AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Victorian Transfer Limit Advice – Outages

March 2022

For the National Electricity Market

Important notice

PURPOSE

AEMO has prepared this document to provide information about voltage and transient stability limits for flows to and from Victoria, as at the date of publication.

DISCLAIMER

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VERSION CONTROL

Version	Release date	Changes
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
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”.

Version	Release date	Changes
		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 Ciffs 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

1. Introduction

AEMO is responsible for calculating the maximum transient and voltage stability limits into and out of Victoria, as well as voltage unbalance and voltage oscillation constraints to keep the system within specified limits, in accordance with the National Electricity Rules (NER) S5.1.2.3 and the Power System Stability Guidelines[1]. This document describes the values for these transfer limits for single prior outage conditions in Victoria.

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

The limit equations for system normal cases are described in a separate document, *Victorian Transfer Limit Advice – System Normal*. Limit equations for outages in NSW and SA are described in *Victorian Transfer Limit Advice – Outages in Adjacent Regions* and multiple prior outages are described in *Victorian Transfer Limit Advice – Multiple Outages*. Both of these documents are available on the AEMO website[2].

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.
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

[1] AEMO, *Power System Stability Guidelines*, Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Congestion-information,Viewed on 31 August 2016.

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

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%.

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

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

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 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:

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 NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

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

Table 1 V::N APD-HYTS-MOPS_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	-30
Offset to system normal equation NILS_decel	N/A [VIC->SA transfer limited to 250 MW]

2.2 Voltage Unbalance

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

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

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 + Dundonnel 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 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 2 V::N APD-HYTS-TRTS_V/Q/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	-30
Offset to system normal equation NILS_decel	N/A [VIC->SA transfer limited to 250 MW]

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 3 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.

Bulgana wind farm ≤ 0 MW

Bulgana battery = 0 MW with all inverters disconnected

Crowlands wind farm ≤ 0 MW

Kiata wind farm ≤ 0 MW

Kiamal solar farm ≤ 0 MW with all inverters 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:

Ararat wind farm ≤ 60 MW

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 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 switched off

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 4 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 5 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.

Ararat wind farm ≤ 0 MW

Bulgana wind farm ≤ 0 MW

Bulgana battery = 0 MW with all inverters disconnected

Crowlands wind farm ≤ 0 MW

Kiata wind farm ≤ 0 MW

Kiamal solar farm ≤ 0 MW with all inverters 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:

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 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 switched off

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 6 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 7 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
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:

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

Crowland wind farm ≤ 40 MW

Darlington Point solar farm ≤ 60 MW

Finley solar farm ≤ 40 MW

Ganawarra 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 wind farm ≤ 60 MW

Murraylink (Vic to SA) ≤ 150 MW

Murraylink (SA to Vic) ≤ 150 MW

Silverton WF ≤ 50

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 NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

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

Table 8 V::N BETS-KGTS_V/Q/S/S_decel offsets

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

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 9 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.

Cohuna Solar Farm ≤ 0 MW with all inverters disconnected

Gannawarra solar farm ≤ 0 MW with all inverters disconnected

Gannawarra battery = 0 MW with all inverters disconnected

8.4 Voltage Oscillation

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

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 in 'Pause Mode')

Limondale 1 solar farm ≤ 60 MW

Limondale 2 solar farm ≤ 25 MW

Murra Warra wind farm ≤ 0 MW (can be operated in 'Pause Mode')

Murraylink (Vic to SA) ≤ 150 MW

Murraylink (SA to Vic) ≤ 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 10 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:

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

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 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. Buronga to Red Cliffs (0X1) 220 kV line

The following limit equations are enabled during an outage of the Buronga to Red Cliffs (0X1) 220 kV line.

