THE AUTHORITY'S DRAFT DETERMINATION OF CAUSER

Published on: Tuesday, 1 August 2023

Submission Close: Tuesday, 29 August 2023

ELECTRICITY AUTHORITY
TE MANA HIKO

Executive Summary

Under-frequency events occurred on 30 July 2022 and 7 October 2022

The normal frequency band in New Zealand is between 49.8 and 50.2 Hz. An under-frequency event (UFE) occurs when the frequency falls below 49.25 Hz because of a loss of more than 60 megawatts (MW) injected into the grid. The Electricity Industry Participation Code 2010 (Code) requires the Electricity Authority (Authority) to determine the causer of a UFE and sets the process for making the determination.

The purpose of this paper is to:

(a) set out the Authority's draft determination of the causer for the 30 July 2022 UFE

(b) set out the Authority's draft determination of the causer for the 7 October 2022 UFE

(c) consult with interested parties on the draft determinations.

The UFE that occurred in the North Island and South Island on 24 January 2023 will be consulted on after the system operator has submitted its report. The Authority considered consulting on the three events together, however that would mean a long time would have elapsed between the July 2022 event and a draft determination.

The Authority's draft determination is that Genesis was the causer for the 30 July 2022 UFE

The Authority's draft determination under clause 8.61 of the Code is that Genesis Energy Limited (Genesis), as a generator, was the causer of the 30 July 2022 UFE.

The reasons for the draft determination are:

(a) the interruption/reduction of energy injected into the grid occurred at Unit 5 of the Huntly power station, which belongs to Genesis

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

(c) in the system operator's view, Genesis is the causer of the UFE

(d) in reply to the system operator's letter, Genesis accepted that it was the causer.

The Authority's draft determination is that the grid owner was the causer for the 7 October 2022 UFE

The Authority's draft determination under clause 8.61 of the Code is that Transpower New Zealand Limited (Transpower), as the grid owner, was the causer of the 7 October 2022 UFE.

The reasons for the draft determination are:

(a) the interruption/reduction of energy occurred at the Haywards HVDC link, which injects energy into the North Island HVDC injection point and belongs to the grid owner

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

(c) in the system operator's view, the grid owner is the causer of the UFE

(d) in reply to the system operator's letter, the grid owner accepted that it was the causer.

Submissions are invited from interested parties

The Authority must consult with interested parties before making a final determination. Interested parties are invited to make a submission on the Authority's draft determinations by 5 pm on Tuesday 29 August 2023. The Authority will consider all submissions received and make a final determination on each UFE.

The Authority also invites comment on the system operator's calculations of the MW lost during the events, which the system operator uses for calculating the UFE charge.

Contents

1. What you need to know to make a submission

What this consultation is about

1.1. The purpose of this paper is to consult with interested parties on the Authority's proposal to:

(a) Genesis Energy Limited, as the generator that owns Huntly Unit 5, was the causer of the UFE on 30 July 2022 at 6:13am.

(b) Transpower New Zealand Limited, as the grid owner that owns the Haywards HVDC, was the causer of the UFE on 7 October 2022 at 5:36am.

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 B. Submissions in electronic form should be emailed to compliance@ea.govt.nz with "Consultation Paper—30 July 2022 and 7 October 2022 under-frequency events" in the subject line.

1.3. If you cannot send your submission electronically, please contact the Authority (info@ea.govt.nz or 04 460 8860) to discuss alternative arrangements.

1.4. Please note the Authority intends to publish all submissions it receives. If you consider that the Authority 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, and

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

1.5. If you indicate part of your submission should not be published, the Authority will discuss this with you before deciding whether to not publish that part of your submission.

1.6. However, please note that all submissions received by the Authority, including any parts that the Authority does not publish, can be requested under the Official Information Act 1982. This means the Authority would be required to release material not published unless good reason existed under the Official Information Act to withhold it. The Authority 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 submission by 5pm on Tuesday 29 August 2023.

1.8. Authority staff will acknowledge receipt of all submissions electronically. Please contact the Authority info@ea.govt.nz or 04 460 8860 if you do not receive electronic acknowledgement of your submission within two business days.

2. Introduction

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

2.2. 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. The 30 July 2022 UFE draft determination

Genesis was the causer of the 30 July 2022 UFE

3.1. The Authority's draft determination under clause 8.61 is that Genesis, as the generator that owns Huntly Unit 5, was the causer of the UFE on 30 July 2022 at 6:13am.

The system operator investigated the causer of the UFE

3.2. The system operator's report (dated September 2022) is attached as Appendix B.

3.3. The circumstances described in the report are summarised below:

(a) At 6:13am Huntly Unit 5 tripped removing 144.50 MW of generation, and the frequency fell to 49.21 Hz in the North Island.

(b) The frequency fall and the quantity of MW lost (greater than the 60 MW minimum) meant that a UFE as defined in Part 1 of the Code had occurred because it was an interruption/reduction of energy injected into the grid.

(c) Instantaneous reserves in the North Island responded, returning the frequency to the normal band within 2 seconds. The threshold for response by available interruptible load providers was not met.

(d) Huntly Unit 5 tripped due a loss of feedwater. Genesis believes this is what caused the UFE.

(e) No other event or asset operation was identified as occurring at or around the time of the UFE.

(f) On 10 August 2022, the system operator wrote to Genesis setting out its view that Huntly Unit 5 tripped resulting in a loss of injection and requesting any information Genesis could provide. On 17 August 2022, Genesis agreed it was the causer.

