The Authority's draft determinations of causers

Draft determinations of the causers of the 2 March 2017 under-frequency events

Consultation paper

Submissions close: 5pm 21 November 2017

10 October 2017

Market Performance

Executive summary

Two under-frequency events occurred on 2 March 2017

The Electricity Industry Participation Code 2010 (Code) requires the Electricity Authority (Authority) to determine the causer of an under-frequency event (UFE), and prescribes the process for making its determination (clause 8.61 of the Code).

The purpose of this paper is to:

(a) set out the Authority's draft determinations of the causers of the two 2 March 2017 UFEs

(b) consult with interested parties on the Authority's draft determinations.

These draft determinations are being consulted on in this single consultation paper due to the close timing of the UFEs.

The Authority's draft determinations

The Authority's draft determination under clause 8.61 is that Transpower New Zealand Limited (Transpower), as the grid owner, was the causer of the first UFE on 2 March 2017.

The Authority's reasons for this draft determination are:

(a) the first UFE was triggered during a planned outage of the Livingston-Naseby circuit, when the two Clyde-Twizel 220 kV transmission circuits disconnected from the grid in quick succession causing a reduction of energy into the North Island at the HVDC injection point

(b) as the grid owner that owns the Clyde-Twizel circuits, Transpower meets the definition of "causer" in Part 1 of the Code.

The Authority's draft determination under clause 8.61 is that Meridian Energy Limited (Meridian) was the causer of the second UFE on 2 March 2017.

The Authority's reasons for this draft determination are:

(a) the interruption or reduction of electricity on 2 March 2017 occurred at the Aviemore power station (Aviemore), which belongs to Meridian

(b) no other asset was identified as having caused or potentially caused this UFE

(c) in a reply to a system operator letter, Meridian has accepted that it was the causer of this UFE.

Submissions are invited from interested parties

The Authority must consult with interested parties before making its final determinations. Interested parties are invited to make a submission on the Authority's draft determinations by 5 pm on Tuesday 21 November 2017.

The Authority will consider submissions received and make a final determination on each UFE.

The Authority also invites comment on the system operator's calculation of the megawatts (MW) lost during the UFE, which the system operator uses for calculating the event charge for the UFE.

Contents

1 What you need to know to make a submission

What this consultation paper is about

1.1 The purpose of this paper is to consult with interested parties on the Authority's draft determinations that:

(a) Transpower was the causer of the first UFE on 2 March 2017 at 11.21 am, when the frequency dropped to 49.17 Hz in the North Island

(b) Meridian was the causer of the second UFE on 2 March 2017 at 11.24 am, when the frequency dropped below 49.25 Hz in the upper South Island (reaching 48.52 Hz by 11.26 am).

How to make a submission

1.2 The Authority's preference is to receive submissions in electronic format (Microsoft Word) in the format shown in Appendix A. Submissions in electronic form should be emailed to submissions@ea.govt.nz with "Consultation Paper—Draft determinations of the causers of the 2 March 2017 under-frequency events" in the subject line.

1.3 If you cannot send your submission electronically, post one hard copy to either of the addresses below, or fax it to 04 460 8879.

Postal address	Physical address
Submissions Electricity Authority PO Box 10041 Wellington 6143	Submissions Electricity Authority Level 7, ASB Bank Tower 2 Hunter Street Wellington

1.4 Please note the Authority wants to publish all submissions it receives. If you consider that we should not publish any part of your submission, please:

(a) indicate which part should not be published

(b) explain why you consider we should not publish that part

(c) provide a version of your submission that we can publish (if we agree not to publish your full submission).

1.5 If you indicate there is part of your submission that should not be published, we will discuss with you before deciding whether to not publish that part of your submission.

1.6 However, please note that all submissions we receive, including any parts that we do not publish, can be requested under the Official Information Act 1982. This means we would be required to release material that we did not publish unless good reason existed under the Official Information Act to withhold it. We would normally consult with you before releasing any material that you said should not be published.

When to make a submission

1.7 Please deliver your submissions by **5pm** on **21 November 2017**.

1.8 The Authority will acknowledge receipt of all submissions electronically. Please contact the Submissions' Administrator if you do not receive electronic acknowledgement of your submission within two business days.

2 The Authority's draft determinations

Transpower, as the grid owner, was the causer of the first UFE

2.1 The Authority's draft determination under clause 8.61 is that Transpower, as the grid owner that owns the Clyde-Twizel 220 kV transmission circuits, was the causer of the first UFE on 2 March 2017 at 11.21 am.

2.2 The Code definitions for "causer" and "under-frequency event" are set out in Appendix C.

2.3 The system operator has investigated this UFE and reported to the Authority that:

(a) a UFE occurred when North Island frequency fell to 49.173 following a 185.8 MW reduction of electricity injected from the HVDC into the North Island

(b) that reduction of electricity occurred to support the frequency of the upper South Island complying with clause 8.17 of the Code, therefore paragraph (c) of the Code definition of "causer" applies

(c) in the system operator's view the first UFE has no causer.

2.4 Having considered the system operator's report and the relevant elements of the Code, the Authority (based on the information available to it at this time) concurs with the system operator's:

(a) description of the circumstances

(b) conclusion that an UFE occurred at 11.21 am

(c) view that the HVDC response to the falling frequency was to comply with the Code, and therefore paragraph (c) of the definition of "causer" applies (though we disagree with the scope of the system operator's application).

2.5 The Authority does not concur with the system operator's findings that there is no causer of the first UFE. On review of the events on 2 March 2017, the Authority has determined that Transpower, as the owner of the two Clyde-Twizel 220 kV transmission circuits, meets the definition of "causer".

2.6 When reaching this determination, the Authority considered each paragraph of the definition of "causer". The Authority considers that:

(a) The requirements of paragraph (a) are met because the disconnection of the Clyde-Twizel circuits was "…an interruption or reduction of electricity from a single…grid owner's asset…" that caused[1] the UFE.

(b) The exception in paragraph (a)(i) relates to situations caused by a single generator, so does not apply in the situation of the first UFE at 11.21 am (as the relevant circumstances do not involve any generators).

(c) The exception in paragraph (a)(ii) relates to situations where *another* grid owner or generator causes the first grid owner's interruption or reduction of electricity, so does not apply in the situation of the first UFE at 11.21 am (as the relevant circumstances do not involve any generators or any *other* grid owner).

[1] There is case law that is generally relevant to interpreting whether something caused another thing. Causation is a question of fact that can be best answered by ordinary common sense (rather than abstract theory) and in a way that is consistent with the objectives of the legislation (for example, see *Auckland Regional Council v URS New Zealand Limited* DC Auckland 16 April 2009, and the cases it refers to).

(d) The requirements of paragraph (b) are not met because, despite the disconnection of the Clyde-Twizel circuits being the "interruption or reduction of electricity" that was "first in time", the application of paragraph (c) (as discussed in paragraph 2.4(c) above) means the HVDC interruption or reduction of electricity must be disregarded. In which case there is not "more than 1 interruption or reduction of electricity" that caused the UFE.

(e) The exception in paragraph (c):

(i) Doesn't apply to the "interruption or reduction of electricity" on the Clyde-Twizel circuits because the trip of the Clyde-Twizel circuits did not occur in order to comply with the Code.

(ii) Does apply to the "interruption or reduction of electricity" on the HVDC (HVDC response) because it was required by clause 8.17 to assist in the prevention of cascade failure. Therefore, the Authority concludes that for the purposes of paragraphs (a) and (b) of the definition of "causer", it must disregard the HVDC response.

