accelerates ahead of the other states), apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 31 V::N DDTS-SMTS-V coefficients

Term	Coefficient
Intercept	847.5
Basslink	0.1478
Vic. to SA (Heywood)	0.1098
Vic. to SA (Heywood)^2	-4.28e-4
Vic. to SA (Murraylink)	-0.901
LV 500 Inertia	1.95
EPS Inertia	16.34
MOPS Inertia	1.854
SNOWY Inertia	0.836
VIC Metro Gen Inertia	1.558
Murray Gen	0.8631
Kiewa Gen	1.057
LV 220 Gen	0.1268
VIC Metro Gen	0.1087
State Grid Load North	-0.8808
Vic Wind & Solar	0.1184
VIC Demand - State Grid Load North	-0.08903
Both TAIL- SESS Series Caps Out	17.552
Num. ROTS SVC	18.34
Confidence Level (95%) offset	-67

14.1.2 V::N DDTS-SMTS-S

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the remaining Dederang to South Morang 330 kV line (where South Australia accelerates ahead of the other states), apply the following limit equation

*Victoria to NSW ≤ Sum [Term Values * Coefficients]*

Table 32 V::N DDTS-SMTS-S coefficients

Term	Coefficient
Intercept	972.9
Basslink	0.1097
Vic. to SA (Heywood)^2	-2.74e-4
Vic. to SA (Murraylink)	-0.849
LV 500 Inertia	1.527
EPS Inertia	19.58
MOPS Inertia	2.563
KIEWA Inertia	2.001
SNOWY Inertia	0.5206
VIC Metro Gen Inertia	3.017
Murray Gen	0.9295
Kiewa Gen	0.9608
LV 220 Gen	0.09506
State Grid Load North	-0.8921
Vic Wind & Solar	0.1513
VIC Demand - State Grid Load North	-0.09823
Num. ROTS SVC	19.1
Confidence Level (95%) offset	-70

The above outage Vic-NSW transient stability limits are also applicable to the multiple outage combination of lines 62 + X5 + Dederang to South Morang 330 kV line.

14.2 Voltage Stability – NSW to Vic

14.2.1 Largest Vic generator or Basslink trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of Basslink or the loss of the largest Victorian generator, apply the following prior outage offset to the system normal equation NIL_VI_BLVG. The limit equation is of the form:

NSW to Victoria ≤ [-1 * Sum [Term Values * System Normal Coefficients]] + Offset

Table 33 NIL_VI_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-100

14.2.2 The remaining Dederang to South Morang r 330 kV line trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of the remaining Dederang to South Morang 330 kV line, apply the following prior outage offset to the system normal equation NIL_VI_BLVG. The limit equation is of the form:

NSW to Victoria ≤ [-1 * Sum [Term Values * System Normal Coefficients]] + Offset

Table 34 NIL_VI_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-150

The above outage NSW-Vic voltage stability limits are also applicable to the multiple outage combination of lines 62 + X5 + Dederang to South Morang 330 kV line.

14.3 Voltage Stability – Vic to NSW

To manage the Vic to NSW voltage stability export limit from Victoria to NSW for loss of both APD Potlines, apply the following prior outage offset to the system normal equation V^N_2xAPD. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * Coefficients] +Offset

Table 35 V^N_2xAPD offset

Term	Offset
Offset to system normal V^N_2xAPD	-100

15 Dederang Substation No. 1 or No. 2 330 kV Bus

The following limit equation is enabled during an outage of a Dederang 330 kV bus.

15.1 Voltage Stability – NSW to Vic

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the fault and trip of Basslink or the loss of the largest Victorian generator or loss of a Dederang to South Morang 330 kV line and series capacitor and the subsequent offloading of a Dederang to Murray 330 kV line. Therefore, no additional offset is required.

16 Dederang to Wodonga 330 kV line

The following limit equations are enabled during an outage of the Dederang to Wodonga 330 kV line.

Note: these limits are in addition to the limits provided by Transgrid for this outage.

16.1 Transient stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 36 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-100
Offset to the system normal equation NIL_O	-90

16.2 Voltage Stability – NSW to Vic

16.2.1 Largest Vic generator or Basslink trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of Basslink or the loss of the largest Victorian generator, apply the following prior outage offset to the system normal equation NIL_VI_BLVG. Studies monitored post-contingent voltages and reactive power margin in northern Victoria and southern NSW. The limit equation is of the form:

NSW to Victoria ≤ [-1 * Sum [Term Values * System Normal Coefficients]] + Offset

Table 37 NIL_VI_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-70

16.2.2 Dederang to Murray 330 kV line trip

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the loss of a Dederang to Murray 330 kV line. Therefore, no additional offset is required.

16.3 Voltage Oscillation

To prevent voltage oscillations for the trip of Ararat to Waubra to Ballarat or Bendigo to Kerang 220 kV line the following limits are applied:

Table 38 Voltage oscillation limits

Generator	MW Limit	Inverter / Turbine maximum
Ararat Wind Farm	≤ 0 MW (can be operated Blocked)	
Bannerton Solar Farm	≤ 45 MW	
Bulgana Wind Farm	≤ 0 MW (can be operated Blocked)	Turbines <=0MW (Blocked), Q-control mode, Q setpoint = zero MVAR
Bulgana Battery	= 0 MW	*0 and disconnected*
Crowlands Wind Farm	≤ 0 MW (can be operated Blocked)	
Gannawarra Solar Farm	≤ 30 MW	
Karadoc Solar Farm	≤ 25 MW	
Kiamal Solar Farm	≤ 50 MW	
Limondale 2 Solar Farm	≤ 0 MW	*0 and disconnected*
Murra Warra 1+2 Wind Farm	≤ 100 MW	
Murraylink (SA to Vic)	≤ 125 MW	
Wemen Solar Farm	≤ 45 MW	
Yatpool Solar Farm	≤ 25 MW	

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

Kerang SVC switched off or set to manual mode with a fixed Q setpoint

17 Eildon to Mount Beauty 220 kV line

The following limits are applied for the above outage.

17.1 Voltage Stability – NSW to Vic

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the fault and trip of Basslink or the loss of the largest Victorian generator or a Dederang to Murray 330 kV line. Therefore, no additional offset is required.

18 Eildon To Thomastown 220 kV line

The following limit equation is enabled during an outage of the Eildon to Thomastown 220 kV line.