(g) On 10 August 2022, the system operator requested the grid owner provide information on the circumstances of the UFE. On 19 August 2022, the grid owner provided some supporting information. The grid owner did not believe it was the causer of the 30 July 2022 UFE.

The Authority considered the circumstances of the UFE

3.4. The Authority has considered the system operator's report and correspondence with Genesis and the grid owner. The Authority's reasons for the draft determination that Genesis is the causer are:

(a) A UFE occurred on 30 July 2022 at 6:13am when frequency dropped to 49.21 Hz in the North Island.

(b) The interruption/reduction of electricity occurred at the grid injection point for Huntly Unit 5, which belong to Genesis.

(c) No other asset was identified as having caused or potentially caused the UFE.

(d) The system operator and Genesis agree that Genesis was the causer of the UFE.

3.5. Having considered the relevant clauses of the Code, the Authority (based on the information available at this time) agrees with the system operator's findings on the causer of the 30 July 2022 UFE.

Q1. Do you agree with the draft determination that Genesis Energy Limited is the causer of the under-frequency event on 30 July 2022 at 6.13am? If not, please advise your view on the causer and give reasons.

4. The 7 October 2022 UFE draft determination

The grid owner was the causer of the 7 October 2022 UFE

4.1. The Authority's draft determination under clause 8.61 is that Transpower, as the grid owner that owns Haywards HVDC, was the causer of the UFE on 7 October 2022 at 5:36am.

The system operator investigated the causer of the UFE

4.2. The system operator's report (dated December 2022) is attached as Appendix C.

4.3. The circumstances described in the report are summarised below:

(a) At 5:36am Haywards HVDC harmonic filter 4B tripped removing 256.1 MW of generation and the frequency fell to 49.16 Hz in the North Island.

(b) The frequency fall and the quantity of MW lost (greater than the 60 MW minimum) meant that a UFE as defined in Part 1 of the Code had occurred because there was an interruption/reduction of energy injected from the HVDC link into the North Island HVDC injection point.

(c) Interruptible load and instantaneous reserves in the North Island responded, returning the frequency to the normal band within 3 seconds.

(d) Haywards HVDC harmonic filter tripped due to an unexpected Pole 2 deblock while two of the Haywards AC filters were out for maintenance, causing the third filter to trip. The grid owner believes this is what caused the UFE.

(e) No other event or asset operation was identified as occurring at or around the time of the UFE.

(f) On 17 November 2022, the system operator requested the grid owner provide information on the circumstances of the UFE. On 24 November 2022, the grid owner provided some supporting information. The grid owner believes it was the causer of the 7 October 2022 UFE.

The Authority considered the circumstances of the UFE

4.4. The Authority has considered the system operator's report and correspondence with the grid owner. The Authority's reasons for the draft determination that the grid owner is the causer are:

(a) A UFE occurred on 7 October 2022 at 5:36am when frequency dropped to 49.16 Hz in the North Island.

(b) The interruption/reduction of electricity occurred at the grid injection point for Haywards HVDC, which injects energy into the North Island HVDC injection point and belongs to the grid owner.

(c) No other asset was identified as having caused or potentially caused the UFE.

(d) The system operator and the grid owner agree that the grid owner was the causer of the UFE.

Q2. Do you agree with the draft determination that Transpower New Zealand Limited, as the grid owner, is the causer of the under-frequency event on 7 October 2022 at 5:36am? If not, please advise your view on the causer and give reasons.

5. The Authority will consider submissions and make a final determination

5.1. Clause 8.61(4) of the Code requires the Authority to consult every generator, grid owner and other participant substantially affected by a UFE in relation to a draft determination. The Authority has allowed a consultation period of four weeks for this draft determination.

5.2. Accordingly, the deadline for submissions is 5 pm on Tuesday 29 August 2023.

5.3. The Authority will consider submissions received and publish its final determination. Clauses 8.62 and 8.63 of the Code set out provisions relating to any disputes regarding the Authority's determination.

6. The System operator has calculated the MW lost during the event based on its investigations

6.1. The Code sets out how to calculate the event charge payable by the causer of a UFE. This in turn enables calculation of the rebates paid for UFEs (clauses 8.64 and 8.65 of the Code).

6.2. Central to the event charge calculation is determining the MW of injection lost at one or more grid injection points as a result of the UFE. The system operator determines the MW lost as part of its investigations into a UFE.

6.3. The system operator followed its procedure PR-RR-017 Calculating the Amount of MW lost to determine the MW value (provided to the clearing manager for calculating UFE charges).

6.4. The system operator has determined the loss of injection into the grid for each event:

(a) The loss of injection for the 30 July 2022 event was 144.50 MW at the grid injection point for Huntly Unit 5, resulting in an event charge of $105,625.

(b) The loss of injection for the 7 October 2022 event was 256.1 MW at the grid injection point for the North Island HVDC link, resulting in an event charge of $245,125.

6.5. The system operator's calculation of the MW lost for each event is included in each respective report. The system operator's calculation does not form part of the Authority's draft determination. However, the Authority acknowledges that the calculation is central to determining the UFE charge payable by the causer, and therefore also to the rebate paid for a UFE. Accordingly, the Authority invites comment on the system operator's calculation of the MW lost.

Q3. Do you agree with the system operator's assessment that 144.50 MW was lost from the power system in the 30 July 2022 UFE? If not, please advise your view on the MW lost and give reasons.

Q4. Do you agree with the system operator's assessment that 256.1 MW was lost from the power system in the 7 October 2022 UFE? If not, please advise your view on the MW lost and give reasons.