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

10.1 Voltage Oscillation

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

Bannerton solar farm ≤ 45 MW

Bulgana wind farm ≤ 60 MW

Coleambally solar farm ≤ 60 MW

Darlington Point solar farm ≤ 100 MW

Finley solar farm ≤ 50 MW

Gannawarra solar farm ≤ 30 MW

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

Karadoc solar farm ≤ 25 MW

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

Kiamal solar farm ≤ 50 MWLimondale 2 solar farm ≤ 15 MW

Murra Warra wind farm ≤ 90 MW

Murraylink (SA to Vic) ≤ 150 MW

Wemen solar farm ≤ 45 MW

Yatpool solar farm ≤ 25 MW

10.2 Voltage Stability – NSW to Vic

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 11 N^V MSS-UTSS_BLVG offsets

Term	Offset
Offset to system normal equation NILV	-200

10.3 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 12 V^N_2xAPD offset

Term	Offset
Offset to system normal V^N_2xAPD	-50

11. Cranbourne to Hazelwood 500 kV line

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

11.1 Transient stability – Vic to NSW

11.1.1 V::N CBTS-HWTS-V

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 (where Victoria accelerates ahead of the other states), apply the following limit equation:

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

Table 13 V::N CBTS-HWTS-V coefficients

Term	Coefficient
Intercept	1024
Basslink	0.4251
Vic. to SA (Heywood)	-0.3073
Vic. to SA (Heywood)^2	-8.43e-4
Vic. to SA (Murraylink)	-1.091
LV 500 Inertia	8.719
EPS Inertia	20.56
MOPS Inertia	11.24
LV 220 Inertia	7.848
SNOWY Inertia	1.033
VIC METRO Gen Inertia	2.628
Murray Gen	0.7519
Kiewa Gen	0.9978
LV 220 Gen	0.2923
VIC Metro Gen	0.6395
State Grid Load North	-0.9315
APD Load	-0.9224
Vic Wind & Solar	0.4395
VIC Demand - State Grid Load North - APD Load	-0.421
220 kV_Caps	-0.1575
Num. ROTS SVC	35.16
Num. SESS SVC	26.32
Confidence Level (95%) offset	-99

11.1.2 V::N CBTS-HWTS-Q

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 (where Queensland accelerates ahead of the other states), apply the following limit equation:

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

Table 14 V::N CBTS-HWTS-V coefficients

Term	Coefficient
Intercept	1554
Basslink	0.537
Vic. to SA (Heywood)	-1.145
Vic. to SA (Murraylink)	0.8559
LV 500 Inertia	9.357
MOPS Inertia	11.93
Murray Gen	0.9247
Kiewa Gen	0.7993
LV 220 Gen	0.6185
VIC Metro Gen	0.6665
Vic Wind & Solar	0.6197
State Grid Load	-0.7364
VIC Demand - State Grid Load	-0.5799
Confidence Level (95%) offset	-71

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

11.1.3 V::N CBTS-HWTS-S

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 (where South Australia accelerates ahead of the other states), apply the following limit equation:

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

Table 15 V::N CBTS-HWTS-S coefficients

Term	Coefficient
Intercept	903
Basslink	0.4955
Vic. to SA (Heywood)	-0.5772
Vic. to SA (Heywood)^2	-6.19e-4
Vic. to SA (Murraylink)	-1.053
LV 500 Inertia	8.706
EPS Inertia	21.63
MOPS Inertia	11.53
LV 220 Inertia	7.143
KIEWA Inertia	4.477
VIC METRO Gen Inertia	6.347
Murray Gen	0.8904
Kiewa Gen	0.797
LV 220 Gen	0.4175
VIC Metro Gen	0.3353
State Grid Load North	-1.033
APD Load	-0.4133
Vic Wind & Solar	0.5446
VIC1 Demand - State Grid Load North - APD Load	-0.4714
220 kV_Caps	-0.1566
Num. ROTS SVC	33.88
Num. SESS SVC	24.1
Confidence Level (95%) offset	-88

11.1.4 V::N CBTS-HWTS- S_decel

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 (where South Australia decelerates away from the other states), apply the following limit equation:

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

Table 16 V::N CBTS-HWTS-S_decel coefficients

Term	Coefficient
Intercept	763
Basslink	0.469
Vic. to SA (Heywood)^2	-0.00151
Vic. to SA (Murraylink)	-1.204
LV 500 Inertia	9.302
EPS Inertia	18.57
MOPS Inertia	14.51
KIEWA Inertia	17.13
VIC METRO Gen Inertia	4.581
Murray Gen	0.8825
LV 220 Gen	0.6197
VIC Metro Gen	0.5306
State Grid Load North	-0.8816
APD Load	-0.3837
Vic Wind & Solar	0.514
VIC1 Demand - State Grid Load North - APD Load	-0.4703
220 kV_Caps	-0.3296
Confidence Level (95%) offset	-113

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

12. 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.