2.7 The Authority has also considered the system operator's interpretations of the Code included in its report. The Authority disagrees with the system operator's interpretations that:

(a) disregarding the interruption or reduction of electricity on the HVDC as required by paragraph (c) of the definition of causer means that no causer can ever be found[2]

(b) the "interruption or reduction of electricity" referred to in the definition of "causer" must be read as an 'interruption or reduction of electricity injected into the grid at a grid injection point or from the HVDC link at an HVDC injection point' (imported from a portion of the definition of "under-frequency event").[3]

Meridian was the causer of the second UFE

2.8 The Authority's draft determination under clause 8.61 is that Meridian, as a generator, was the causer of the second UFE on 2 March 2017 at 11.24 am.

2.9 The system operator has investigated this UFE (in accordance with clause 8.60), and has reported to the Authority that:

(a) the interruption/reduction of electricity on 2 March 2017 at 11.24 am occurred at Aviemore, which belongs to Meridian

(b) no other asset was identified as having caused or potentially caused the second UFE

(c) in the system operator's view, Meridian was the causer of this UFE.

(d) Meridian has accepted that it was the causer of this UFE.

2.10 Having considered the system operator's report and the relevant elements of the Code, the Authority (based on the information available to it at this time) concurs with the system operator's findings on the second UFE.

[2] Paragraph 22 of Appendix B

[3] Paragraph 21 of Appendix B

3 How the Authority reached this draft determination

The system operator investigated the causer of the first and second UFEs

3.1 Clause 8.60 requires the system operator to investigate the causer of a UFE and provide a report to the Authority.

3.2 The system operator has fulfilled its obligations under clause 8.60. The system operator's report to the Authority (dated June 2017) is attached as Appendix B of this draft determination. The report finds two UFEs occurred on 2 March 2017, which are summarised as follows:

(a) During a planned outage of one transmission circuit in the lower South Island, the remaining two circuits disconnected separating the South Island into two electrical islands. The frequency increased to 53.6 Hz in the lower South Island, and fell to 47.4 Hz in the upper South Island.

(b) Automatic under-frequency load shedding (AUFLS), generator governor response, and HVDC response responded to the fall in frequency in the upper South Island. Instantaneous reserves responded in both the North and South Islands.

(c) The HVDC responded to the reduced frequency in the upper South Island by reducing transfer into the grid from the HVDC North Island injection point, and at 11.21 am the North Island frequency fell to 49.17 Hz.

(d) The frequency fall and the quantum of MW lost (greater than the 60 MW de minimis set out in the definition for "under-frequency event) meant that a UFE, as defined in Part 1 of the Code, had occurred— this is the first UFE on 2 March 2017.

(e) The system operator considers:

(i) Transpower, as the grid owner, does not fit the Code definition of "causer" in relation to the disconnection of the Clyde-Twizel circuits

(ii) the HVDC owner is not the causer due to the effect of paragraph (c) in the Code definition of "causer".

(f) No other event was identified as contributing to or causing the first UFE. The system operator concluded there was no causer for the first UFE.

(g) As mentioned in paragraph 3.2(b) above, instantaneous reserve generation activated in the upper South Island and interruptible load and AUFLS tripped. One of the several generators that remained connected was Aviemore.

(h) Aviemore initially performed as expected and responded to the falling frequency by increasing its output. An incorrectly set parameter within the Aviemore control system reacted when the frequency reached 47.5 Hz. This caused the control mode of the governors to change from power control mode to speed control mode causing Aviemore generation to ramp down.

(i) At 11.26 am, five minutes after the first UFE, the reduction of generation at Aviemore caused the frequency in the upper South Island to fall to 48.52 Hz.

(j) The frequency fall and the quantum of MW lost (greater than the 60 MW de minimis) meant that a UFE, as defined in Part 1 of the Code, had occurred—this is the second UFE on 2 March 2017.

(k) Frequency was restored to the normal band quickly.

(l) No other event was identified as contributing to or causing the second UFE. The system operator concluded that Meridian was the causer for the second UFE.

3.3 The system operator report includes copies of the following correspondence with Transpower, as the grid owner:

(a) On 6 April 2017, the system operator wrote to Transpower, as the grid owner, setting out its view that the first UFE was initiated at the HVDC link resulting in a loss of injection. The system operator requested any information Transpower, as the grid owner, could provide on the UFE.

(b) On 16 May 2017, in a reply to the system operator, Transpower, as the grid owner, disputed that it was the causer of this UFE. The grid owner asserted the HVDC link acted in accordance with clause 8.17 to ensure the maximum possible injection contribution to maintain frequency within the normal band. Therefore paragraph (c) of the definition of "causer" applies, and the interruption or reduction of electricity must be disregarded in determining the causer.

3.4 The system operator report includes copies of the following correspondence with Meridian:

(a) On 6 April 2017, the system operator wrote to Meridian setting out its view that the second UFE was initiated at Aviemore resulting in a loss of injection, and requesting any information Meridian could provide.

(b) In a reply to the system operator, Meridian agreed it was the causer of the second UFE. Meridian did not provide any further information.

The Authority has considered the system operator's report

3.5 Clause 8.61(2) requires the Authority to publish a draft determination that states whether a UFE was caused by a generator or grid owner, and, if so, the identity of the causer. Clause 8.61(3) requires the Authority to give reasons for its findings in the draft determination.

3.6 The Authority has considered the system operator's report and liaised directly with system operator staff in relation to the system operator's investigation and report.

3.7 Based on the information available to it, the Authority does not concur with the system operator's findings that there was no causer of the first UFE of 2 March 2017 at 11.21 am. The Authority's draft determination and reasons are set out above in paragraphs 2.1–2.7.

3.8 Based on the information available to it, the Authority concurs with the system operator's findings that Meridian was the causer of the second UFE of 2 March 2017 at 11.24 am. The Authority's draft determination and reasons are set out above in paragraphs 2.8–2.10.

Q1. Do you agree with the Authority's draft determination that Transpower, as the grid owner that owns the Clyde-Twizel 200 kV transmission circuits, was the causer of the first UFE on 2 March 2017? If not, please state your alternative view on the causer and give your reasons.

Q2. Do you agree with the Authority's draft determination that Meridian, as a generator, was the causer of the second UFE on 2 March 2017? If not, please state your alternative view on the causer and give your reasons.

4 The Authority will consider submissions and make a final determination

4.1 Clause 8.61(4) of the Code requires the Authority to consult every generator, grid owner, and other participant substantially affected by an UFE in relation to the draft determination.

4.2 The Authority has allowed a consultation period of six weeks for these draft determinations.[4] Accordingly, the deadline for submissions is 5 pm on 21 November 2017.

4.3 The Authority will consider submissions received, and publish its final determination.

4.4 Clauses 8.62 and 8.63 of the Code set out provisions relating to any disputes regarding Authority determinations.

5 The system operator has calculated the MW lost during the UFE based on its investigations

5.1 Clause 8.64 of the Code prescribes how the system operator must calculate the event charge payable by the causer of an UFE. This in turn enables calculation of the rebates paid for UFEs (clause 8.65 of the Code).

5.2 Determining the 'MW lost' as a result of the UFE is central to the event charge calculation.

5.3 The system operator determines the MW lost as part of its investigations into an UFE.

5.4 The system operator has followed its published procedure *PR-RR-017 Calculating the Amount of MW lost* to determine the MW value provided to the clearing manager for the purposes of calculating the UFE charge. This procedure includes a factor of 95 % applied to the MW lost value to account for any margin of error.

5.5 Based on the information provided by the system operator, the Authority considers the following table sets out the system operator's intended calculations.