Appendix A Format for Submissions

Submitter	

Questions	Comment
Q1. Do you agree with the draft determination that Genesis Energy Limited is the causer of the under-frequency event on 30 July 2022 at 6.13am? If not, please advise your view on the causer and give reasons.	
Q.2 Do you agree with the draft determination that Transpower New Zealand Limited, as the grid owner, is the causer of the under-frequency event on 7 October 2022 at 5:36am? If not, please advise your view on the causer and give reasons	
Q3. Do you agree with the system operator's assessment that 144.50 MW was lost from the power system in the 30 July 2022 UFE? If not, please advise your view on the MW lost and give reasons.	
Q4. Do you agree with the system operator's assessment that 256.1 MW was lost from the power system in the 7 October 2022 UFE? If not, please advise your view on the MW lost and give reasons.	

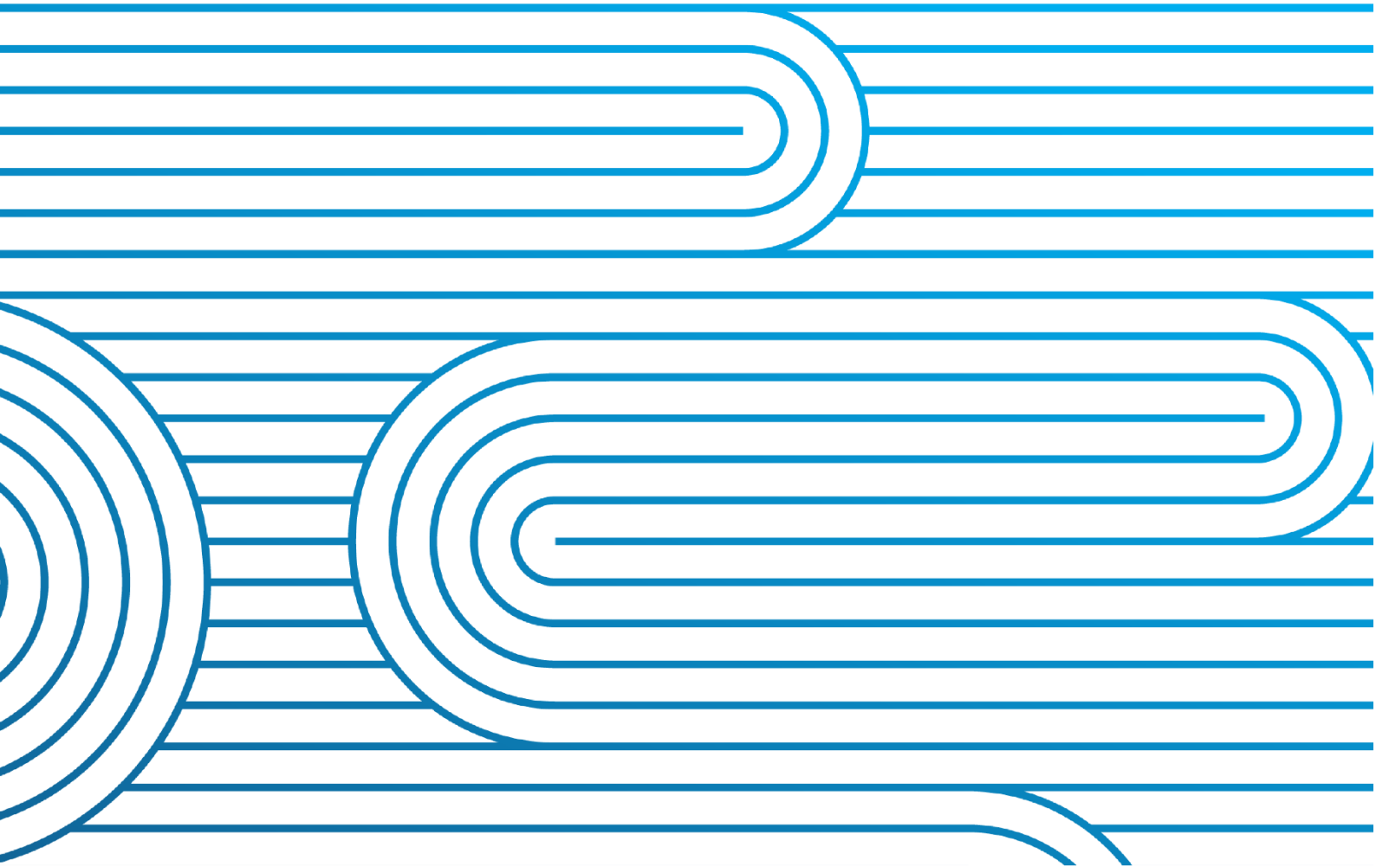
Appendix B Causation report 30 July 2022

TRANSPOWER

Causation Report
30th July 2022
Under-Frequency Event

System operator event 4298

September 2022



IMPORTANT

Disclaimer

Copyright

Contact Details

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22 Boulcott Street
PO Box 1021
Wellington
New Zealand

Telephone: +64 4 495 7000

Email: system.operator@transpower.co.nz

Website: *http://www.transpower.co.nz*

PURPOSE

On 30th July 2022 a reduction of energy into the power system caused the system frequency in the North Island to fall below 49.25 Hz, resulting in an under-frequency event.

Pursuant to clause 8.60 of the Electricity Industry Participation Code (**Code**), the system operator investigated the event to assist the Electricity Authority (**Authority**) in determining a causer of the under-frequency event.

This Causation Report is provided to the Authority pursuant to clause 8.60(5) of the Code and includes the following:

- The system operator's recommendation of the causer of the under-frequency event.
- The system operator's reasons for forming its view.
- The information considered in reaching this view.