12.1 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 17 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

12.2 Islanding

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

Kiata wind farm ≤ 0 MW

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

Bulgana wind farm ≤ 0 MW

12.3 Voltage Oscillation

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

Bannerton solar farm ≤ 45 MW with ≤ 22 inverters connected, otherwise 0 MW

Broken Hill solar farm ≤ 30 MW with ≤ 44 inverters connected, otherwise 0 MW

Gannawarra solar farm ≤ 30 MW with ≤ 12 inverters connected, otherwise 0 MW

Karadoc solar farm ≤ 45 MW with ≤ 21 inverters connected, otherwise 0 MW

Murra Warra wind farm ≤ 15 MW with ≤30 turbines connected, otherwise 0 MW

Wemen solar farm ≤ 45 MW with ≤ 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:

Bulgana wind farm ≤ 130 MW

13. Dederang to Mount Beauty 220 kV line

The following limit equations are enabled during an outage of one Dederang to Mount Beauty 220 kV line.

13.1 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 18 V::N DDTS-MBTS_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	-30
Offset to system normal equation NILS_decel	-30

13.2 Voltage Stability – NSW to Vic

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

14. 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.

14.1 Transient Stability – Vic to NSW

14.1.1 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 19 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

14.1.2 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 20 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

14.2 Voltage Stability – NSW to Vic

14.2.1 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 21 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
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

14.2.2 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 22 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

15. 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.

15.1 Transient Stability – Vic to NSW

15.1.1 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 23 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

15.1.2 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 24 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

15.2 Voltage Stability – NSW to Vic

15.2.1 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 25 NIL_VI_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-100

15.2.2 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 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 26 NIL_VI_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-150

15.3 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 27 V^N_2xAPD offset

Term	Offset
Offset to system normal V^N_2xAPD	-150

16. 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.

16.1 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.

17. 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.

17.1 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 28 V::N DDTS-WOTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-110
Offset to system normal equation NILQ	-15
Offset to system normal equation NILS	-85
Offset to system normal equation NILS_decel	-60

17.2 Voltage Stability – NSW to Vic

17.2.1 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 29 - V^N DDTS-WOTS_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-60

17.2.2 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.

17.3 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:

Ararat wind farm **≤** *0 MW (can be operated in 'Pause Mode')*

Bannerton solar farm **≤** *45 MW*

Bulgana wind farm **≤** *0 MW (can be operated in 'Pause Mode')*

Bulgana battery = 0 MW with all inverters disconnected.

Crowlands wind farm **≤** *0 MW (can be operated in 'Pause Mode')*

Gannawarra solar farm **≤** *30 MW*

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

Karadoc solar farm **≤** *25 MW*

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

Kiamal solar farm **≤** *50 MW*

Limondale 2 solar farm **≤** *0 with all inverters disconnected*

Murra Warra wind farm **≤** *90 MW*

Murraylink SA-VIC **≤** *125 MW*

Wemen solar farm **≤** *45 MW*

Yatpool solar farm **≤** *25 MW*

18. Eildon to Mount Beauty 220 kV line

The following limit equations are enabled during an outage of one Eildon to Mount Beauty 220 kV line.

18.1 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 30 V::N EPS-MBTS_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	-30
Offset to system normal equation NILS_decel	-30

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 Murray 330 kV line. Therefore no additional offset is required.

19. Eildon To Thomastown 220 kV line

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

19.1 Transient Stability – Vic to NSW

19.1.1 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 31 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

19.1.2 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 32 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

19.2 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.

20. 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.

20.1 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 33 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

21. 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.

21.1 Transient Stability – Vic to NSW

21.1.1 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 34 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

21.1.2 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 35 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.