[4] For further information about the Authority's approach to setting consultation periods for draft determinations, see the consultation paper - *Draft determination of who caused the 8 September 2016 under-frequency event* dated 14 February 2017 at http://www.ea.govt.nz/development/work-programme/risk-management/determinations-of-who-caused-under-frequency-events/consultations/#c16347.

Table 1: Expected event charges and calculations

UFE	MW lost (A)	A x .95 = B	B – 60 MW = C	C x $1250 = D
First	185.8 MW[5]	176.51 MW	116.51 MW	$145,637.50
Second	60.4 MW	57.38 MW	-2.62 MW	$0

5.6 The system operator's calculation of the MW lost during the UFE for the purposes of calculating the UFE charge is included in its report. Note this calculation does not form part of the Authority's draft determinations (refer clause 8.61). However, the Authority acknowledges that the calculation is central to determining the UFE charge payable by the causer, and therefore also to the rebates paid for UFEs.

5.7 Accordingly, the Authority invites comment on the system operator's calculation of the MW lost, as set out in the system operator's report to the Authority.

Q3. Do you agree with the system operator's calculation that, for the purposes of calculating the UFE charge, 185.8 MW was lost at the North Island HVDC injection point as a result of the first UFE on 2 March 2017? If not, please state your alternative view on the MW lost and give your reasons.

Q4. Do you agree with the system operator's calculation that, for the purposes of calculating the UFE charge, 60.4 MW was lost at the Aviemore grid injection point as a result of the second UFE on 2 March 2017? If not, please state your alternative view on the MW lost and give your reasons.

[5] Paragraph 42 of the system operator's report concludes that 185.5 MW was lost. However, subsequent correspondence with the system operator on 25 August 2017 has confirmed that 185.8 MW is the actual number of MW lost. This aligns with the amount set out in the system operator's letter to the grid owner dated 6 April 2017.

Appendix A Format for submissions

Submitter	

Question		Comment
Q1.	Do you agree with the Authority's draft determination that Transpower, as the grid owner that owns the Clyde-Twizel 200 kV transmission circuits, was the causer of the first UFE on 2 March 2017? If not, please state your alternative view on the causer and give your reasons.	
Q2.	Do you agree with the Authority's draft determination that Meridian, as a generator, was the causer of the second UFE on 2 March 2017? If not, please state your alternative view on the causer and give your reasons.	
Q3.	Do you agree with the system operator's calculation that, for the purposes of calculating the UFE charge, 185.8 MW was lost at the North Island HVDC injection point as a result of the first UFE on 2 March 2017? If not, please state your alternative view on the MW lost and give your reasons.	

Q4.	Do you agree with the system operator's calculation that, for the purposes of calculating the UFE charge, 60.4 MW was lost at the Aviemore grid injection point as a result of the second UFE on 2 March 2017? If not, please state your alternative view on the MW lost and give your reasons.	

Appendix B Under Frequency Event Causation Report

Under-Frequency Events Causation Report – 2 March 2017

System Operator events 3402 & 3403

June 2017

Keeping the energy flowing




TRANSPOWER

Transpower New Zealand Limited The National Grid

Version	Date	Change
1.0	19 June 2017	Initial draft
2.0	31 July 2017	Contextual edits following comment from EA
3.0	22 August 2017	Clarification of report

	Position	Date
Prepared By:	Scott Avery, Risk and Compliance Manager, System Operations	22 August 2017
Reviewed By:	Matthew Copland, Power Systems Group Manager	22 August 2017

IMPORTANT

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PURPOSE

1. On Thursday 2 March 2017 two events occurred on the power system that reduced the system frequency.
2. As per clause 8.60 of the Electricity Industry Participation Code (Code), Transpower as system operator investigated these events to assist the Electricity Authority in determining causers for under-frequency events.
3. The results of this investigation report are prepared under clause 8.60(5) of the Code, provided to the Authority, and relating to each identified under-frequency event includes:

- Whether in Transpower's view each under-frequency event was caused by the grid owner or a generator and identifies that potential causer;
- The reasons for forming this view; and
- The information considered in reaching this view.

EXECUTIVE SUMMARY

4. On 2 March 2017 two events occurred that impacted the system frequency.
5. Firstly, at 11:21 the South Island experienced an unplanned grid reconfiguration and formed two electrical islands. This resulted in the frequency in the upper South Island falling to 47.4Hz. At this point the lowering of the frequency in the upper South Island was not accompanied by any interruption or reduction of electricity at grid injection points.
6. The automatic HVDC controls detected the reduction in frequency in the upper South Island and provided frequency response as well as transferred procured reserves from the North Island. The HVDC response, transfer of reserves from the North Island, and the operation of the AUFLS scheme in the upper South Island arrested the fall in the frequency.
7. The frequency response of the HVDC link and the effect of the reserves being transferred reduced the frequency of the North Island to 49.17Hz. This reduction of the frequency was accompanied by an interruption or reduction of electricity into the North Island at the Haywards HVDC injection point and constituted an under-frequency event. This event is referred to in this report as the first under-frequency event.
8. Secondly, at 11:26 a reduction of generation from the Aviemore generator through the Aviemore grid injection point into the upper South Island grid reduced the frequency to 48.52Hz.
9. Corrective action by Aviemore generator and the governor response from other connected generators returned the frequency to the normal band. This event is referred to as the second under-frequency event.
10. In relation to the first under-frequency event the system operator recommends that no causer be identified due to the actions of the HVDC link being undertaken in order to comply with the Code, and once disregarded, no other under-frequency event exists under the Code for which to identify a causer.
11. In relation to the second under-frequency event the system operator recommends Meridian Energy as the causer.

SEQUENCE OF EVENTS

1. On Thursday 2 March 2017 at 11:21 hours, during a planned outage of a transmission circuit in the lower South Island, two other transmission circuits disconnected. This disconnection split the South Island into two separate electrical islands – effectively an unplanned grid reconfiguration.
2. From investigation into the circumstances of 2 March 2017, Transpower as system operator has identified two separate under-frequency events.

FIRST UNDER FREQUENCY EVENT CIRCUMSTANCES

3. Normally three circuits connect the upper and lower South Island, one between Livingston and Naseby and two between Clyde and Twizel.
4. During a planned outage of the Livingston-Naseby circuit, the upper and lower South Island remained connected by the two Clyde-Twizel 220 kV transmission circuits. At 11:21 both transmission circuits were disconnected from the grid in quick succession. Consequently, the frequency in the lower electrical island increased to 53.6 Hz and the frequency in the upper electrical island dropped 47.4 Hz. At this time the HVDC link was transferring 820 MW in a northerly direction.
5. Over-frequency reserve action and generating plant governor response reduced the frequency in the lower South Island to the normal band.
6. In the upper South Island, automatic under-frequency load shedding (AUFLS), generator governor response, HVDC response, and instantaneous reserves (spinning reserve and interruptible load) from both the North and upper South Islands acted to restore the frequency to the normal band.
7. The HVDC response was to run-back transfer north, effectively delivering the reserve response from the North Island. The run-back reduced the electricity transfer into the North Island grid at the Haywards HVDC injection point, and the North Island frequency fell to 49.17. This is identified as the first event.
8. Excursion Notices were sent immediately following the event

   North Island

Date	Time	Minimum Hz	Island
02-Mar-2017	11:21:36	49.173	North

Date	Time	Maximum Hz	Island
02-Mar-2017	11:21:49	50.512	North

   South Island

Date	Time	Minimum Hz	Island
02-Mar-2017	11:21:36	47.397	South

Date	Time	Maximum Hz	Island
02-Mar-2017	11:21:49	50.411	South

SECOND UNDER FREQUENCY EVENT CIRCUMSTANCES

9. The disconnection of the Clyde-Twizel circuits created two electrical islands in the South Island. The combined system responses to the disconnection of the circuits restored the frequency in each electrical island immediately after the initial event.