EXECUTIVE SUMMARY

At 06:13:23 on 30th July 2022 Genesis Energy's Huntly Station Unit 5 generator (**Huntly Unit 5**) tripped.

The disconnection of generation from Huntly Unit 5 removed 144.50MW of injection into the power system.

At 06:13:24 the North Island frequency fell to 49.21 Hz. The North Island frequency falling below 49.25 Hz constitutes an under-frequency event, as defined in the Code.

Genesis Energy has stated that it believes the tripping of Huntly Unit 5 was the cause of the under-frequency on 30th July 2022.

Investigation into the tripping and other system events supports Genesis's position that the trip of Huntly Unit 5 caused the under-frequency event.

Accordingly, the system operator recommends Genesis Energy be found as the causer of the under-frequency event on 30th July 2022.

SYSTEM EVENTS – 30TH JULY 2022

Prior to the under-frequency event

According to the grid owner, there were no protection operations on any grid assets in the vicinity of Huntly either before or after Huntly Unit 5 tripped that may have contributed to the frequency falling below 49.25 Hz.

The under-frequency event

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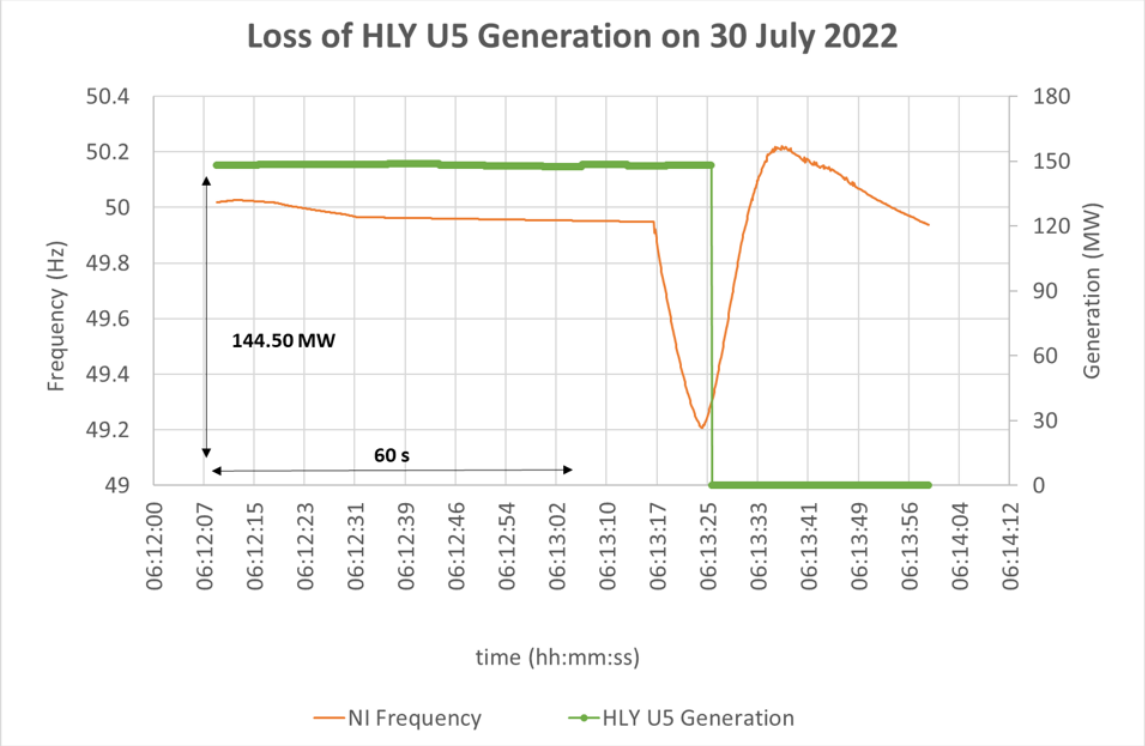
According to Genesis, Huntly Unit 5 tripped on heat recovery steam generator protection due to a loss of feedwater issue.

At 06:13:23 the disconnection of Huntly Unit 5 removed 144.50MW of generation injection into the power system and, as a consequence, reduced the system frequency at 06:13:24 to 49.21 Hz in the North Island.

Genesis' proposed the MW lost as 144 and provided supporting SCADA data in its response to the system operator on 17th August 2022. However, the system operator's SCADA data confirmed the value of MW lost as 144.50, as the system operator's data is higher resolution at 100 milliseconds while Genesis data is 1 second.

Please note the system operator's graph below does not precisely time the tripping of Huntly Unit 5. This is because there is a time delay in the system operator's SCADA data (which resulted in the delayed recording of Huntly Unit 5 tripping)..



After the under-frequency event

At the time of the event, the system operator had dispatched:

- North Island instantaneous reserve providers to be available to provide 32.39MW FIR and 147.32MW SIR;
- North Island interruptible load providers to be available to trip 5.41MW FIR and 82.22MW SIR.

The frequency returned to the normal band within 2 seconds. However, interruptible load providers are not required to respond until the frequency drops below 49.20 MW.

No other event or asset operation was identified as occurring at or around the time of the under-frequency event.

RATIONAL FOR RECOMMENDATION

Factors considered

Only one event occurred in close proximity to the North Island frequency falling below 49.25 Hz, namely the tripping of Huntly Unit 5 at 06:13:23.

Accordingly, assessment of this information confirms that only the tripping of Huntly Unit 5 can be linked with the North Island frequency falling below 49.25Hz.