21.1.3 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 36 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
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

21.1.4 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 37 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.

22. 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.

22.1 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 38 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]

23. Horsham SVC

23.1 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:

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 wind farm **≤** *135 MW*

Silverton wind farm **≤** *119 MW*

Sunraysia solar farm **≤** *120 MW*

Wemen solar farm **≤** *53 MW*

Yatpool solar farm **≤** *49 MW*

24. 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.

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 NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

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

Table 39 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

24.2 Voltage Stability – Murraylink

24.2.1 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 40 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

24.2.2 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 41 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

24.3 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.

Kiata wind farm ≤ 0 MW

24.4 Voltage Oscillation

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

Bannerton solar farm ≤ 45 MW

Broken Hill solar farm ≤ 30 MW

Gannawarra solar farm ≤ 0 MW with all inverters disconnected

Gannawarra battery ≤ 0 MW

Karadoc solar farm ≤ 45 MW

Kiamal ≤ 40 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:

Murra Warra ≤ 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:

Murra Warra ≤ 15 MW from collector groups 3 and 4, otherwise 0 MW

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

25. 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).

25.1 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 42 V::N JIND-WOTS_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	-70
Offset to system normal equation NILS_decel	-50

25.2 Voltage Stability – NSW to Vic

25.2.1 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 43 V^N JIND-WOTS_BLVG offset

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-60

25.2.2 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.

25.3 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 17.3 are applied.

26. Keilor to Sydenham 500 kV line

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

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 NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

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

Table 44 V::N KTS-SYTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-25
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-10
Offset to system normal equation NILS_decel	-10

27. Kerang SVC

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

27.1 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:

Bannerton solar farm **≤** *25MW*

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*

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

Karadoc solar farm **≤** *25 MW*

Kiamal solar farm **≤** *50 MW*

Limondale 1 solar farm **≤** *50 MW*

Limondale 2 solar farm **≤** *25 MW*

Murra Warra 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*

28. Kerang to Wemen to Red Cliffs 220 kV line

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

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

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 NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

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

Table 45 V::N KTS-SYTS_V/Q/S/S_decel offsets

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

28.2 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 46 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

28.3 Islanding

Limitation to prevent islanding of local load:

Cohuna solar farm ≤ 0 MW with all inverters disconnected

Gannawarra solar farm ≤ 0 MW with all inverters disconnected

Gannawarra battery=0 MW with all inverters disconnected

Wemen solar farm ≤ 0 MW with all inverters disconnected

Bannerton solar farm ≤ 0 MW with all inverters disconnected

28.4 Voltage Oscillation

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

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

Kiamal solar farm ≤ 50 MW

Kiata wind farm ≤ 15 MW

Limondale1 Solar Farm ≤ 60 MW

Limondale2 Solar Farm ≤ 15 MW

Murra Warra wind farm ≤ 80 MW

Murraylink (Vic to SA) ≤ 150 MW

Murraylink (SA to Vic) ≤ 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 Kerang to Wemen or Kerang 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

29. Kiamal to Red Cliffs 220 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 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 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

29.2 Voltage Stability – Murraylink

29.2.1 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 48 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

29.2.2 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 49 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

29.3 Islanding

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

Kiata wind farm ≤ 0 MW

Kiamal solar farm ≤ 0 MW with all inverters disconnected

29.4 Voltage Oscillation

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

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 with all inverters disconnected

Gannawarra battery = 0 MW

Karadoc solar farm ≤ 45 MW

Limondale 1 solar farm ≤ 50 MW

Limondale 2 solar farm ≤ 10 MW

Murraylink (SA to Vic) ≤ 150 MW
Murra Warra ≤ 15 MW from collector groups 3 and 4, otherwise 0 MW

Silverton wind farm ≤ 50 MW

Sunraysia solar farm ≤ 60 MW

Wemen solar farm ≤ 45 MW

Yatpool solar farm *≤ 40 MW*

30. Moorabool to Mortlake 500 kV line

The following limit equations are enabled during an outage of the Moorabool to Mortlake 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 NILV, NILQ, NILS and NILS_decelerating. The limit equation is of the form:

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

Table 50 V::N MLTS-MOPS_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	-30
Offset to system normal equation NILS_decel	N/A [VIC->SA transfer limited to 250MW]

30.2 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 VIC to SA power transfer. If flow is SA to VIC, including zero power transfer, no limitations are required.

