Basslink outage and under frequency load shedding in Tasmania on 12 March 2017

REVIEWABLE OPERATING INCIDENT REPORT UNDER THE NATIONAL ELECTRICITY RULES

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	2142 hrs on 12 March 2017
Region of incident	Victoria
Affected regions	Tasmania
Event type	Under frequency load shedding
Generation Impact	There was no loss of generation as a result of this incident.
Customer Load Impact	383 MW of customer load was lost as a result of this incident.
Associated reports	Nil

IMPORTANT NOTICE

Purpose

AEMO has prepared this report in accordance with clause 4.8.15(c) of the National Electricity Rules, using information available as at the date of publication, unless otherwise specified.

Disclaimer

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1. OVERVIEW

This report relates to a reviewable operating incident[1] that occurred on Sunday 12 March 2017 where the Basslink interconnector between Victoria and Tasmania tripped resulting in load shedding in Tasmania.

There was a loss of 383 MW of industrial customer load as a result of this incident. There was no loss of generation.

As a reviewable operating incident[2], AEMO is required to assess power system security over the course of this incident, and assess the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security.[3]

AEMO has concluded that:

- A run-back[4] and subsequent trip of Basslink resulted in a low frequency event in Tasmania.
- The under frequency load shed (UFLS) scheme in Tasmania operated correctly and as expected.
- Delivery of enabled frequency control ancillary services was appropriate.
- The power system was in a secure operating state prior to this event.

This report is prepared in accordance with clause 4.8.15 of the National Electricity Rules (NER). It is based on information provided by Basslink Pty Ltd and TasNetworks and from AEMO's energy and market management systems.

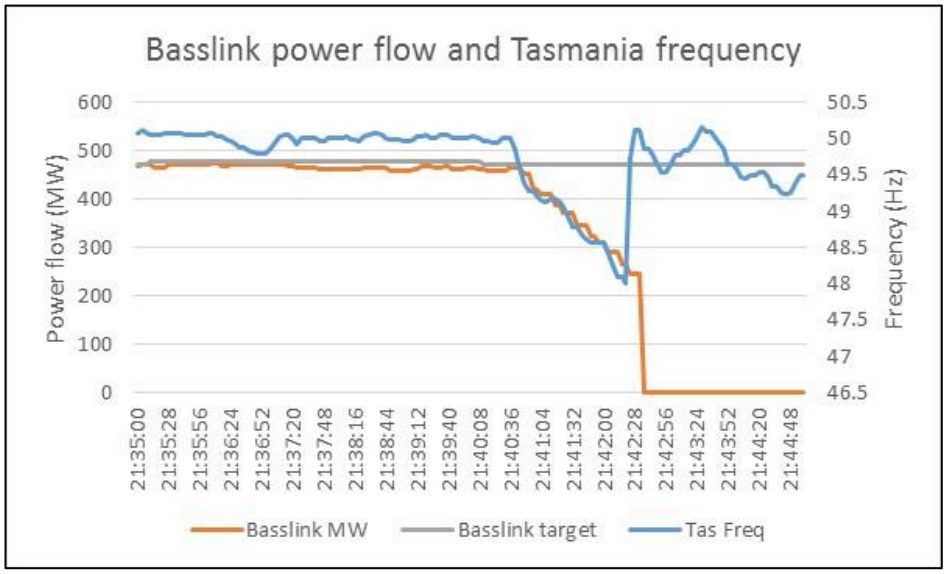
Australian Eastern Standard Time (AEST) is used in this report. Local time in Tasmania and Victoria in March is AEST plus one hour.

2. THE INCIDENT

At 21:40:30 hrs the power flow into Tasmania on Basslink began to decrease from ~460 MW[5] to ~200 MW before Basslink tripped at 21:42:30 hrs. The initial decrease in Basslink flow resulted in a decrease in frequency in Tasmania as shown in Figure 1, resulting in operation of the under frequency load shed (UFLS) scheme to trip 144 MW of industrial load. When Basslink tripped, the frequency control special protection scheme (FCSPS) operated to shed a further 241 MW of industrial load.