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Genesis Energy and the grid owner were both asked if they considered themselves the causer of the under-frequency event.

Genesis Energy confirmed that the tripping of Huntly Unit 5 caused the under-frequency event.

The grid owner does not believe it caused the under-frequency event.

CALCULATION OF MW LOST

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.

The system operator follows the procedure 'Calculating the Amount of MW lost' (PR-RR-017) to determine the MW lost. This procedure follows the formula set out in clause 8.64 of the Code for calculating 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

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

To establish the amount of MW lost, SCADA data was extracted for the 60 seconds prior to the North Island frequency reaching 49.25 Hz for generation into the Huntly grid injection point.

Using the event charge formula the calculation is as follows:

Event Charge = $1250 * (144.50MW – 60MW)

Event Charge = $105,625

Appendix 1: CORRESPONDENCE

1.1 CONFIRMATION OF EVENT NOTICE

TRANSPOWER CAN

Customer Advice Notice

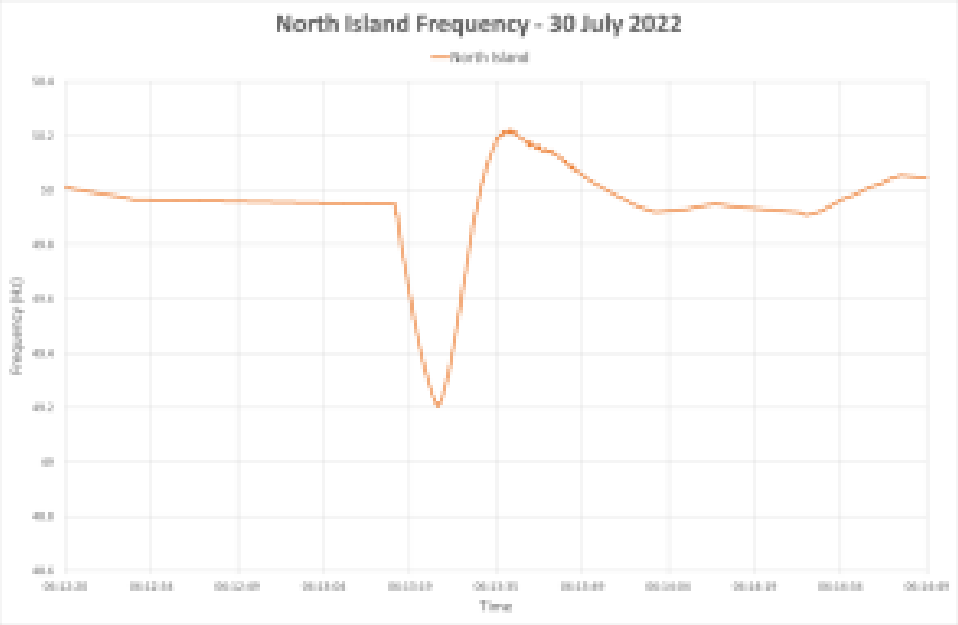
To:	CAN NZ Participants, cm@nzx.com	**From:**	The System Operator
Sent:	03-aug-2022 14:09	**Telephone:**	0800 488 500
Ref:	4422360295	**Email:**	NMData@transpower.co.nz

Revision of:

Under-Frequency Event Confirmation

The system operator wishes to advise market participants of the under-frequency event which occurred in the North Island on 30 July 2022.

Event ID	4298
Affected Islands:	North Island
North Island Minimum Frequency:	49.21 Hz
Time (start of UFE):	06:13:23
Time (of min. frequency):	06:13:24



1.2 SYSTEM OPERATOR REQUEST FOR INFORMATION - GENESIS

TRANSPOWER

Waikoukou
22 Boulcott Street
PO Box 1021, Wellington
New Zealand
Telephone +64-4-590 7000
Facsimile: +64-4-495 7100
richard.renouf@transpower.co.nz

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10 August 2022

Steve Leppien
Genesis Energy
Private Bag 3131
Hamilton

Dear Steve,

30th July 2022 North Island Under-Frequency Event

At 06:13 on 30th July 2022 an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- Could you provide information regarding the event and what you believe may have caused the under-frequency to occur on 30th July 2022.
- We have assessed the MW lost during the event as 148.33 MW at Huntly. Can you please confirm this assessment or provide data that indicates a different value of MW lost. We rely on SCADA data, but your data from site may be more accurate.
- Could you also confirm whether or not you could have been the causer of the under-frequency event as per the Code.

The information you provide will be used by the system operator to recommend to the Electricity Authority who the causer of the event was. The Electricity Authority will make the final determination of causer.

Please contact me if you require any further information.

Yours sincerely,

Richard Renouf
SO Compliance & Impartiality Manager

1.3 SYSTEM OPERATOR REQUEST FROM INFORMATION – GRID OWNER

TRANSPOWER

Waikoukou
22 Boulcott Street
PO Box 1021, Wellington
New Zealand
Telephone +64-4-590 7000
Facsimile: +64-4-495 7100
richard.renouf@transpower.co.nz

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10 August 2022

Mao Reyes
Grid Compliance Manager
Grid Owner
Transpower
Wellington

Dear Mao,

30th July 2022 North Island Under-Frequency Event

At 06:13 on 30th July 2022 an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- Could you provide information regarding the event and what you believe may have caused the under-frequency to occur on 30th July 2022.
- Could you also confirm whether or not you could have been the causer of the under-frequency event as per the Code.

The information you provide will be used by the system operator to recommend to the Electricity Authority who the causer of the event was. The Electricity Authority will make the final determination of causer.