10. Instantaneous reserve generation in the upper South Island had activated and interruptible load and AUFLS tripped. All generation in the South Island remained connected through this initial reduction in the frequency.

11. One of the connected generators in the upper South Island was Aviemore. In initially responding Aviemore increased its generation output from 203 MW (dispatched) to 222 MW. The generator performed as expected and assisted in arresting the falling frequency and returning frequency to the normal band.

12. However, unknown to the Aviemore generation controllers a parameter within the control system at Aviemore had been incorrectly set. This setting reacted once the frequency reached 47.5 Hz and changed the control mode of Aviemore's governors from power control mode to speed control mode. This caused Aviemore generation output to ramp down.

13. At 11:26, five minutes after the initial disconnection of the two Clyde-Twizel transmission circuits a reduction of generation at Aviemore station reduced the frequency in the upper South Island to 48.52 Hz. This was the second event.

14. Excursion Notices were sent immediately following the event

    South Island

Date	Time	Minimum Hz	Island
02-Mar-2017	11:26:37	48.515	South

Date	Time	Maximum Hz	Island
02-Mar-2017	11:28:20	50.097	South

FINDINGS

IDENTIFYING THE CAUSER OF AN UNDER-FREQUENCY EVENT

15. The definition of "causer" is as follows:

> **causer**, in relation to an **under-frequency event**, means—
>
> (a) if the **under-frequency event** is caused by an interruption or reduction of **electricity** from a single **generator's** or **grid owner's asset** or **assets**, the **generator** or **grid owner**; unless—
>
> (i) the **under-frequency event** is caused by an interruption or reduction of **electricity** from a single **generator's asset** or **assets** but another **generator's** or a **grid owner's** act or omission or property causes the interruption or reduction of **electricity**, in which case the other **generator** or the **grid owner** is the **causer**; or
>
> (ii) the **under-frequency event** is caused by an interruption or reduction of **electricity** from a single **grid owner's asset** or **assets** but a **generator's** or another **grid owner's** act or omission or property causes the interruption or reduction of **electricity**, in which case the **generator** or other **grid owner** is the **causer**; or
>
> (b) if the **under-frequency event** is caused by more than 1 interruption or reduction of **electricity**, the **generator** or **grid owner** who, in accordance with paragraph (a), would be the **causer** of the **under-frequency event** if it had been caused by the first in time of the interruption or reduction of **electricity**; but
>
> (c) if an interruption or reduction of **electricity** occurs in order to comply with this Code, the interruption or reduction of **electricity** must be disregarded for the purposes of determining the **causer** of the **under-frequency event**

16. This definition contemplates two types of causer, which we call the "primary causer" and the "initial causer".

17. A primary causer is a generator or grid owner from whose asset there was an interruption or reduction of electricity that caused an under-frequency event. This is the type of causer referred to in the preamble to paragraph (a) and in paragraph (b).

18. An initial causer is a generator or grid owner whose act, omission or property caused an interruption or reduction of electricity that caused an under-frequency event. This is the type of causer referred to in paragraphs (a)(i) and (a)(ii).

19. The definition of causer is expressly linked to the definition of "under-frequency event", and functionally linked as well – there can be no causer without an under-frequency event. This makes the definition of under-frequency event relevant to the proper interpretation of the definition of causer.

20. An under-frequency event is an interruption or reduction of electricity of a certain type, namely of electricity injected *into the grid at a grid injection point* or *from the HVDC link at an HVDC injection point*.

21. We consider the definition of causer to be using the words "interruption or reduction of electricity" in the same sense as the definition of under-frequency event. That is, it refers to an interruption or reduction of electricity of the same type as the definition of under-frequency event. That conclusion is reinforced by the observation that the definition of causer need not have used the words "interruption or reduction of electricity" at all. For example, it could have said "if the under-frequency event is caused by ~~an interruption or reduction of electricity from~~ a single generator's or grid owner's asset or assets…". We consider the repeated use of the words in the definition of causer to be a clear and intentional link to the definition of under-frequency event.

22. Paragraph (c) of the definition of causer is also relevant to this report. Paragraph (c) requires a Code-compliant interruption or reduction of electricity to be "disregarded for the purposes of determining the causer of the under-frequency event". "Disregarded" means ignored completely, and not only for the purposes of determining whether the participant complying with the Code is the causer but for the purposes of determining *any* causer of the under-frequency event.

FIRST (NORTH ISLAND) EVENT

23. We consider there was no causer of the first under-frequency event.

Primary causer

24. Initial analysis identified the interruption or reduction of electricity on 2 March 2017 occurred at the North Island HVDC injection point. A Prior Notification of Causer letter was sent to the HVDC owner (Transpower) accordingly, identifying the HVDC owner as the causer of the event under paragraph (a) of the definition.
25. In its response of 16 May 2017 the HVDC owner rejected that it was the causer of the event. It cited compliance with clause 8.17 of the Code as the HVDC link transfer was modulating to maintain frequency in the South Island. That meant paragraph (c) of the definition of causer applied and the HVDC owner and the associated "interruption or reduction of electricity" must be disregarded.
26. We agreed that the HVDC owner was not the causer of the event under paragraph (a) or (b) of the definition due to the effect of paragraph (c).
27. We have considered whether Transpower as the AC grid owner was the causer of the event under paragraph (a) or (b) of the definition due to the disconnection of the Clyde-Twizel circuits.
28. For that to be the case the disconnection of the Clyde-Twizel circuits would need to be an "interruption or reduction of electricity" in the sense those words are used in the definition. We do not consider that it was because:

    (a) the disconnection was an unplanned outage and reconfiguration of the grid and not an interruption or reduction of electricity injected into the grid as a whole. Immediately after the disconnection the same amount of electrical energy was being injected into the grid, causing over-frequency in the lower South Island and under-frequency in the upper South Island; and

    (b) even if the disconnection was an interruption or reduction of electricity it did not occur at a grid injection point or HVDC injection point.
29. Accordingly, we consider there was no causer of the event under paragraph (a) or (b) of the definition.

Initial causer

30. We have considered whether Transpower as the AC grid owner was the causer of the event under paragraph (a)(ii) of the definition due to the disconnection of the Clyde-Twizel circuits.
31. If the AC grid owner was the initial causer then the HVDC owner would need to be the primary causer. However, paragraph (c) of the definition requires us to disregard the interruption or reduction of electricity from the HVDC link. That means, as far as the Code is concerned, there was no relevant interruption or reduction of electricity to be caused by anything or anybody, including the AC grid owner. Put another way, paragraph (a) does not get started in this case due to the effect of paragraph (c).

32. In addition, the HVDC owner and AC grid owner are not separate participants under the Electricity Industry Act. The only relevant participant here is Transpower. Therefore, there cannot have been "another grid owner" whose act, omission or property caused the relevant interruption or reduction of electricity, as required by paragraph (a)(ii) of the definition.

33. Accordingly, we consider there was no causer of the event under paragraph (a)(ii) of the definition.

SECOND (SOUTH ISLAND) EVENT

34. Initial analysis identified the interruption or reduction of energy on 2 March 2017 occurring at the Aviemore grid injection point. Meridian Energy is the asset owner of Aviemore station. A Prior Notification of Causer letter was sent to Meridian, identifying the HVDC owner as the causer of the event under paragraph (a) of the definition.