[1] See NER clause 4.8.15
[2] The unplanned outage of Basslink is a credible contingency and would not normally be a reviewable operating incident. In this case the under frequency load shed scheme in Tasmania also operated. Any operation of the UFLS requires AEMO to treat the event as a reviewable incident.
[3] See NER clause 4.8.15(b).
[4] Decrease in flow
[5] Measured at the Tasmania end of Basslink

Figure 1: Basslink power flow



AEMO gave permission to TasNetworks to restore load at 70 MW per dispatch interval from 2155 hrs. All load was restored by 2230 hrs on 12 March 2017. Basslink was returned to service at 2235 hrs on 12 March 2017.

3. BASSLINK OPERATION

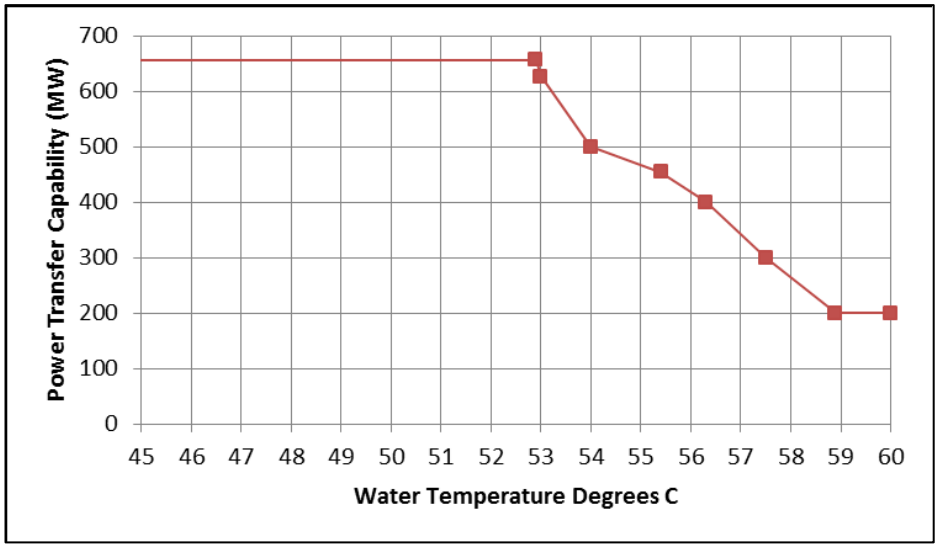
The following is based on information provided by Basslink Pty Ltd.

The Basslink interconnector is a high voltage direct current (HVDC) interconnector between Loy Yang in Victoria and George Town in Tasmania using thyristor–based converters with water cooling.

The thyristor cooling system is a closed loop system using a series of heat exchangers and variable speed cooling fans to control the cooling water inlet temperature to below 45°C.

When the Loy Yang converter cooling water inlet temperature exceeds 53°C, the maximum power transfer through the converter station is automatically reduced as shown in Figure 2. This is to prevent damage to the thyristors. If the cooling water inlet temperature exceeds 60°C, Basslink is tripped automatically.

Figure 2: Loy Yang maximum power transfer by valve cooling inlet temperature.



The thyristor cooling system is supplied via a 22kV/415V auxiliary supply transformer connected to the local distribution network. In the event of a supply over-voltage or under-voltage, the variable speed cooling fans on the heat exchangers are automatically shut-down. The cooling system control system will automatically attempt to restart the variable speed drives three times before a manual restart is required.

Basslink Pty Ltd has advised AEMO that a series of steep wavefront transient over-voltages over a short period on the auxiliary supply shut down the variable speed cooling fans on the heat exchangers. Although the cooling fans were restarted a number of times, the control system locked out after the third attempt, resulting in the loss of all cooling fans at 2134 hrs. After a lockout, a manual reset of the variable speed drives is required before the cooling fans can be restarted.

After the loss of the cooling fans, the cooling water inlet temperature rose above 53^{o}C at 2138 hrs, initiating a ramp–down in Basslink power flow. The cooling water inlet temperature reached 60^{o}C at 2142 hrs, resulting in the trip of Basslink from ~200 MW.

Basslink staff attended the site and reset the cooling fans' variable speed drives. Basslink was returned to service at 2235 hrs on 12 March 2017.