18.1 Transient Stability – Vic to NSW

18.1.1 V::N EPS-TTS -V

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Dederang to South Morang 330 kV line where Victoria accelerates ahead of the other states, apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 39 V::N EPS-TTS -V coefficients

Term	Coefficient
Intercept	1239
Basslink	0.217
Vic. to SA (Heywood)^2	-5.05e-4
Vic. to SA (Murraylink)	-0.9143
LV 500 Inertia	3.003
EPS Inertia	16.9
MOPS Inertia	4.407
LV 220 Inertia	6.021
SNOWY Inertia	3.11
Murray Gen	0.7123
Kiewa Gen	0.9577
VIC Metro Gen	0.2778
State Grid Load North	-0.8903
Vic Wind & Solar	0.1359
VIC Demand - State Grid Load North	-0.1087
220 kV_Caps	-0.1669
Confidence Level (95%) offset	-84

18.1.2 V::N EPS-TTS -S

To manage the Victorian transient stability export limit from Victoria to fault and trip of a Dederang to South Morang 330 kV line (where South Australia accelerates ahead of the other states), apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 40 V::N EPS-TTS-S coefficients

Term	Coefficient
Intercept	1241
Basslink	0.207
Vic. to SA (Heywood)	-0.1075
Vic. to SA (Heywood)^2	-4.30e-4
Vic. to SA (Murraylink)	-0.9241
LV 500 Inertia	3.313
EPS Inertia	18.36
MOPS Inertia	4.039
SNOWY Inertia	1.55
VIC Metro Gen Inertia	4.291
Murray Gen	0.894
Kiewa Gen	1.095
LV 220 Gen	0.182
State Grid Load North	-0.777
Vic Wind & Solar	0.1821
VIC Demand - State Grid Load North	-0.156
220 kV_Caps	-0.1031
Num. ROTS SVC	22.35
Num. SESS SVC	18.94
Confidence Level (95%) offset	-75

18.2 Voltage Stability – NSW to Vic

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the fault and trip of Basslink or the loss of the largest Victorian generator or a Dederang to South Morang 330 kV line. Therefore, no additional offset is required.

19 Hazelwood to Loy Yang 500 kV line

The following limit equation is enabled during an outage of the Hazelwood to Loy Yang 500 kV line.

19.1 System Strength

Electro Magnetic Transient (EMT) studies identified the requirement of minimum number of synchronous generators in Victoria to be available prior to this outage. This is to maintain sufficient system strength in Victoria network for the loss of all three Hazelwood to Loy Yang 500 kV lines. Verified combinations are listed below.

Table 41 Hazelwood – Loy Yang outage system strength minimum generator combinations

Combination	Bogong	Dartmouth	Jeeralang A+B	Mortlake	Murray (unit 1-10)	Murray (unit 11-14)	Newport	Yallourn
1			4			4		3
2						4	1	3
3				2		4		3
4			4	1		4		2
5		1	4	1		2		2
6	1	1	4	1	1	1		2

20 Hazelwood To South Morang 500 kV line

The following limit equations are enabled during an outage of one Hazelwood to South Morang 500 kV line.

20.1 Transient Stability – Vic to NSW

20.1.1 V::N HWTS-SMTS -V

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the remaining Hazelwood to South Morang 500 kV line (where Victoria accelerates ahead of the other states), apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 42 V::N HWTS-SMTS-V coefficients

Term	Coefficient
Intercept	1282
Basslink	0.4379
Vic. to SA (Heywood)	-0.3323
Vic. to SA (Heywood)^2	-9.229e-4
Vic. to SA (Murraylink)	-1.092
LV 500 Inertia	7.984
EPS Inertia	24.30
MOPS Inertia	8.864
LV 220 Inertia	6.883
Murray Gen	0.8310
Kiewa Gen	1.167
LV 220 Gen	0.3025
VIC Metro Gen	0.9260
State Grid Load North	-0.7591
APD Load	-1.176
Vic Wind & Solar	0.4519
VIC Demand - State Grid Load North - APD Load	-0.4406
Num. ROTS SVC	32.41
Num. SESS SVC	27.43
Confidence Level (95%) offset	-88

20.1.2 V::N HWTS-SMTS-Q

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the remaining Hazelwood to South Morang 500 kV line (where Queensland accelerates ahead of the other states), apply the following limit equation:

*Victoria to NSW ≤ Sum [Term Values * Coefficients]*

Table 43 V::N HWTS-SMTS-Q coefficients

Term	Coefficient
Intercept	1748
Basslink	0.619
Vic. to SA (Heywood)	-1.275
Vic. to SA (Murraylink)	-0.6562
LV 500 Inertia	9.343
MOPS Inertia	16.42
Murray Gen	0.7247
Kiewa Gen	0.7898
LV 220 Gen	0.5231
Vic Wind & Solar	0.719
State Grid Load	-0.7987
VIC Demand - State Grid Load	-0.615
Confidence Level (95%) offset	-78

Note: this equation should only be applied when power transfers are above 900 MW from Queensland to New South Wales.

20.1.3 V::N HWTS-SMTS-S

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the remaining Hazelwood to South Morang 500 kV line (where South Australia accelerates ahead of the other states), apply the following limit equation:

*Victoria to NSW ≤ Sum [Term Values * Coefficients]*

Table 44 V::N HWTS-SMTS-S coefficients

Term	Coefficient
Intercept	970.8
Basslink	0.5021
Vic. to SA (Heywood)	-0.5782
Vic. to SA (Heywood)^2	-5.973e-4
Vic. to SA (Murraylink)	-1.149
LV 500 Inertia	8.332
EPS Inertia	22.71
MOPS Inertia	10.68
LV 220 Inertia	17.10
KIEWA Inertia	4.865
VIC METRO Gen Inertia	7.135
Murray Gen	0.9213

Term	Coefficient
Kiewa Gen	0.7844
VIC Metro Gen	0.2938
State Grid Load North	-1.166
APD Load	-0.4342
Vic Wind & Solar	0.5615
VIC Demand - State Grid Load North - APD Load	-0.4538
220 kV_Caps	-0.1530
Num. ROTS SVC	33.88
Num. SESS SVC	22.04
Confidence Level (95%) offset	-92

20.1.4 V::N HWTS-SMTS-S_decel

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the remaining Hazelwood to South Morang 500 kV line (where South Australia decelerates away from the other states), apply the following limit equation:

Victoria to NSW ≤ Sum [Term Values * Coefficients]

Table 45 V::N HWTS-SMTS-S_decel coefficients

Term	Coefficient
Intercept	1211
Basslink	0.4028
Vic. to SA (Heywood)	-1.772
Vic. to SA (Murraylink)	-1.065
LV 500 Inertia	9.683
MOPS Inertia	11.69
LV 220 Inertia	18.59
KIEWA Inertia	18.86
VIC METRO Gen Inertia	7.38
Murray Gen	0.8217
State Grid Load North	-0.8141
Vic Wind & Solar	0.565
VIC Demand - State Grid Load North	-0.4551
Confidence Level (95%) offset	-128

Note: this equation should only be applied when power transfers are above 500 MW from Victoria to South Australia.