Please contact me if you require any further information.

Yours sincerely,

Richard Renouf
SO Compliance & Impartiality Manager

1.4 GENESIS ENERGY RESPONSE

Genesis Energy Limited
The Genesis Energy Building
94 Bryce Street
Private Bag 3131
Hamilton 3204
New Zealand

T. 07 982 7909

17 August 2022

Richard Renouf
SO Compliance and Impartiality Manager
Transpower New Zealand Limited
P O Box 1021
WELLINGTON 6140

By email: Richard.Renouf@transpower.co.nz

Dear Richard,

RE: 30 July 2022 North Island Under-Frequency Event

I refer your letter dated 10 August 2022 requesting information from Genesis to help identify the causer of the 30 July 2022 North Island under-frequency event.

Information regarding the event
Huntly Unit 5 tripped on Heat Recovery Steam Generator protection due to a loss of feedwater issue.

Loss of Injection Figure:
Genesis has assessed the MW lost during the event as 144 MW using the methodology defined in Section 4.2 of the Transpower PR-RR-017 Providing Under Frequency Event Causer Recommendations procedure. The data supporting this assessment is attached.

Causer:
Genesis considers it (Huntly Unit 5) was the causer of the 30 July 2022 North Island under-frequency event.

Yours faithfully
GENESIS ENERGY LIMITED

Steve Leppien
Regulatory and Quality Assurance Manager

1.5 GRID OWNER RESPONSE

Waikoukou
22 Boulcott Street
PO Box 1021
Wellington 6140
New Zealand
P 64 4 590 7000
F 64 4 590 6968
www.transpower.co.nz

19 August 2022

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Richard Renouf
Compliance and Impartiality Manager
System Operations
Transpower
Wellington

Dear Richard

30th July 2022 North Island Under-Frequency Event

Thank you for your letter dated 10 August 2022 regarding the under-frequency event that occurred on 30th July 2022 in the North Island. My understanding of the event is as follows:

- At 06:13 on 30th July 2022 Huntly unit 5 tripped, resulting in an under-frequency event occurring in the North Island.
- Market participants were notified by a frequency excursion notice issued at 06:19 on 30th July, that Huntly generation had tripped and that the North and South Islands' frequency had fallen to 49.21Hz and 48.33Hz, respectively.
- A customer advice notice issued at 14:09 on 3rd August confirmed that an under-frequency event occurred in the North (06:13:23) Island on 30th July 2022.
- There were no protection operations of any grid assets in the vicinity of Huntly either before or after Huntly unit 5 tripped that may have contributed to the frequency falling below 49.21Hz.

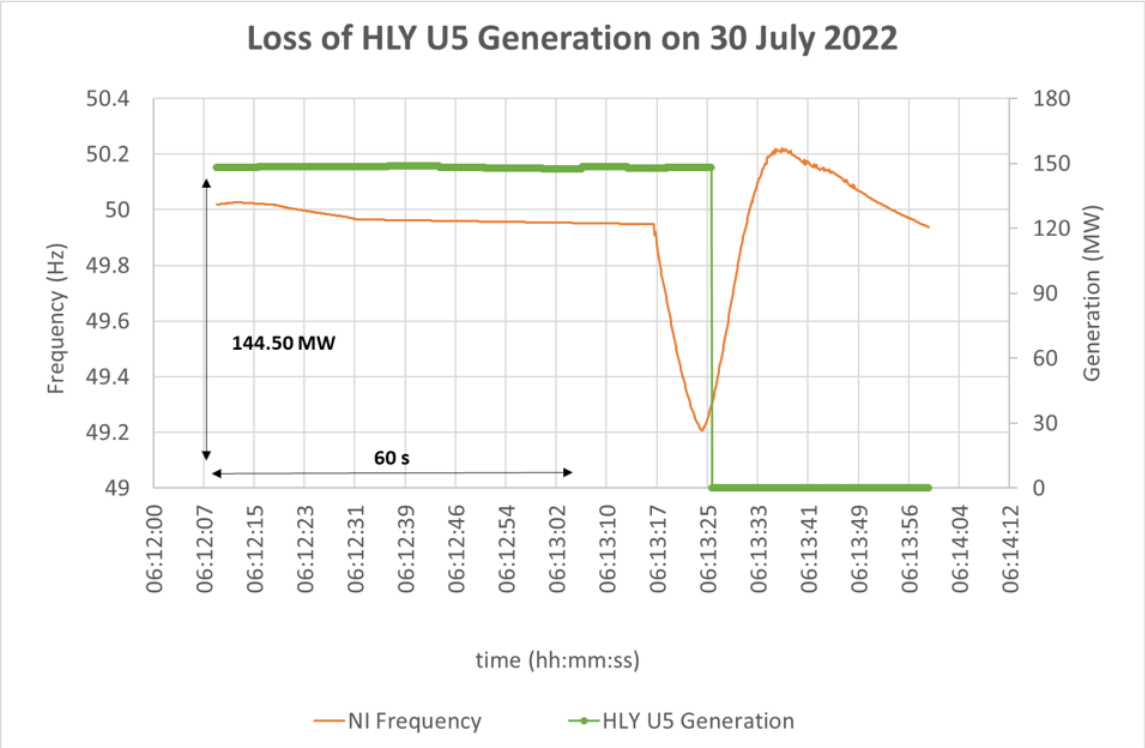
Considering the above information, I do not believe that the Grid Owner was the causer of the under-frequency event that occurred on this day.