3.1 Previous events

Basslink Pty Ltd has reported that similar run-backs and trip of Basslink have occurred at least five times since July 2006. AEMO has reviewed each of these and determined that they did not have such a large impact on the frequency in Tasmania as the latest run-back, and therefore did not require the UFLS scheme to operate. This is because either the run-back amounts were smaller, there was lower power flow across Basslink before the run-back began, and/or there was greater demand in Tasmania.

In response, Basslink Pty Ltd has installed surge diverters on the auxiliary supply to alleviate issues associated with voltage transients.

4. FREQUENCY

The minimum frequency reached was 47.96 Hz at 21:42:23 hrs just before Basslink tripped, and was outside the normal operating frequency band of 49.85 – 51.15 Hz for 105 seconds. As this event is classified as a separation event, the frequency is allowed to fall to 47.0 Hz[6] and must return to the normal operating frequency band within 10 minutes. The frequency standard for this event was met as the result of a combination of load shedding and Frequency Control Ancillary Services (FCAS) delivery.

4.1 Load shedding

To ensure frequency in Tasmania remains within the frequency operating standards following an unplanned outage of Basslink, the FCSPS will operate to trip industrial load or generation, depending on the direction of power flow on Basslink at the time of the outage. This load or generation is tripped under a contractual agreement outside of the market and tripping is initiated by a loss of link signal from Basslink rather than an actual change in frequency.

To correct any reduction in frequency caused by loss of generation or other events generally unrelated to Basslink, the UFLS scheme will operate to trip load. The UFLS scheme operates in response to a reduction in frequency.

Unusually during this incident, both the UFLS and the FCSPS operated. The UFLS operated in response to the reduction in frequency caused by the initial reduction in power transfer across Basslink. Approximately 144 MW of load was tripped by the UFLS scheme at 21:42:12 hrs.

When Basslink tripped from ~200 MW at 21:42:23 hrs the FCSPS operated to trip an additional 239 MW of load.

[6] Refer to the Tasmanian frequency operating standard

If Basslink had tripped from its initial flow of 450 MW instead of running back and then tripping, the FCSPS would have operated to trip the same loads as tripped by the UFLS and FCSPS. That is, the outcome would have been the same, with the only difference being the way in which the load was tripped.

Both the UFLS and FCSPS operated correctly and as expected.

4.2 FCAS delivery

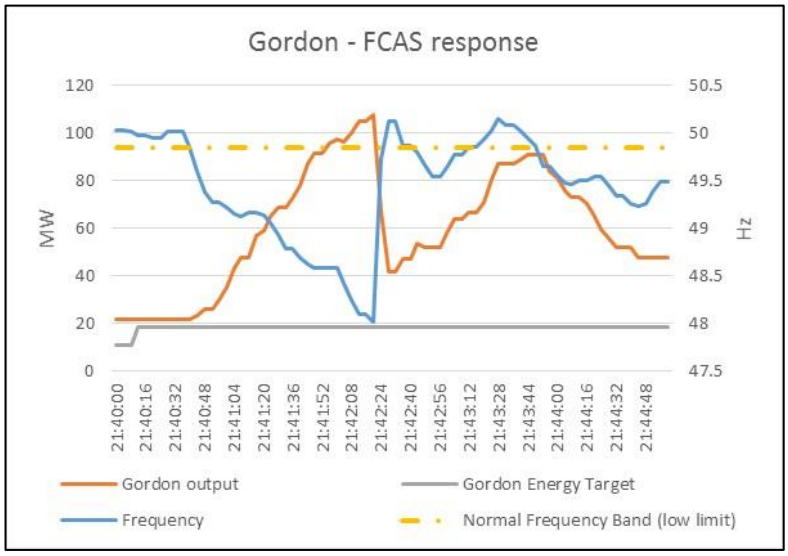
Table 1 shows the generating units in Tasmania enabled to provide contingency raise FCAS for the dispatch interval ending 2145 hrs.