20.2 Voltage Stability- VIC to NSW

To manage the Vic to NSW voltage stability export limit from Victoria to NSW for loss of both APD Potlines, apply the following prior outage offset to the system normal equation V^N_2xAPD. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * Coefficients] +Offset

Table 46 V^N_2xAPD offset

Term	Offset
Offset to system normal equation V^N_2xAPD	-50

21 Heywood to South East 275 kV line

The following limit equations are enabled during an outage of one Heywood to South East 275 kV line.

21.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 47 V::N HYTS-SESS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-70
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-27
Offset to system normal equation NILS_decel	N/A [VIC->SA transfer limited to 250MW]

22 Horsham SVC

22.1 Voltage Oscillation

To prevent voltage oscillations for trip of an Ararat to Waubra to Ballarat 220 kV line or Bendigo to Kerang 220 kV line the following limits applied:

Table 48 Voltage oscillation limits

Generator	MW Limit
Ararat Wind Farm	≤ 145 MW
Bannerton Solar Farm	≤ 53 MW
Broken Hill Solar Farm	≤ 32 MW
Bulgana Wind Farm	≤ 111 MW
Cohuna Solar Farm	≤ 17 MW
Coleambally Solar Farm	≤ 105 MW
Crowlands Wind Farm	≤ 48 MW
Darlington Point Solar Farm	≤ 193 MW
Finley Solar Farm	≤ 93 MW
Gannawarra Solar Farm	≤ 30 MW
Karadoc Solar Farm	≤ 54 MW
Kiamal Solar Farm	≤ 120 MW
Kiata Wind Farm	≤ 18 MW
Limondale 1 Solar Farm	≤ 132 MW
Limondale 2 Solar Farm	≤ 18 MW
Murra Warra 1+2 Wind Farm	≤ 135 MW
Silverton Wind Farm	≤ 119 MW
Sunraysia Solar Farm	≤ 120 MW
Wemen Solar Farm	≤ 53 MW
Yatpool Solar Farm	≤ 49 MW

23 Horsham to Murra Warra to Kiamal 220 kV line

The following limit equations are enabled during an outage of the Horsham to Murra Warra, Murra Warra to Kiamal or Horsham to Murra Warra to Kiamal 220 kV lines unless indicated.

23.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 49 V::N HOTS-RCTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-60
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-40
Offset to system normal equation NILS_decel	-50

23.2 Voltage Stability – Murraylink

23.2.1 Buronga to Balranald to Darlington Point (X5) trip

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Buronga to Balranald to Darlington point 220 kV line, apply the following prior outage limit equation. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 50 V^S [MRLK] HOTS-RCTS_X5

Term	Coefficient
Intercept	277.7
RCTS Load	-0.9364
KGTS Load	-1.225
BETS Load	-0.1876
WETS Load	-0.6805
BKNH TX MW	-0.7594

Term	Coefficient
VIC2NSW	0.01024
KGTS SVC out of service	-18.79
Confidence Level (95%) offset	-32

23.2.2 Bendigo to Kerang trip

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Bendigo to Kerang 220 kV line, apply the following prior outage limit equation. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 51 V^S [MRLK] HOTS-RCTS_BEKG

Term	Coefficient
Intercept	164.4
RCTS Load	-0.9846
KGTS Load	-0.6067
WETS Load	-0.89
BKNH TX MW	-1.071
BHSS220 Load	-0.7057
KGTS SVC out of service	-6.367
Confidence Level (95%) offset	-31

23.3 Islanding

Limitation to prevent islanding of local load following the trip of the Ararat to Waubra to Ballarat or Kiamal to Red Cliffs 220 kV lines.

Table 52 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Kiata Wind Farm	*≤ 0 MW*	

23.4 Voltage Oscillation

To prevent voltage oscillations for trip of the Bendigo to Kerang 220 kV line the following limits are applied:

Table 53 Voltage oscillation limits

Generator	MW Limit	Inverter / Turbine maximum
Bannerton Solar Farm	≤ 45 MW	
Broken Hill Solar Farm	≤ 30 MW	
Coleambally Solar Farm	≤ 40 MW	
Darlington Point Solar Farm	≤ 65 MW	
Finley Solar Farm	≤ 40 MW	
Gannawarra Solar Farm	≤ 0 MW	0 and disconnected
Gannawarra Battery	≤ 0 MW	
Karadoc Solar Farm	≤ 45 MW	
Koorangie BESS	≥ -90 MW and ≤ 20 MW	
Kiamal Solar Farm	≤ 40 MW	
Limondale 1 Solar Farm	≤ 50 MW	
Limondale 2 Solar Farm	≤ 10 MW	
Murraylink (SA to Vic)	≤ 150 MW	
Silverton Wind Farm	≤ 50 MW	
Sunraysia Solar Farm	≤ 60 MW	
Wemen Solar Farm	≤ 45 MW	
Yatpool Solar Farm	≤ 40 MW	

For an outage of the Horsham to Murra Warra 220 kV line the following limits are also applied:

Table 54 Voltage oscillation limit

Generator	MW Limit
Murra Warra 1+2 Wind Farm	≤ 15 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

Kerang SVC switched off or set to manual mode with a fixed Q setpoint

For outage of Murra Warra to Kiamal 220 kV line the following limits are also applied:

Table 55 Voltage oscillation limit

Generator	MW Limit
Murra Warra 1+2 Wind Farm	≤ 15 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

24 Jindera to Wodonga (060) 330 kV line

The following limit equations are enabled during an outage of the Jindera to Wodonga 330 kV line.

Note: these limits are in addition to the limits provided by TransGrid for this outage.

Note 2: Balranald to Darlington Point (X5) line is also out of service for this outage and the limits for an X5 outage also apply (see Vic Transfer Limit Advice – Outages in Adjacent Regions).

24.1 Transient stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 56 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-100
Offset to the system normal equation NIL_O	-90

24.2 Voltage Stability – NSW to Vic

24.2.1 Largest Vic generator or Basslink trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of Basslink or the loss of the largest Victorian generator, apply the following prior outage offset to the system normal equation NIL_VI_BLVG. Studies monitored post-contingent voltages and reactive power margin in northern Victoria and southern NSW. The limit equation is of the form:

NSW to Victoria ≤ [-1 * Sum [Term Values * System Normal Coefficients]] + Offset

Table 57 V^N JIND-WOTS_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-60

24.2.2 Dederang to Murray 330 kV line trip

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the loss of a Dederang to Murray 330 kV line. Therefore, no additional offset is required.

24.3 Voltage Oscillation

To prevent voltage oscillations for the trip of Ararat to Waubra to Ballarat or Bendigo to Kerang 220 kV line the limits of Section 16.3 are applied.

25 Kerang SVC

The following limit equations are enabled during an outage of the Kerang SVC.