Yours sincerely

Mao Reyes
Grid Compliance Manager

Appendix 2: CHARTS

System Frequency and MW Trace 30th July 2022



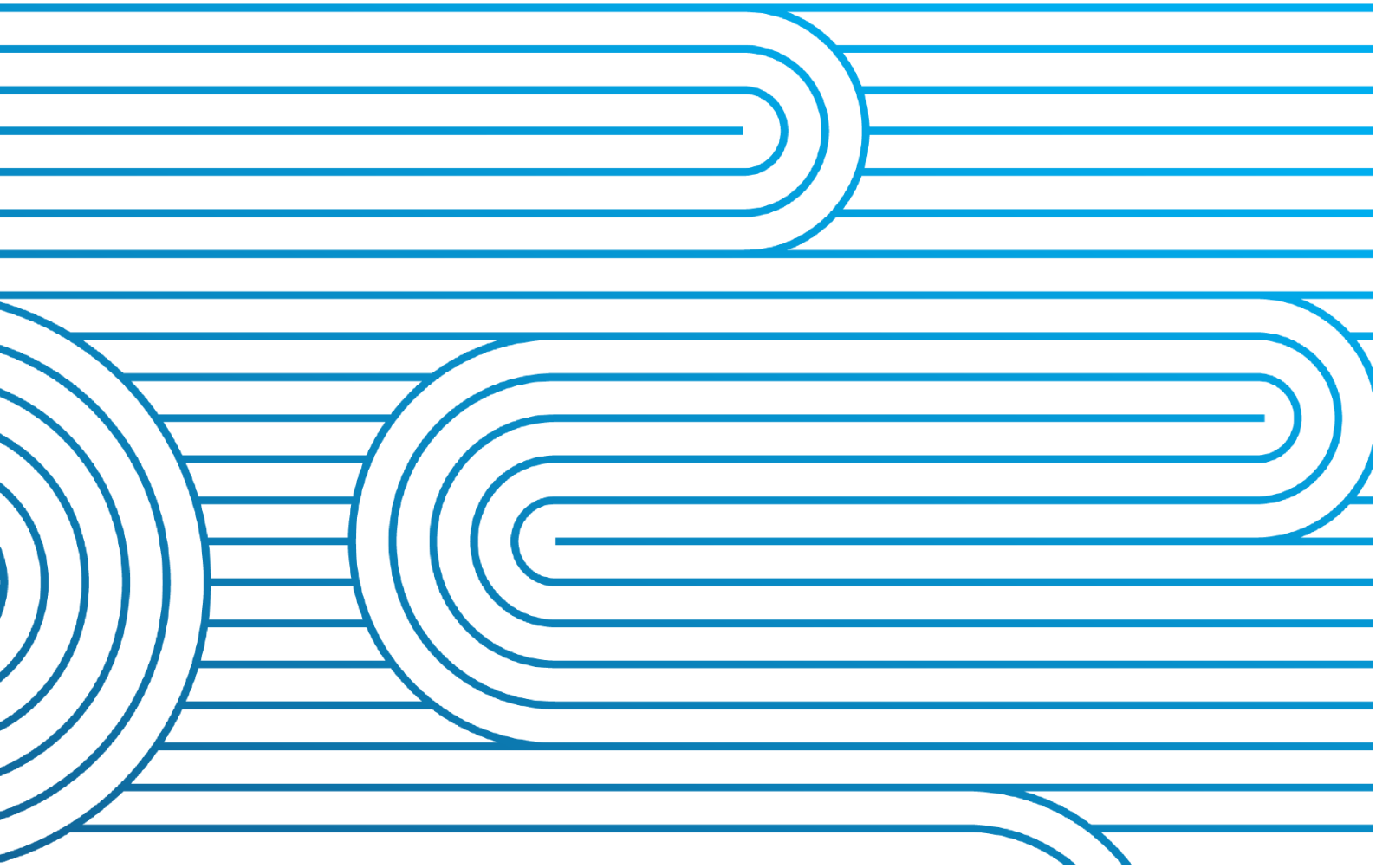
Appendix C Causation report 7 October 2022

TRANSPOWER

Causation Report
7th October 2022
Under-Frequency Event

System operator event 4309

December 2022



IMPORTANT

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Email: system.operator@transpower.co.nz

Website: *http://www.transpower.co.nz*

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PURPOSE

On 7th July 2022 a reduction of energy into the power system caused the system frequency in the North Island to fall below 49.25 Hz, resulting in an under-frequency event.

Pursuant to clause 8.60 of the Electricity Industry Participation Code (**Code**), the system operator investigated the event to assist the Electricity Authority (**Authority**) in determining a causer of the under-frequency event.

This Causation Report is provided to the Authority pursuant to clause 8.60(5) of the Code and includes the following:

- The system operator's recommendation of the causer of the under-frequency event.
- The system operator's reasons for forming its view.
- The information considered in reaching this view.

EXECUTIVE SUMMARY

At 05:36:55 on 7th July 2022 the HVDC harmonic filter 4B (**HVDC harmonic filter**) tripped at Haywards. The HVDC power transfer was reduced by 256.1MW.

At 05:36:56 the North Island frequency fell to 49.16 Hz.

The North Island frequency falling below 49.25 Hz constitutes an under-frequency event, as defined in the Code.

Transpower, as grid owner, has stated that it believes the tripping of the HVDC harmonic filter was the cause of the under-frequency on 7th October 2022. Investigation into the tripping and other system events supports the grid owner's position that the HVDC harmonic filter trip caused the under-frequency event. Accordingly, the system operator recommends Transpower, as grid owner, be found as the causer of the under-frequency event on 7th October 2022.