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

≤ *10931*

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

≤ *1015*

31. Moorabool To Sydenham 500 kV line

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

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, NILS_decelerating. The limit equation is of the form:

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

Table 51 V::N MLTS-SYTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-50
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-20
Offset to system normal equation NILS_decel	-100

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.

31.2 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 52 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

31.3 Voltage Oscillation

To prevent voltage oscillations for trip of the remaining Moorabool – Sydenham 500 kV line which results in offloading multiple 500 kV lines between Sydenham and South Morang, the following limits are applied:

Macarthur wind farm ≤ 0 MW

Moorabool wind farm ≤ 150 MW with ≤ 50 turbines connected, otherwise 0 MW

31.4 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 53 Moorabool – Sydenham outage system strength minimum generator combinations

Combination	Bogong	Dartmouth	Jeeralang A	Loy Yang	Mortlake	Murray (unit 1-10)	Murray (unit 11-14)	Newport	Valley Power	Yallourn	Loy Yang + Yallourn
1											7
2		1		4	1	2				2	
3				4				1		2	
4							4				5
5			4								5
6					2						5
7	1	1									5
8					1			1			5
9									4		5

32. Moorabool to Haunted Gully or Haunted Gully to Tarrone 500 kV line

The following limit equations are enabled during an outage of the Moorabool to Haunted Gully or Haunted Gully to Tarrone 500 kV line.

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 NILV, NILQ, NILS and NILS decelerating. The limit equation is of the form:

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

Table 54 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]

32.2 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 + Dundonnel 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*

32.3 Fault Levels

Limitation due to insufficient fault level for converter operation at Macarthur wind farm.

Macarthur wind farm ≤ 0

33. Moorabool A2 Transformer 500/220 kV

The following limit equations are enabled during an outage of the Moorabool 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 NILV, NILQ, NILS and NILS_decelerating. The limit equation is of the form:

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

Table 55 V::N MLTS-A2_V/Q/S/S_decel offsets

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

34. Murraylink

34.1 Voltage Stability – Wemen to Kerang limit

To manage the Wemen to Kerang flow limit to prevent voltage collapse at Kerang 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. The limit equation is of the form:

Table 56 **V^V MRLK_KERANG offset**

Term	Offset
Offset to system normal NIL_KERANG	-45

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 57 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 58 V^N MRLK_ARWBBA offset

Term	Offset
Offset to system normal equation NIL_VI_ARWBBA	-100

35. 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.

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 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 59 V::N ROTS-SMTS _V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-230
Offset to system normal equation NILQ	-100
Offset to system normal equation NILS	-150
Offset to system normal equation NILS_decel	-200

36. South Morang Series Capacitor

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

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 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 60 V::N SMTS-CAP_V/Q/S/S_decel offsets

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

36.2 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.

37. 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.

37.1 Transient Stability – Vic to NSW

37.1.1 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 61 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

37.1.2 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 62 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

38. South Morang F2 Transformer 500 / 330 kV

The following limit equations are enabled during an outage of the South Morang F2 500 / 330 kV transformer.

38.1 Transient Stability – Vic to NSW

38.1.1 V::N SMTS-F2_V

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 (where Victoria accelerates ahead of the other states), apply the following limit equation:

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

Table 63 V::N SMTS-F2_V coefficients

Term	Coefficient
Intercept	929
Basslink	0.4031
Vic. to SA (Heywood)	-0.1602
Vic. to SA (Heywood)^2	-8.24e-4
Vic. to SA (Murraylink)	-1.09
LV 500 Inertia	7.414
EPS Inertia	18.68
MOPS Inertia	10.58
LV 220 Inertia	8.461
SNOWY Inertia	1.347
VIC Metro Gen Inertia	3.332
Murray Gen	0.766
Kiewa Gen	0.9235
LV 220 Gen	0.1746
VIC Metro Gen	0.4473
State Grid Load North	-0.938
APD Load	-0.7043
Vic Wind & Solar	0.32
VIC Demand - State Grid Load North - APD Load	-0.3325
220 kV_Caps	-0.1765
Num. ROTS SVC	25.8
Num. SESS SVC	21.73
Confidence Level (95%) offset	-92