25.1 Voltage Oscillation

To prevent voltage oscillations for trip of an Ararat to Waubra to Ballarat 220 kV line or Bendigo to Kerang 220 kV line the following limits applied:

Table 58 Voltage oscillation limits

Generator	MW Limit
Bannerton Solar Farm	≤ 25 MW
Broken Hill Solar Farm	≤ 25 MW
Coleambally Solar Farm	≤ 30 MW
Darlington Point Solar Farm	≤ 80 MW
Finley Solar Farm	≤ 30 MW
Gannawarra Solar Farm	≤ 25 MW
Karadoc Solar Farm	≤ 25 MW
Kiamal Solar Farm	≤ 50 MW
Limondale 1 Solar Farm	≤ 50 MW
Limondale 2 Solar Farm	≤ 25 MW
Murra Warra 1+2 Wind Farm	≤ 90 MW
Murraylink (SA to Vic)	≤ 150 MW
Sunraysia Solar Farm	≤ 50 MW
Wemen Solar Farm	≤ 25 MW
Yatpool Solar Farm	≤ 25 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

26 Koorangie to Wemen to Red Cliffs 220 kV line

The following limit equations are enabled during an outage of the Koorangie to Wemen, Red Cliffs to Wemen or Koorangie to Wemen to Red Cliffs 220 kV lines unless indicated.

Note: For the outage of Koorangie to Wemen to Red Cliffs 220 kV line Bannerton solar farm and Wemen solar farm are disconnected as they are connected to Wemen.

26.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 59 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-60
Offset to system normal equation NIL_O	-60

26.2 Voltage Stability – Murraylink

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Ararat to Horsham 220 kV line, apply the following prior outage limit equations. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 60 V^S [MRLK] KGTS-WETS-RCTS

Term	Coefficient
Intercept	188.3
RCTS Load	-0.8288
KGTS Load	-0.857
WETS load	-1.156
BKNH TX MW	-1.023
BHSS220 Load	-1.137
Confidence Level (95%) offset	-25.7

26.3 Islanding

Limitation to prevent islanding of local load:

Table 61 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Cohuna Solar Farm	≤ *0 MW*	*0 and disconnected*
Gannawarra Solar Farm	≤ *0 MW*	*0 and disconnected*
Gannawarra Battery	= *0 MW*	*0 and disconnected*
Wemen Solar Farm	≤ *0 MW*	*0 and disconnected*
Bannerton Solar Farm	≤ *0 MW*	*0 and disconnected*

26.4 Voltage Oscillation

To prevent voltage oscillations for trip of the Ararat to Waubra to Ballarat 220 kV line the following limits are applied:

Table 62 Voltage oscillation limits

Generator	MW Limit
Ararat Wind Farm	≤ 160 MW
Broken Hill Solar Farm	≤ 30 MW
Bulgana Wind Farm	≤ 40 MW
Crowlands Wind Farm	≤ 55 MW
Coleambally Solar Farm	≤ 45 MW
Darlington Point Solar Farm	≤ 85 MW
Finley Solar Farm	≤ 45 MW
Karadoc Solar Farm	≤ 20 MW

Generator	MW Limit
Kiamal Solar Farm	≤ 50 MW
Kiata Wind Farm	≤ 15 MW
Limondale 1 Solar Farm	≤ 60 MW
Limondale 2 Solar Farm	≤ 15 MW
Murra Warra 1+2 Wind Farm	≤ 80 MW
Murraylink (SA to Vic)	≤ 150 MW
Murraylink (Vic to SA)	≤ 150 MW
Silverton Wind Farm	≤ 100 MW
Sunraysia Solar Farm	≤ 60 MW
Yatpool Solar Farm	≤ 20 MW

Horsham SVC switched off or set to manual mode with a fixed Q setpoint

For the outage of the Koorangie to Wemen or Koorangie to Wemen to Red Cliffs 220 kV lines the following limits are also applied:

Kerang SVC switched off or set to manual mode with a fixed Q setpoint

27 Kiamal synchronous condenser

27.1 Voltage Oscillation

To prevent voltage oscillations for a contingency, the following limit is applied:

Table 63 Voltage oscillation limits when Murrawarra 2 synchronous condenser is in service

Generator	MW Limit	Inverter / Turbine maximum
Kiamal Solar Farm	≤ 135 MW	

28 Kiamal to Red Cliffs 220 kV line

28.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 64 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-70
Offset to system normal equation NIL_O	-70

28.2 Voltage Stability – Murraylink

28.2.1 Buronga to Balranald to Darlington Point (X5) trip

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Buronga to Balranald to Darlington point 220 kV line, apply the following prior outage limit equation. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 65 V^S [MRLK] HOTS-RCTS_X5

Term	Coefficient
Intercept	277.7
RCTS Load	-0.9364
KGTS Load	-1.225
BETS Load	-0.1876
WETS Load	-0.6805
BKNH TX MW	-0.7594
VIC2NSW	0.01024
KGTS SVC out of service	-18.79
Confidence Level (95%) offset	-32

28.2.2 Bendigo to Kerang trip

To manage the Murraylink voltage stability export limit from Victoria to SA for fault and trip of the Bendigo to Kerang 220 kV line, apply the following prior outage limit equation. Studies assume the Red Cliffs Voltage source controller (VSC) is in voltage control mode with the Very Fast Runback (VFRB) scheme disabled. Studies monitored post-contingent voltages and reactive power margin in southern NSW and the Victorian state grid. The limit equation is of the form:

Victoria to SA (Murraylink) ≤ Sum [Term Values * Coefficients]

Table 66 V^S [MRLK] HOTS-RCTS_BEKG

Term	Coefficient
Intercept	164.4
RCTS Load	-0.9846
KGTS Load	-0.6067
WETS Load	-0.89
BKNH TX MW	-1.071
BHSS220 Load	-0.7057
KGTS SVC out of service	-6.367
Confidence Level (95%) offset	-31

28.3 Islanding

Limitation to prevent islanding of local load following the trip of the Ararat to Waubra to Ballarat 220 kV line.

Table 67 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Kiata Wind Farm	*≤ 0 MW*	
Kiamal Solar Farm	*≤ 0 MW*	*0 and disconnected*

Kiamal SynCon switched off

Murrawarra 2 SynCon switched off

28.4 Voltage Oscillation

To prevent voltage oscillations for trip of the Bendigo to Kerang 220 kV line the following limits are applied:

Table 68 Voltage oscillation limits

Generator	MW Limit	Inverter / Turbine maximum
Bannerton Solar Farm	≤ 45 MW	

Generator	MW Limit	Inverter / Turbine maximum
Broken Hill Solar Farm	≤ 30 MW	
Coleambally Solar Farm	≤ 40 MW	
Darlington Point Solar Farm	≤ 65 MW	
Finley Solar Farm	≤ 40 MW	
Gannawarra Solar Farm	≤ 0 MW	0 and disconnected
Gannawarra Battery	= 0 MW	
Karadoc Solar Farm	≤ 45 MW	
Koorangie BESS	≥ -90 MW and ≤ 20 MW	
Limondale 1 Solar Farm	≤ 50 MW	
Limondale 2 Solar Farm	≤ 10 MW	
Murra Warra 1+2 Wind Farm	≤ 15 MW	
Murraylink (SA to Vic)	≤ 150 MW	
Silverton Wind Farm	≤ 50 MW	
Sunraysia Solar Farm	≤ 60 MW	
Wemen Solar Farm	≤ 45 MW	
Yatpool Solar Farm	≤ 40 MW	

29 Cressy to Mortlake 500 kV line

The following limit equations are enabled during an outage of the Cressy to Mortlake 500 kV line.