35. In its response of 20 April 2017 Meridian Energy accepted that it was the causer of the second under-frequency event.

36. No other asset was identified as having caused or potentially caused the under-frequency event.

37. Transpower as the system operator therefore recommends that Meridian Energy is the causer of the second (South Island) event on 2 March 2017.

CALCULATION OF MW LOST

38. The purpose of this calculation is to determine the MW value provided to the clearing manager for the purposes of calculating the under-frequency event charge. Transpower as system operator follows procedure PR-RR-017 “Calculating the Amount of MW lost”.

39. This procedure follows the formula set out under section 8.64 of the Code for evaluating an event charge.

    The **event charge** payable by the **causer** of an **under-frequency event** (referred to as “Event e” below) must be calculated in accordance with the following formula:

    EC = ECR * (∑y (INTye for all y) – INJd)

    where

    EC is the **event charge** payable by the causer

    ECR is $1,250 per **MW**

    INJd is 60**MW**

    INTye is the electric power (expressed in **MW**) lost at point y by reason of Event e (being the net reduction in the **injection** of **electricity** (expressed in **MW**) experienced at point Y by reason of Event e) excluding any loss at point y by reason of secondary Event e

    y is a **point of connection** or the **HVDC injection point** at which the **injection** of **electricity** was interrupted or reduced by reason Event e

40. As the ECR and INJd values are constants the values to calculate and complete the formula are Y and INTye.

CALCULATION FOR FIRST (NORTH ISLAND) EVENT

41. If the interruption or reduction of electricity associated with this under-frequency event was the MW lost through the Haywards HVDC injection point into the North Island.

42. To establish the amount of MW lost, SCADA data was extracted for the 60 seconds prior to the frequency reaching 49.25 Hz for generation transfer through the North Island HVDC grid injection point. After evaluation, the amount of MW lost causing the frequency to fall below 49.25 Hz was determined to be 185.5 MW.

43. A factor of 0.95 is applied to the MW lost, 185.5 MW, to account for any margin of error, reducing the MW lost value to 176.2 MW. Subtracting 60 MW from this value yields 116.2 MW. Multiplying this figure by the ECR gives an event charge of $145,281.

44. Note that due to an error in the calculation applied in the Prior Notification of Causer letter to Transpower as the grid owner[1], this calculated value differs from that value.

45. In response to the letter received from the grid owner[2] the system operator agreed that the reduction of electricity by the HVDC occurred in order to comply with clause 8.17 of the Code and not the causer.

46. It should be noted that once disregarded, there is no longer a MW lost value that can be used as part of the calculation as prescribed under clause 8.64.

CALCULATION FOR THE SECOND (SOUTH ISLAND) EVENT

47. The fall in frequency to 47.5 Hz in the upper South Island triggered a change in Aviemore station's control system. This change prompted the station to run back generation output. The generation is injected at Aviemore grid injection point (GIP).

48. To establish the amount of MW lost, SCADA data was extracted for the 60 seconds prior to the frequency reaching 49.25 Hz for generation at the Aviemore grid injection point. After evaluation, the amount of MW lost causing the frequency to fall below 49.25 Hz was determined to be 60.4 MW.

49. In this event the slow ramp down of Aviemore generation, combined with the lack of instantaneous reserves which had already fired, meant that frequency slowly declined over the course of several minutes.

50. A factor of 0.95 is applied to the MW lost value to account for any margin of error, reducing the MW lost value to 57.4 MW. Subtracting the 60 MW from this value yields a negative value, and an event charge of zero.

51. Note that due to an error in the calculation applied in the Prior Notification of Causer letter to Meridian[3], this calculated value differs from that value.

[1] Letter dated 6 April 2017, appendix 1.3

[2] Letter dated 16 May 2017, appendix 2.1

[3] Letter dated 6 April 2017, appendix 1.6

Appendix 1: System Operator Correspondence

1.1 Confirmation of event notice – First Event

TRANSPOWER SYSTEM OPERATOR

Date: 8 March 2017

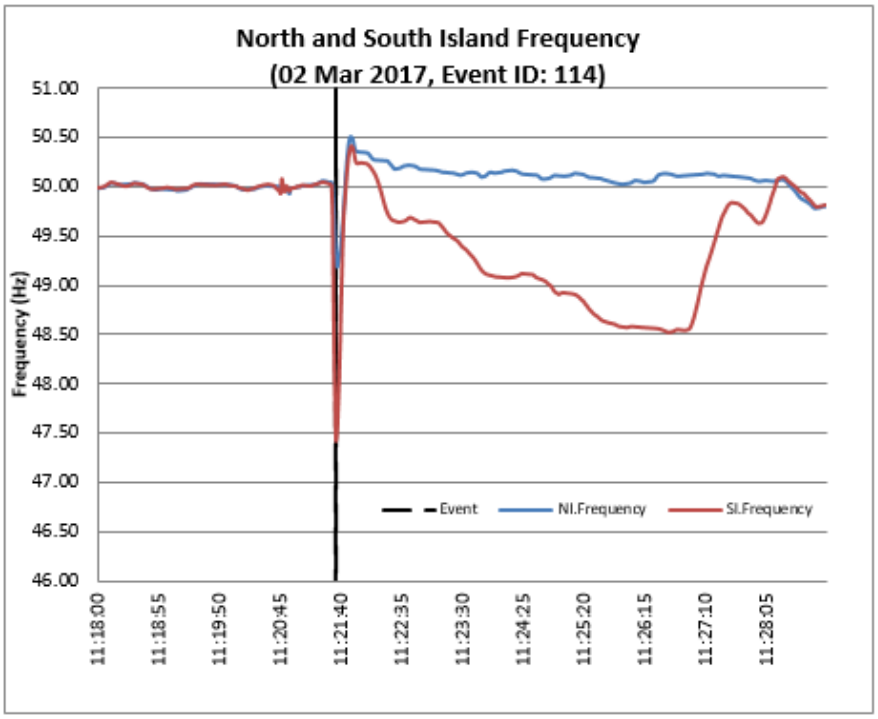
To: Market Participants
cc: Clearing Manager
From: System Operator

Under-frequency Event Confirmation

The System Operator wishes to advise market participants of the under-frequency event which occurred in both the North Island and South Island on 02 March 2017.

Event ID:	114
Affected Islands:	North Island and South Island
North Island Minimum Frequency:	49.17 Hz
Time (of min. frequency):	11:21:36
South Island Minimum Frequency:	47.40 Hz
Time (of min. Frequency):	11:21:36