Table 1: FCAS enablement

	Fast Raise (MW)	Slow Raise (MW)	Delayed Raise (MW)
Gordon	48	63.97	1.96
Trevallyn	1.43	0	0
Meadowbank	1.74	0	0

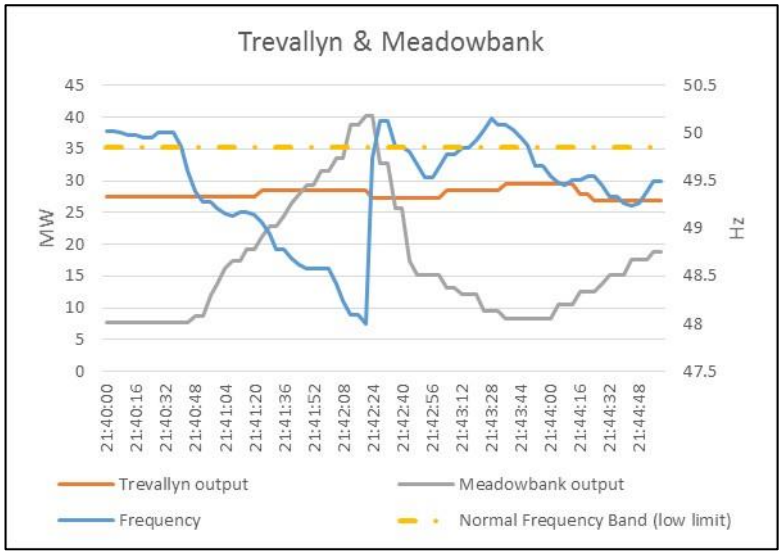
Based on data supplied by Hydro Tasmania, AEMO has analysed FCAS delivery. This analysis has shown that the Gordon units delivered 5 MW of fast raise FCAS, 82 MW of slow raise FCAS and no delayed raise FCAS. The low delivery of fast raise FCAS is due to the very slow rate of change of frequency. Over the course of the low frequency event, Gordon output increased by approximately 86 MW before the UFLS operated, as shown in Figure 3.

Figure 3: Gordon response



Due to the small enablement of fast raise FCAS on the Trevallyn and Meadowbank generating units, AEMO has not conducted a detailed analysis of actual delivery. However as shown in Figure 4, both generating units increased output by a total of about 33 MW in response to the low frequency.

Figure 4: Trevallyn & Meadowbank response



AEMO considers the FCAS delivery from enabled generating units as appropriate.

5. POWER SYSTEM SECURITY

AEMO is responsible for power system security in the National Electricity Market (NEM). This means AEMO is required to operate the power system in a secure operating state to the extent practicable, and take all reasonable actions to return the power system to a secure state following a contingency event in accordance with the NER.[7]

This section assesses how AEMO managed power system security over the course of this incident.

[7] Refer to AEMO's functions in section 49 of the National Electricity Law and the power system security principles in clause 4.2.6 of the NER

AEMO invoked constraint set I-BL_ZERO[8] at 2150 hrs after Basslink tripped. This is the normal action after Basslink trips. The power system was in a secure operating state immediately after this incident and no further action was required by AEMO.

With Basslink out of service, all frequency control ancillary services (FCAS) for Tasmania must be provided locally in Tasmania. For dispatch interval (DI) 2155 constraint equation F_T+NIL_MG_R6 violated for a single dispatch interval (violation 16 MW) indicating a shortage of raise six second FCAS in Tasmania for that DI. The violation was resolved in the next DI without intervention by AEMO.

6. MARKET INFORMATION

AEMO is required by the NER and operating procedures to inform the market about incidents as they progress. This section assesses how AEMO informed the market[9] over the course of this incident.

For this incident, AEMO was required to inform the market on the following matters:

- Constraints invoked with interconnector terms on the LHS.[10]

  AEMO issued Market Notice 57962 at 2210 hrs – 28 minutes after the trip of Basslink to advise the market that constraint set I-BL_ZERO had been invoked.

Over the course of this incident, AEMO issued appropriate, timely and sufficiently detailed market information.

7. CONCLUSIONS

AEMO has assessed this incident in accordance with clause 4.8.15 of the NER. In particular, AEMO has assessed the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.

AEMO has concluded that:

- A run-back and subsequent trip of Basslink resulted in a low frequency event in Tasmania.
- The under frequency load shed (UFLS) scheme in Tasmania operated correctly and as expected.
- Delivery of enabled frequency control ancillary services was appropriate.
- The power system was in a secure operating state prior to this event.

[8] Out = Basslink
[9] AEMO generally informs the market about operating incidents as the progress by issuing Market Notices – see AEMO website
[10] For short term outage AEMO is required to notify the Market of variances to interconnector transfer limits AEMO, *Power System Security Guidelines,* Section 22