38.1.2 V::N SMTS-F2_Q

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 (where Queensland accelerates ahead of the other states), apply the following limit equation is of the form:

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

Table 64 V::N SMTS-F2_Q coefficients

Term	Coefficient
Intercept	1632
Basslink	0.5317
Vic. to SA (Heywood)	-1.192
Vic. to SA (Murraylink)	-0.8195
LV 500 Inertia	8.32
MOPS Inertia	9.365
Murray Gen	0.9399
Kiewa Gen	0.9622
LV 220 Gen	0.425
State Grid Load	-0.663
Vic Wind & Solar	0.4482
VIC Demand – State Grid Load	-0.5102
Confidence Level (95%) offset	-80

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

38.1.3 V::N SMTS-F2_S

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 (where Queensland accelerates ahead of the other states), apply the following limit equation is of the form:

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

Table 65 V::N SMTS-F2_S coefficients

Term	Coefficient
Intercept	833.3
Basslink	0.4764
Vic. to SA (Heywood)	-0.4127
Vic. to SA (Heywood)^2	-5.93e-4
Vic. to SA (Murraylink)	-1.017
LV 500 Inertia	7.366
EPS Inertia	22.56
MOPS Inertia	9.875
LV 220 Inertia	9.283
VIC METRO Gen Inertia	10.06
Murray Gen	0.8986
Kiewa Gen	1.04
LV 220 Gen	0.2476
State Grid Load North	-0.9763
APD Load	-0.2712
Vic Wind & Solar	0.4478
VIC Demand - State Grid Load North - APD Load	-0.3879
220 kV_Caps	-0.1567
Num. ROTS SVC	26.67
Num. SESS SVC	21.68
Confidence Level (95%) offset	-82

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

38.1.4 V::N SMTS-F2_S_decel

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 (where South Australia decelerates away from the other states), apply the following limit equation:

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

Table 66 V::N SMTS-F2_S_decel coefficients

Term	Coefficient
Intercept	709.7
Basslink	0.4699
Vic. to SA (Heywood)^2	-0.00161
Vic. to SA (Murraylink)	-1.128
LV 500 Inertia	9.785
MOPS Inertia	13.05
KIEWA Inertia	19.58
VIC Metro Gen Inertia	11.25
Murray Gen	0.833
LV 220 Gen	0.5818
State Grid Load North	-0.5924
APD Load	-0.4469
Vic Wind & Solar	0.4344
VIC Demand - State Grid Load North - APD Load	-0.4643
Confidence Level (95%) offset	-123

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

38.2 Voltage Stability – NSW to Vic

38.2.1 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 67 V^N SMTS_F2_BLVG offsets

Term	Offset
Offset to system normal equation NIL_VI_BLVG	-120

38.2.2 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.

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 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 68 V::N SMTS-SYTS_V/Q/S/S_decel offsets

Term	Offset
Offset to system normal equation NILV	-50
Offset to system normal equation NILQ	0
Offset to system normal equation NILS	-20
Offset to system normal equation NILS_decel	-100

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 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 69 V::N SMTS-TTS_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	-30
Offset to system normal equation NILS_decel	-30

A1. Measures and Definitions

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.

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

Abbreviation	Definition
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: 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

Abbreviation	Definition
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).
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).

Abbreviation	Definition
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).
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).

Abbreviation	Definition
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, Burrinjuck Hydro, Blowering Hydro, Gadara, and Jounama Hydro Embedded generation
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 Gelibrand WF, Mount Mercer WF, Murra Warra WF, Numerkah SF, Oaklands Hill WF, Portland WF, Salt Creek WF, Waubra WF, Wemen SF, Yaloak South WF,Yambuk WF, Yatpool SF and Yendon SF

Abbreviation	Definition
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].
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.

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