29.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 69 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-100
Offset to system normal equation NIL_O	-100

29.2 Voltage Unbalance

The following limit equations are enabled to manage the voltage unbalance at APD 500kV and Heywood 275kV buses. These equations are only for Heywood Link Vic to SA power transfer. If the flow in Heywood Link is from SA to Vic, including zero power transfer, no limitations are required.

6.5562 x APD Net Load + Mortlake + Dundonnell generation - 34.965 x Macarthur generation + 16.6738 x VIC to SA (Heywood)
≤ 10931

APD Net Load - 0.6605 x (Mortlake + Dundonnell generation) – 2.6368 x Macarthur generation + 1.9966 x VIC to SA (Heywood)

≤ 1015

29.3 Islanding

Limitation to prevent islanding of local load following the next credible contingency.

Table 70 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Macarthur Wind Farm	*≤ 0 MW*	

30 Moorabool to Sydenham 500 kV line

The following limit equations are enabled during an outage of one Moorabool to Sydenham 500 kV line.

30.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 71 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-80
Offset to system normal equation NIL_O	-80

Studies assume the Emergency Moorabool Transformer Tripping Scheme (EMTT) is disabled. The equation is also valid when the scheme is enabled but the post-contingent conditions do not result in scheme operation.

30.2 Voltage Stability – Vic to SA

To manage the Victorian voltage stability export limit from Victoria to SA for fault and trip of the remaining Moorabool to Sydenham 500 kV line, apply the following limit equation:

Victoria to SA (Heywood) ≤ Sum [Term Values * Coefficients]

Table 72 V^S[HEY]_MLTS-SYTS coefficients

Term	Coefficient (dVs)	Coefficient
Intercept	930.6	1008
APD-HYTS_MW	0.4953	0.4813
APD-HYTS_MVAR	0.3203	0.5232
GTS_LOAD	-0.5702	-0.6298
MOPS_Gen	0.7568	0.5596
MCAR_Gen	0.7757	0.312
MLTS_220_Reactors	0	-10.04
MLTS_Line_Reactors	-42.64	-43.67
Confidence Level (95%) offset	-85.97	-78.21

Studies assume the Emergency Moorabool Transformer Tripping Scheme (EMTT) is disabled. The equation is also valid when the scheme is enabled but the post-contingent conditions do not result in scheme operation.

30.3 System Strength

Electro Magnetic Transient (EMT) studies identified the requirement of minimum number of synchronous generators in Victoria to be online prior to this outage. This is to prevent undamped oscillations in Victoria network following a credible contingency of the remaining Moorabool – Sydenham 500 kV line which results in offloading multiple 500 kV lines between Sydenham and South Morang. Verified combinations are listed below.

Table 73 Moorabool – Sydenham outage system strength minimum generator combinations

Combination	Bogong	Dartmouth	Jeeralang A or B	Loy Yang	Mortlake	Murray (unit 1-10)	Murray (unit 11-14)	Newport	Valley Power	Yallourn	Loy Yang + Yallourn
New_1											8
New_2							2				7
New_3			2								7
New_4			2				2				6
New_5			2			4					6
New_6					1			1			6
New_7					2						6
New_8		1						1			6

'Loy Yang' in Table 73 refers to generators in Loy Yang A or Loy Yang B power stations.

31 Cressy to Haunted Gully or Haunted Gully to Tarrone 500 kV line

The following limit equations are enabled during the above prior outage conditions.

31.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 74 V::N MLTS-TRTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-30
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	0
Offset to system normal equation NILS_decel	N/A [VIC->SA transfer limited to 250MW]

31.2 Voltage Unbalance

The following limit equations are enabled to manage the voltage unbalance at APD 500kV and Heywood 275kV buses:

4.73 x APD Net Load + Mortlake + Dundonnell generation + 1.07 x Macarthur generation + 2.4 x VIC to SA (Heywood) ≤ 4665

1.61 x APD Net Load + 1.18 x Macarthur generation + VIC to SA (Heywood) ≤ 2146

31.3 Fault Levels

Limitation due to insufficient fault level for converter operation at Macarthur Wind Farm.

Table 75 Fault level limit

Generator	MW Limit
Macarthur Wind Farm	*≤ 0 MW*

32 Cressy to Moorabool 500 kV line 1 or 2

The following limit equations are enabled during the above outage condition.

32.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 76 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-100
Offset to system normal equation NIL_O	-100

32.2 Islanding

Limitation to prevent islanding of local load following the next credible contingency.

Table 77 Islanding limits

Generator	MW Limit	Inverter / Turbine maximum
Macarthur Wind Farm	*≤ 0 MW*	
Mortlake power station	*≤ 0 MW*	

33 Moorabool A1 or A2 Transformer 500/220 kV

The following limit equations are enabled during an outage of the Moorabool A1/A2 500 kV transformer.

33.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 78 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-60
Offset to system normal equation NIL_O	-60

34 Murraylink

34.1 Voltage Stability – Wemen to Koorangie limit

To manage the Wemen to Koorangie flow limit to prevent voltage collapse at Kerang, Koorangie or Wemen for the loss of the Crowlands to Bulgana to Horsham or Horsham to Murra Warra to Kiamal 220kV line apply the following prior outage offset to the system normal equation NIL_KERANG when Murraylink VFRB disabled only. The limit equation is of the form:

Table 79 V^V MRLK_KERANG offset

Term	Offset
Offset to system normal NIL_KERANG Disabled	-30

34.2 Voltage Stability – NSW to Vic

34.2.1 Largest Vic generator or Basslink trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of Basslink or the loss of the largest Victorian generator, apply the following prior outage offset to the system normal equation NIL_VI_BLVG. Studies monitored post-contingent voltages and reactive power margin in northern Victoria and southern NSW. The limit equation is of the form:

NSW to Victoria ≤ [-1 * Sum [Term Values * System Normal Coefficients]] + Offset

Table 80 V^N MRLK_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-100

34.2.2 Ballarat to Waubra to Ararat 220kV line trip

To manage the Victorian voltage stability import limit from NSW to Victoria for fault and trip of Ballarat to Waubra to Ararat 220kV line (this also trips Waubra, Ararat and Crowlands, Bulgana and Murra Warra WFs), apply the following prior outage offset to the system normal equation NIL_VI_ARWBBA. Studies monitored post-contingent voltages and reactive power margin in northern Victoria and southern NSW. The limit equation is of the form:

NSW to Victoria ≤ [-1 * Sum [Term Values * System Normal Coefficients]] + Offset

Table 81 V^N MRLK_ARWBBA offset

Term	Offset
Offset to system normal equation NIL_VI_ARWBBA	-100

35 Rowville to Hazelwood 500 kV line

The following limit equations are enabled during the above prior outage.