Transpower New Zealand Ltd The National Grid



Market Operations
Transpower NZ Ltd
P.O. Box 1021.
Wellington,
New Zealand

Telephone: 04 590 7470

1.2 CONFIRMATION OF EVENT NOTICE – SECOND EVENT

TRANSPOWER SYSTEM OPERATOR

Date: 8 March 2017

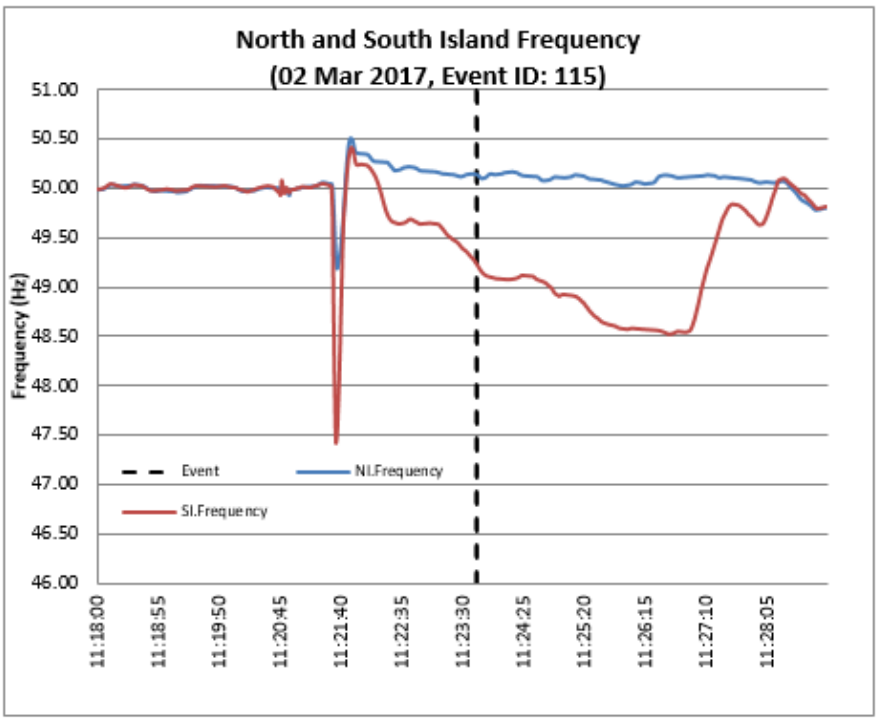
To: Market Participants
cc: Clearing Manager
From: System Operator

Under-frequency Event Confirmation

The System Operator wishes to advise market participants of the under-frequency event which occurred in both the North Island and South Island on 02 March 2017.

Event ID:	115
Affected Islands:	South Island
North Island Minimum Frequency:	50.13 Hz
Time (of min. frequency):	11:25:55
South Island Minimum Frequency:	48.52 Hz
Time (of min. Frequency):	11:26:37

Transpower New Zealand Ltd The National Grid



Market Operations
Transpower NZ Ltd
P.O. Box 1021.
Wellington,
New Zealand

Telephone: 04 590 7470

1.3 PRIOR NOTIFICATION OF CAUSER – FIRST EVENT

TRANSPOWER

Transpower House
96 The Terrace
PO Box 1021
Wellington 6140
New Zealand
P 64 4 495 7000
F 64 4 495 7100
www.transpower.co.nz

Scott Avery
Tel: (04) 590 6144
Mob: 027 7065164

6 April 2017

17

Kent Murrell
Transpower NZ Ltd
PO Box 17188
Wellington

Dear Kent

Under frequency event 2 March 2017

On 2 March 2017, an under-frequency event occurred in the North Island at 11:21. Based on the information available we believe that the event was potentially caused by the HVDC Link.

In order to report to the Electricity Authority as required by clause 8.60 of the Electricity Industry Participation Code we would appreciate any information you can provide around this event, and whether you believe Transpower New Zealand (as Grid Owner) is the causer of the under-frequency event.

From our assessment of the event at time the frequency reached 49.25Hz in the North Island the HVDC transfer was at 603.82MW (11:21:36). 60 seconds prior to this the HVDC transfer was 789.64MW.

Time	HVDC MW	North Island Frequency
02-Mar-17 11:20:36	789.64	50.00
02-Mar-17 11:21:36	603.82	49.23

This indicates that the reduction of 185.8MW of HVDC transfer was the MW lost which caused the event. Using this figure of MW lost the event fee would likely be ((185.8-60)*.95)*$1250 = $149,420.

If you have a view on the amount of electricity lost during this event please include that information in your response.

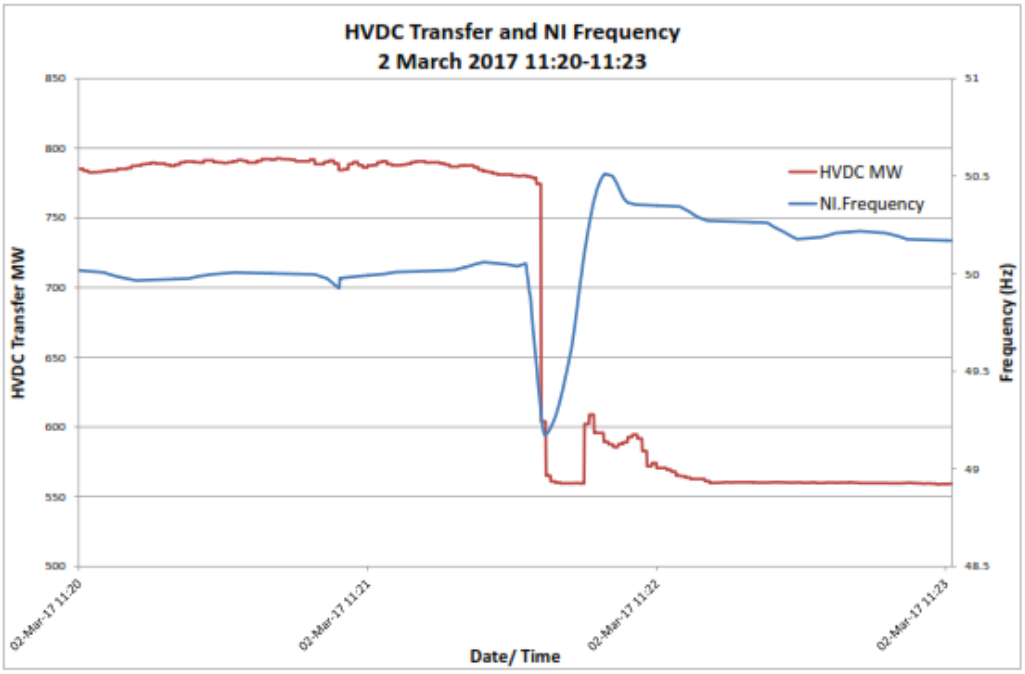
After receipt of your information Transpower (as the system operator) will prepare and send a report to the Electricity Authority with our view on whether the under-frequency was caused by a generator or grid owner, the identity of the causer, the reasons for our view and all of the information considering in reaching our view.

Please respond to the system operator with your information relating to this event no later than 5 May 2017.

Regards,

Scott Avery
Risk and Compliance Manager

CC Dean Eagle (System Operator)



Keeping the energy flowing Transpower New Zealand Ltd The National Grid

1.4 PRIOR NOTIFICATION OF CAUSER – SECOND EVENT

TRANSPOWER

Transpower House
96 The Terrace
PO Box 1021
Wellington 6140
New Zealand
P 64 4 495 7000
F 64 4 495 7100
www.transpower.co.nz

Scott Avery
Tel: (04) 590 6144
Mob: 027 7065164

6 April 2017

Simone O'Loughlin
Meridian Energy Ltd
287 – 293 Durham Street
PO Box 2146
Christchurch

19

Dear Simone

Under frequency event 2 March 2017

On 2 March 2017, an under-frequency event occurred in the South Island at 11:23. Based on the information available we believe that this event was potentially caused by the Aviemore Power Station.

In order to report to the Electricity Authority as required by clause 8.60 of the Electricity Industry Participation Code we would appreciate any information you can provide around this event, and whether you believe Meridian Energy is the causer of this under-frequency event.

We have also calculated the loss of injection of electricity to the grid for the event as 60.4MW.