35.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to the system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 82 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-230
Offset to system normal equation NIL_O	-230

36 Rowville to South Morang 500 kV line

The following limit equations are enabled during an outage of the Rowville to South Morang 500 kV line.

36.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to the system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 83 NIL_V and NIL_O Offsets

Term	Offset
Offset to the system normal equation NIL_V	-190
Offset to the system normal equation NIL_O	-190

37 South Morang Series Capacitor

The following limit equations are enabled during an outage of one South Morang series capacitor.

37.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 84 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-50
Offset to system normal equation NIL_O	-50

37.2 Voltage Stability – NSW to Vic

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the fault and trip of Basslink, the loss of the largest Victorian generator, the loss of a Dederang to Murray 330 kV line, the loss of a Dederang 330/220 kV transformer or the loss of the parallel Dederang to South Morang 330 kV line and series capacitor. Therefore, no additional offset is required.

38 South Morang Substation No. 2 330 kV bus

The following limit equation is enabled during an outage of the South Morang B2 330 kV bus.

38.1 Transient Stability – Vic to NSW

38.1.1 Hazelwood to South Morang trip

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to SMTS F2 prior outage equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * SMTS F2 Prior Outage Coefficients] + Offset

Table 85 V::N SMTS-B2_V/Q/S/S_decel offsets (HWTS-SMTS 500 kV fault)

Term	Offset
Offset to SMTS F2 prior outage equation NILV	-50
Offset to SMTS F2 prior outage equation NILQ	0
Offset to SMTS F2 prior outage equation NILS	-50
Offset to SMTS F2 prior outage equation NILS_decel	-50

38.1.2 South Morang to Thomastown trip

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of the South Morang to Thomastown No 1 220 kV line, apply the following prior outage offsets to system normal equations NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 86 V::N SMTS-B2_V/Q/S/S_decel offsets (SMTS-TTS 220 kV fault)

Term	Offset
Offset to system normal equation NILV	-20
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-20
Offset to system normal equation NILS_decel	0

39 South Morang H1 or H3 Transformer 330 / 220 kV

The following limit equations are enabled during an outage of the South Morang H1 or H3 330/220 kV transformer.

39.1 Voltage Stability – NSW to Vic

The system normal voltage stability equation NIL_VI_BLVG will manage voltage stability associated with the fault and trip of Basslink, the loss of the largest Victorian generator, the loss of a Dederang to Murray 330 kV line, the loss of a Dederang to South Morang 330 kV line, the loss of the parallel H3 or H1 transformer, the loss of the F2 transformer, or the loss of a Dederang transformer. Therefore, no additional offset is required.

40 South Morang to Sydenham 500 kV line

The following limit equations are enabled during an outage of the South Morang to Sydenham 500 kV line.

40.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to the system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 87 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-70
Offset to system normal equation NIL_O	-70

41 South Morang to Thomastown 220 kV line

The following limit equations are enabled during an outage of one South Morang to Thomastown 220 kV line.

41.1 Transient Stability – Vic to NSW

To manage the Victorian transient stability export limit from Victoria to NSW for fault and trip of a Hazelwood to South Morang 500 kV line, apply the following prior outage offsets to the system normal equations NIL_V and NIL_O. The limit equations are of the form:

Victoria to NSW ≤ Sum [Term Values * System Normal Coefficients] + Offset

Table 88 NIL_V and NIL_O Offsets

Term	Offset
Offset to system normal equation NIL_V	-50
Offset to system normal equation NIL_O	-50

42 Wemen B1 or B2 220/66 kV Transformers

The following limits are enabled during the above outage.

42.1 System Strength

To manage the low fault level during the above outage the following limits are applied:

Table 89 System strength limits

Generator	MW Limit	Inverter / Turbine maximum
Bannerton Solar Farm	-	15
Wemen Solar Farm	-	15

A1. Measures and Definitions

A1.1 Units of Measure

Abbreviation	Unit of measure
kV	Kilovolt.
MVA	Megavolt amperes.
MVAR	Megavolt amperes reactive.
MW	A Megawatt (MW) is one million watts. A watt (W) is a measure of power and is defined as one joule per second and it measures the rate of energy conversion or transfer.
MW.sec	Megawatt seconds – a measure of the inertia of a generating unit.

A1.2 Parameter Definitions

Abbreviation	Definition
220 kV Caps	MVAR output from capacitors connected at 220 kV busbars (i.e. Altona, Brooklyn, Dederang, Fishermans Bend, Keilor, Moorabool, Rowville, Ringwood, Templestowe and Thomastown).
APD–HYTS_MVAR	Alcoa Portland smelter (APD) reactive power export (measured at 500 kV feeders). A negative value indicates that APD is importing MVAr.
APD–HYTS_MW	APD real power export (measured at 500 kV feeders. A negative value indicates that APD is importing MW).
APD Load	APD MW load at 33 kV and 22 kV.
APD Net Load	Net load measured at APD 500kV bus (Actual APD load consumption – Portland wind farm generation).
BANReac	MVAR output of Bannaby reactors. Values associated with this term are negative.
Basslink	MW flow on the Basslink interconnector (measured at the receiving end).
BATS TX MW	MW flow through 220/66kV transformers at Ballarat (measured at HV side, positive value indicates load MW).
BETS Load	Bendigo (BETS) customer load (MW).
BHSS220 Load	Broken Hill 220 kV MW industrial (mine) load.
BKNH GEN	MW output from Broken Hill Generation.
BRKNHLSF_SilvWF	MW output from Broken Hill SF and Silverton WF.
BKNH TX MW	MW flow through 220/22kV transformers at Broken Hill (measured at HV side, positive value indicates load MW).
BOPS+MKPS GEN	MW output from Bogong and McKay Power Station [BOPS & MKPS].
Both TAIL-SESS Series Caps Out	Both Tailem Bend – South East series caps out of service (1= Both series caps are out of service).
BRGAshnt	MVAR output of Buronga shunt devices. Values associated with this term can be positive or negative.
CANCap	MVAR output of Canberra 220 kV capacitor banks. Values associated with this term are positive.
CMACap	MVAR output of Cooma capacitor banks. Values associated with this term are positive.
Constraint equation	These are the mathematical representations that AEMO uses to model power system limitations and FCAS requirements in National Electricity Market Dispatch Engine (NEMDE).
Contingent MW	Maximum of:

Abbreviation	Definition
	a) MW Transfer from Tas to Vic via Basslink (measured at Loy Yang). Values associated with this term are positive for flows from Tas to Vic. b) MW output of a single generating unit in Vic (MW associated with the contingency: Loss of the Largest Generator). Values associated with this term are positive.
CUECap	MVAR output of Queanbeyan capacitor banks. Values associated with this term are positive.
DARL_PT_3WTX_MW	MW flow through 3 winding 330/220/33 transformers at Darlington point measured at 330kV transformer terminal with positive values indicate MW flow into transformers from 330kV side.
DARL_PT_3WTX_MVAR	MVAR flow through 3 winding 330/220/33 transformers at Darlington point measured at 330kV transformer terminal with positive values indicate MVAr flow into transformers from 330kV side.
DD220Cap	MVAR output of Dederang 220 kV capacitor banks. Values associated with this term are positive.
DD330Cap	MVAR output of Dederang 330 kV capacitor banks. Values associated with this term are positive.
DLPTshunt	MVAR output of Darlington Point shunt devices. Values associated with this term can be positive or negative.
DPS GEN	MW output from Dartmouth Power Station [DPS].
EPS Inertia	Inertia from Eildon Power Station (EPS). Inertia is on a 100 MVA base (MW.sec / 100 MVA) as per EMS.
GEN EPS on	Number of Eildon Power station (EPS) units online.
GEN DPS on	Number of Dartmouth Power station units online [DPS].
GEN BOPS on	Number of Bogong Power station units online [BOPS].
Gen_Lower_NW_VIC_MW	Sum of generation MW output from lower NorthWest Victoria wind farms including Ararat WF, Bulgana WF, Crowlands WF, Kiata WF, Murra Warra WF, Waubra WF.
GEN MKPS on	Number of Mckay Power station units online [MKPS].
GEN WKPS on	Number of West Kiewa Power station units online [WKPS].
Gen_Upper_NW_VIC_MW	Sum of generation MW output from upper NorthWest Victoria wind and solar farms including Bannerton SF, Cohuna SF, Gannawarra SF, Gannawarra Battery, Karadoc SF, Kiamal SF, Wemen SF, Yatpool SF.
Guthega GEN	MW output from Guthega Power Station [GGA].
Guthega Inertia	Inertia from Guthega Power Station [GGA]. Inertia is on a 100 MVA base (MW.sec / 100 MVA) as per EMS.
HOTS Load	Horsham (HOTS) customer load (MW).
HOTS SVC out of service	Horsham SVC out of service, This term is equal to 0 when the SVC is in service, and equal to 1 when the SVC is out of service.
HOTS_TX1_TX2 MW	Sum of MW flow on Horsham B2 and B3 220/66 kV transformers. Positive value indicates power flow from HV to LV side.
HOTS_TX1_TX2 MVAR	Sum of MVAR flow on Horsham B2 and B3 220/66 kV transformers. Positive value indicates power flow from HV to LV side.
HOTS-66REC	MVAR output from Horsham 66kV reactor. Values associated with this term are negative.
HOTS-66CAP	MVAR output from Horsham 66kV Capacitor. Values associated with this term are positive.
HUME VIC GEN	MW output from Hume Power station (Victorian connection).
HYTS_CAP_Status	Heywood capacitor status (1 = capacitor in service).
JBE Pump	MW at Jindabyne Power Station [JBE]. Values associated with this term are negative.
KGTS Load	Kerang (KGTS) customer load (MW).
KGTS SVC MVAR	MVAR flow through SVC installed at Kerang.
KGTS SVC out of service	Kerang SVC out of service, This term is equal to 0 when the SVC is in service, and equal to 1 when the SVC is out of service.
Kiewa Gen	MW output from Kiewa hydro scheme generators (Bogong, Clover, Dartmouth, Mckay and West Kiewa).
Kiewa Inertia	Inertia from Kiewa hydro scheme generators (Bogong, Clover, Dartmouth, McKay and West Kiewa). Inertia is on a 100 MVA base (MW.sec / 100 MVA).

Abbreviation	Definition
L_TUMUT_Gen	MW output from Lower Tumut 3 power station (LTSS). Values associated with this term can be positive or negative due to the ability of Lower Tumut units to operate in pumping mode.
LTUM3SC	Number of generator units operating as synchronous condensers at Lower Tumut.
LV 220 Gen	MW output from Latrobe Valley generation on the 220 kV network (Yallourn W2, 3, and 4, and Yallourn unit 1 when connected to the 220 kV network).
LV 220 Inertia	Inertia associated with Latrobe Valley generation on the 220 kV network (Yallourn W2, 3, and 4, and Yallourn unit 1 when connected to the 220 kV network).
LV 500 Inertia	Inertia associated with Latrobe Valley generation on the 500 kV network (Loy Yang (A, B, and Valley Power), Jeeralang, Bairnsdale, and Yallourn W unit 1 when connected to the 500 kV network).
MCAR_Gen	MW output from the Macarthur Wind Farm (MCAR).
MLTS_220_Reactors	Count of MLTS 220 kV reactors.
MLTS_Line_Reactors	Count of MLTS line reactors (2=both reactors in service).
MMWF_Gen	MW output from the Mount Mercer Wind Farm (MMWF).
MOPS Inertia	Inertia from Mortlake Power Station (MOPS). Inertia is on a 100 MVA base (MW.sec / 100 MVA) as per EMS.
MSS2SC	Number of generator units operating as synchronous condensers at Murray 2.
MSSReac	MVAR output of Murray reactors. Values associated with this term are negative.
Murray Gen	MW output from Murray Power Station (Murray 1 and Murray 2).
Num. MSS1 on	Number of generator units operating at Murray 1.
Num. ROTS SVC	Number of Static Var Compensators (SVCs) at Rowville in service.
Num. SESS SVC	Number of SVCs at South East in service.
NSW_D	New South Wales demand.
NSWd- SW_NSW	NSW demand (customer load + losses) minus the load in southern NSW.
NSW_H	Inertia of New South Wales generators excluding Murray, Lower Tumut and Upper Tumut (Eraring, Vales Point, Bayswater, Munmorah, Redbank, Mt Piper, Liddell, Bendeela, Kangaroo Valley, Colongra, Tallawarra, Uranquinty).
Parallel System	Victorian system operating in "Parallel" mode, This term is equal to 0 when operating in radial mode, and equal to 1 when operating in parallel mode.
Portland WF	Portland wind farm generation, MW.
QLD_H	Inertia of Queensland generators (Swanbank B, Gladstone, Tarong, Wivenhoe, Callide B, Stanwell, Callide C, Tarong North, Swanbank E, Barcaldine, Barron Gorge, Callide A, Collinsville, Invicta, Kareeya, Mackay, Mt Stuart, Townsville, Oakey, Millmerran, Braemar, Darling Downs, Condamine, Braemar 2, Kogan Creek).
Q2-BURNGA 220	MVAR output from the two line reactors on the X2 and X3 line at Buronga. Values associated with this term are negative.
Q3-REDCLF 220	MVAR output from Redcliff Capacitor at 220kV bus. Values associated with this term are positive.
RCTS Load	Red Cliffs (RCTS) customer load (MW).
RCTS-MLK_MVAR	MVAR flow from Redcliff to Murraylink 220kV line. Measured at Redcliff. Flow is positive from Redcliff to Murraylink.
Rowville SVC1 or SVC2 out of service	Rowville SVC out of service, This term is equal to 0 when the SVC is in service, and equal to 1 when one SVC is out of service.
SNOWY Inertia	Inertia from the Snowy area (Murray, Lower Tumut and Upper Tumut). Inertia is on a 100 MVA base (MW.sec / 100 MVA).
SNOWY_GSC_H	Inertia of Snowy generation (Murray, Guthega, Lower Tumut and Upper Tumut) minus the inertia of Lower Tumut machines running as pumps. Inertia is on a 100 MVA base (i.e. MW.sec / 100 MVA).
State Grid Load	Vic State Grid Load. This is the sum of the State Grid Load North (SGLN) and State Grid Load South (SGLS).