Time	AVI Generation	SI Frequency
02-Mar-17 11:22:42	173.40	49.68
02-Mar-17 11:23:42	113.00	49.249

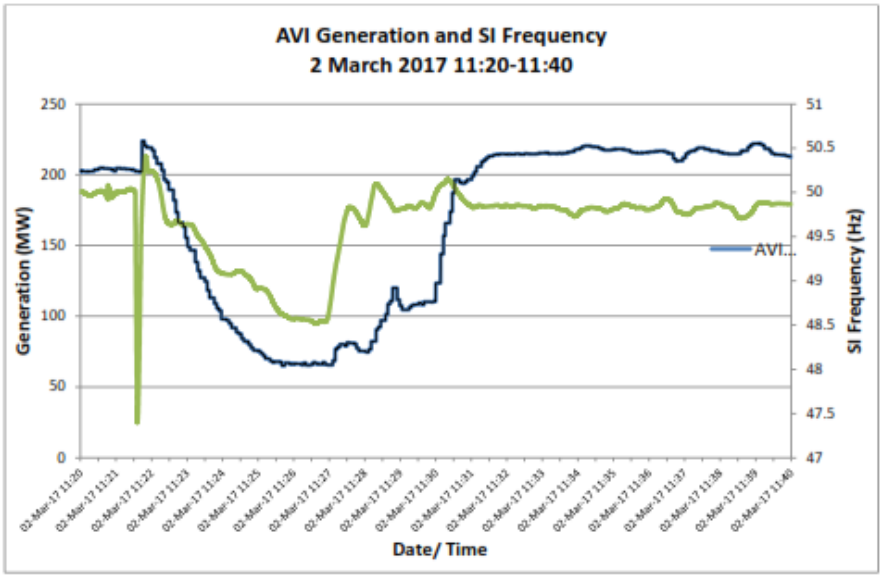
From our assessment of the event at time the frequency reached 49.25Hz in the South Island the generation at Aviemore was 113.0 MW (11:23:42). 60 seconds prior to this the generation was 173.4 MW.

This indicates that the reduction of 60.4 MW of generation at Aviemore was the MW lost which caused the event. Using this figure of MW lost the event fee would likely be

((60.4-60) *0.95) * $1250 = $475

If you have a view on the amount of electricity lost during this event please include that information in your response.

After receipt of your information the Transpower (as system operator) will prepare and send a report to the Electricity Authority with our view on whether the under-frequency was caused by a generator or grid owner, the identity of the causer, the reasons for our view and all of the information considering in reaching our view.



Please respond to Transpower (as system operator) with your information relating to this event no later than 28 April 2017.

Regards,

Scott Avery
Audit and Compliance Manager

CC Dean Eagle (System Operator)

Appendix 2: RECEIVED CORRESPONDENCE

2.1 TRANSPOWER RESPONSE TO FIRST EVENT

TRANSPOWER
Keeping the energy flowing

Transpower House
96 The Terrace
PO Box 1021
Wellington 6140
New Zealand
P 64 4 495 7000
F 64 4 495 7100
www.transpower.co.nz

Kent Murrell
Tel: (04) 590 6924
DX: SR 56017

16 May 2017

Scot Avery
Risk and Compliance Manager
Transpower New Zealand Limited
P O Box 1021
Wellington

Dear Scott

Thank you for your letter of 06 April 2017 regarding the under-frequency event that occurred at 11:21 on 02 March 2017 in the North Island. The following is in answer to your questions:

Prior to the event that occurred in the South Island on 02 March 2017, the HVDC was running in Frequency Keeping Control mode. When the South Island was split into two separate islands at 11:21, the HVDC transfer into the North Island was reduced by about 236MW to arrest the frequency fall in the upper South Island. This reduction in North transfer resulted in the North Island frequency falling to 49.17Hz.

Clause 8.17 of the EIPC states that "*the HVDC owner must at all times ensure that its assets make the maximum possible injection contribution to maintain frequency within the normal band (and to restore frequency to the normal band)*". The reduction in North transfer by the HVDC to arrest the falling frequency in the upper South Island was as expected and in accordance with this requirement of the Code.

Clause 1.1 of the EIPC states that *"if an interruption or reduction of electricity occurs in order to comply with this Code, the interruption or reduction of electricity must be disregarded for the purposes of determining the causer of the under-frequency event."* As the response of the HVDC was in order to comply with Clause 8.17 of the Code, the Grid Owner does not accept that is was the causer of the under-frequency event that occurred at 11:21 on 02 March in the North Island.

The Grid Owner agrees that the reduction of electricity into the North Island by the HVDC for this event was 185.5 MW as advised by the System Operator.

If you require any further information, please contact me on 04 590 6924 or e-mail me on kent.murell@transpower.co.nz.

Yours sincerely

Kent Murrell

Kent Murrell
Grid Compliance Manager

Transpower New Zealand Ltd The National Grid

2.2 MERIDIAN ENERGY RESPONSE TO SECOND EVENT

Hi Scott,

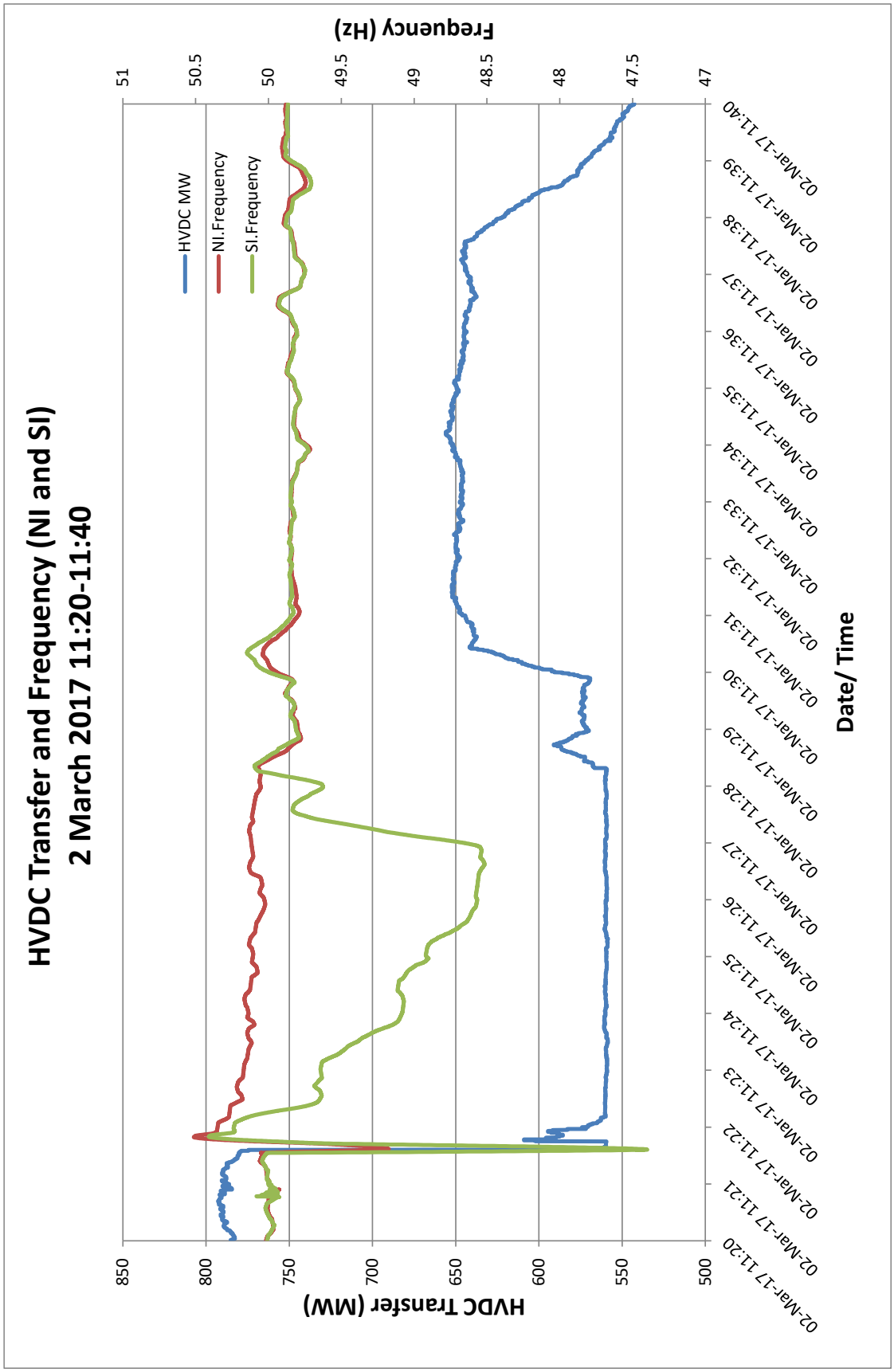
[redacted] Having reviewed the event on the 2nd March 2017 11:23, Meridian agrees that the second under frequency event at the time was attributed to the Aviemore generation reduction and therefore that Meridian was the causer of the second under frequency event.

Regards,

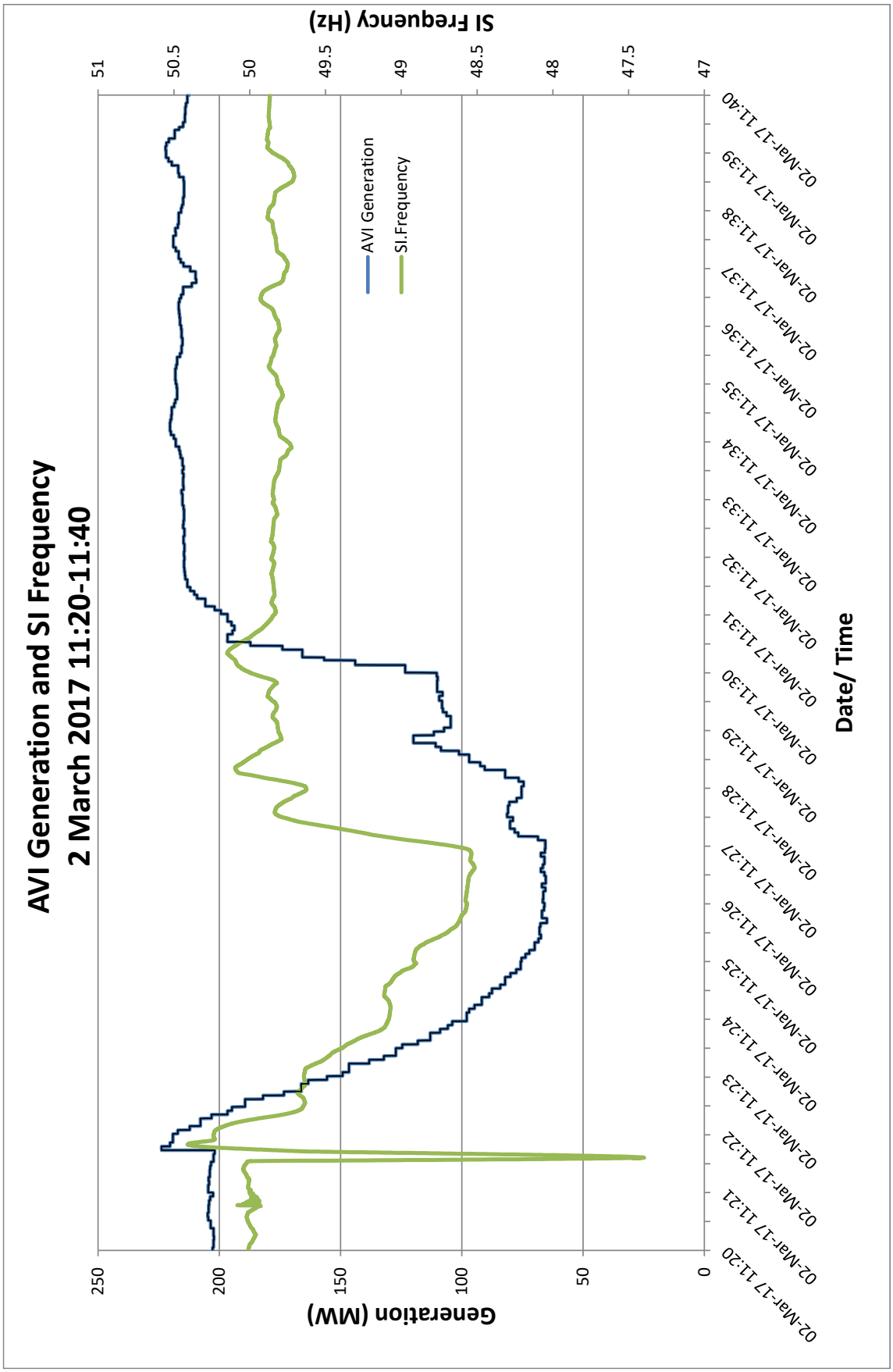
Jon Spiller
Transmission Manager
Meridian Energy Limited
33 Customhouse Quay, PO Box 10840, Wellington.
P. 04 381-1235
C. 021-754-218
W. www.meridianenergy.co.nz

Appendix 3: CHARTS

3.1 ISLAND FREQUENCIES AND HVDC TRANSFER



3.2 LOSS OF AVIEMORE GENERATION



Appendix C Code definitions of causer and under-frequency event

causer, in relation to an **under-frequency event**, means—

(a) if the **under-frequency event** is caused by an interruption or reduction of **electricity** from a single **generator's** or **grid owner's asset** or **assets**, the **generator** or **grid owner**; unless—

(i) the **under-frequency event** is caused by an interruption or reduction of **electricity** from a single **generator's asset** or **assets** but another **generator's** or a **grid owner's** act or omission or property causes the interruption or reduction of **electricity**, in which case the other **generator** or the **grid owner** is the **causer**; or

(ii) the **under-frequency event** is caused by an interruption or reduction of **electricity** from a single **grid owner's asset** or **assets** but a **generator's** or another **grid owner's** act or omission or property causes the interruption or reduction of **electricity**, in which case the **generator** or other **grid owner** is the **causer**; or

(b) if the **under-frequency event** is caused by more than 1 interruption or reduction of **electricity**, the **generator** or **grid owner** who, in accordance with paragraph (a), would be the **causer** of the **under-frequency event** if it had been caused by the first in time of the interruption or reduction of **electricity**; but

(c) if an interruption or reduction of **electricity** occurs in order to comply with this Code, the interruption or reduction of **electricity** must be disregarded for the purposes of determining the **causer** of the **under-frequency event**

under-frequency event means—

(a) an interruption or reduction of **electricity** injected into the **grid**; or

(b) an interruption or reduction of **electricity** injected from the **HVDC link** into the South Island **HVDC injection point** or the North Island **HVDC injection point**—

if there is, within any 60 second period, an aggregate loss of **injection** of **electricity** in excess of 60 **MW** (being the aggregate of the net reductions in the **injection** of **electricity** (expressed in **MW**) experienced at **grid injection points** and **HVDC injection points** by reason of paragraph (a) or (b)), and such loss causes the frequency on the **grid** (or any part of the **grid**) to fall below 49.25 Hz (as determined by **system operator** frequency logging)