Abbreviation	Definition
State Grid Load North	Vic State Grid Load north is the sum of load at the following bulk supply points: Bendigo (BETS), Fosterville (FVTS), Glenrowan (GNTS), Kerang (KGTS), Mt Beauty (MBTS), Red Cliffs (RCTS), Shepparton (SHTS), Wemen (WETS), and Wodonga (WOTS).
State Grid Load South	Vic State Grid Load south is the sum of load at the following bulk supply points: Ararat (ARTS), Ballarat (BATS), Horsham (HOTS), Stawell (STA) and Terang (TGTS).
SW_NSW	Load in Southern NSW is the sum of customer load at the following bulk supply points: Broken Hill (BKH_S1-22 and BKH-220), Gadara (GAD-11), Jounama (JOU-66), Darlington Point (DLP-132), Morven (MOR-132), Albury (ALB-132), AMN-132, Coleambally (CLY-132), Marulan (MRN-132, GOU-132), Wagga (WAN-132, WAN-66, WAW-132), Murrumburrah (MRU-66), Deniliquin (DNQ-66), Yass (YAS-66), Balranald (BRD-22), Finley (FNY-132), Griffith (GRF-132), Mulwala (MUL-132), Corowa (COR-132), and Yanco (YNC-33).
STH_NSW_GEN	Generation in southern NSW. Values associated with this term are positive. Generation in this region are Gullen Range WF, Gullen SF, Capital WF, Cullerin Range WF, Coleambally SF, Gunning WF, Boco Rock WF, Taralga WF, Woodlawn WF, and Blowering Hydro, Crookwell 2 WF, Walla Walla SF 1 and Walla Walla SF2, Bango 973 Wind Farm, Bango 999 Wind Farm, Bomen Solar Farm, Collector Wind Farm, Darlington Point Solar Farm, Finley Solar Farm, Griffith Solar Farm, Gullen Range 2 Wind Farm, and Wagga North Solar Farm.
System normal	The configuration of the power system where: a) All transmission elements are in service, or b) The network is operating in its normal network configuration.
TNSP	Transmission Network Service Provider.
Tumut Pump	MW of Lower Tumut machines in pumping mode (this MW value is negative).
UQT Gen	MW output from Uranquinty (UQT) Power Station.
U_TUMUT_Gen	MW output from Upper Tumut 1 and Upper Tumut 2 Power Station (UTSS).
UTUM1SC+UTUM2SC	Number of generator units operating as synchronous condensers at Upper Tumut 1 and Upper Tumut 2.
V_MLTS5	MLTS 500 kV voltage (typical values between 450 and 550 kV).
V_MSS3330	Voltage (kV) at the Murray Power Station 330 kV bus.
VIC220_Gen	MW output from Latrobe Valley generation on the 220 kV network (Yallourn W units 2, 3 and 4 and unit 1 when connected to 220 kV network).
Vic Demand	Vic MW demand (calculated as generation minus export).
Vic to SA (Heywood)	MW transfer from Vic to SA via Heywood (measured at South East end). The interconnector direction and lines it consists of follow the NEM standard.
Vic to SA (Murraylink)	MW transfer from Vic to SA via Murraylink (measured at Red Cliffs end).
VIC to NSW	MW transfer from Vic to NSW.
Vic Demand - State Grid Load	Vic Demand (MW) minus Vic State Grid Load (SGL).
Vic Demand - State Grid Load North – APD Load	Vic Demand (MW) minus Vic State Grid Load North (SGLN) minus APD Load.
Vic Metro Gen	MW output from Vic metropolitan generators (Newport, Somerton, and Laverton North).
Vic Metro Gen Inertia	Inertia from Vic metropolitan generators (Newport, Somerton and Laverton North). Inertia is on a 100 MVA base (MW.sec / 100 MVA) as per EMS.
Vic Wind & Solar	MW Generation from all Vic windfarms and solar plant. This includes Ararat WF, Bald Hills WF, Ballarat Battery (Gen Component), Bannerton SF, Bulgana WF, Challcum Hills WF, Crowlands WF, Gannawarra Battery (Gen component), Gannawarra SF, Karadoc SF, Kiata WF, Macarthur WF, Moorabool WF, Mortons Lane WF, Mount Gellibrand WF, Mount Mercer WF, Murra Warra WF, Numurkah SF, Oaklands Hill WF, Portland WF, Salt Creek WF, Waubra WF, Wemen SF, Yaloak South WF, Yambuk WF, Yatpool SF and Yendon SF.
WAGGACap	MVAR output of Wagga Wagga capacitor banks. Values associated with this term are positive.
WKPS GEN	MW output from West Kiewa Power Station [WKPS].

Abbreviation	Definition
WETS Load	Wemen (WETS) customer load (MW).
WOTSCap	MVAR output of Wodonga capacitor banks. Values associated with this term are positive.
YASSCap	MVAR output of Yass capacitor banks. Values associated with this term are positive.
YASSReac	MVAR output of Yass reactors. Values associated with this term are negative.

A2. Glossary

This document uses many terms that have meanings defined in the National Electricity Rules (NER). The NER meanings are adopted unless otherwise specified.

Term	Definition
Constraint equation	These are the mathematical representations that AEMO uses to model power system limitations and FCAS requirements in National Electricity Market Dispatch Engine (NEMDE).
System normal	The configuration of the power system where: • All transmission elements are in service, or • The network is operating in its normal network configuration.
TNSP	Transmission Network Service Provider.