SYSTEM EVENTS – 7TH OCTOBER 2022

Prior to the under-frequency event

The grid owner provided an HVDC Power Reduction Timeline that sets out the circumstances around the HVDC harmonic filter trip. The Timeline is attached to this Report as Appendix 3.

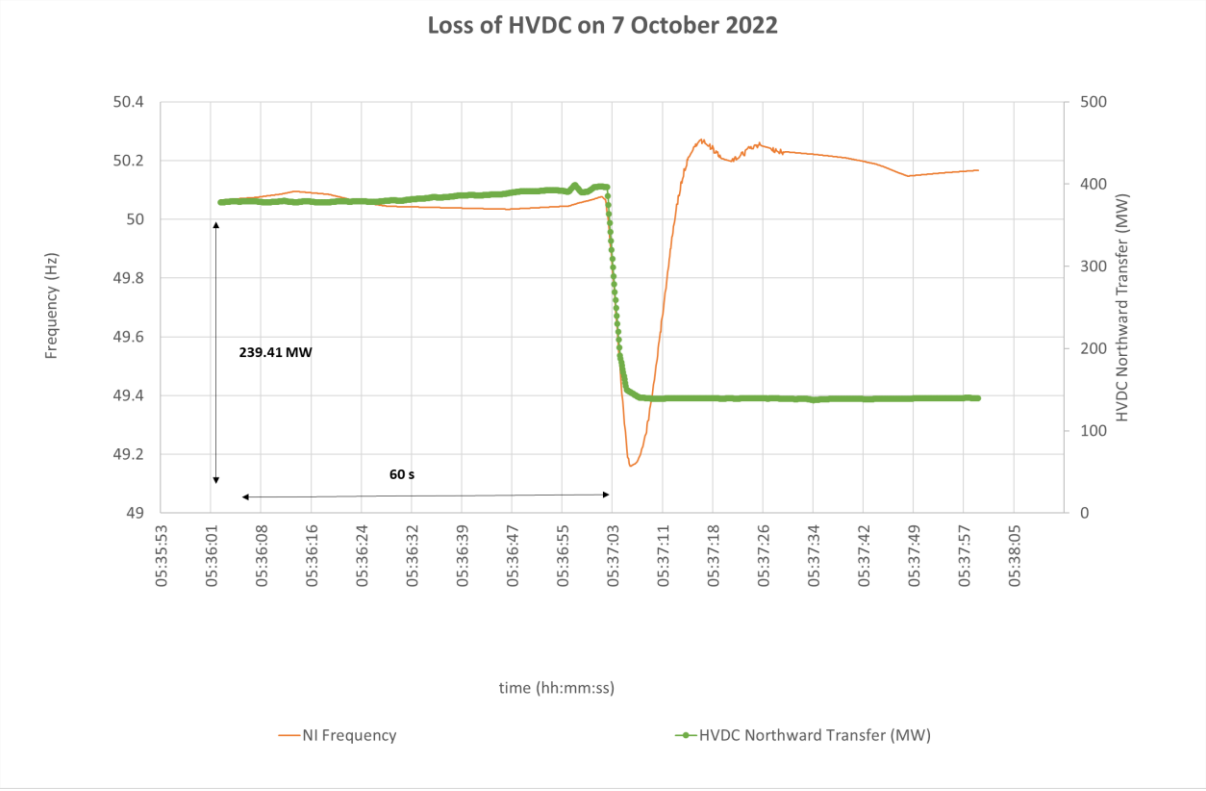
The under-frequency event

According to the grid owner, the reduction in the HVDC power transfer was caused by the HVDC harmonic filter trip.

At 05:36:55 the HVDC harmonic filter trip reduced the HVDC power transfer by 256.1MW and, as a consequence, reduced the system frequency at 05:36:57 to 49.16 Hz in the North Island.

Please note:

- *The system operator's SCADA data calculated the value of MW lost as 239.41. However, the system operator's load SCADA data may be a different resolution to the grid owner's HVDC SCADA data and the system operator is comfortable to rely on the grid owner's data for the purposes of calculating the event charge.*
- *The time delay in the system operator's SCADA data (which resulted in the delayed recording of the HVDC harmonic filter tripping) has not been represented in the graph below. The tripping of the HVDC harmonic filter and the frequency deviation have been aligned for the purpose of the graph.*



After the under-frequency event

At the time of the event, the system operator had dispatched:

- North Island instantaneous reserve providers to be available to provide 285.3MW FIR and 398.98MW SIR;
- North Island interruptible load providers to be available to trip 146.1MW FIR and 174.05MW SIR.

The frequency returned to the normal band within 3 seconds.

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Performance of instantaneous reserve providers in an under-frequency event is assessed by the system operator to ascertain if these providers are meeting their respective ancillary service contracts. One ancillary service provider fell short by approximately 1MW of its contractual obligations. The system operator is comfortable with the remedial actions implemented by the ancillary service provider to prevent recurrence.

No other event or asset operation was identified as occurring at or around the time of the under-frequency event.

Rational for recommendation

Factors considered

Only one event occurred in close proximity to the North Island frequency falling below 49.25 Hz, namely the HVDC harmonic filter trip at 05:36:56.

Accordingly, assessment of this information confirms that only the tripping of the HVDC harmonic filter can be linked with the North Island frequency falling below 49.25Hz.

The Grid Owner was if it considered itself the causer of the under-frequency event. The Grid Owner confirmed that the tripping of the HVDC harmonic filter caused the under-frequency event.

Calculation of MW Lost

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.

The system operator follows the procedure 'Calculating the Amount of MW lost' (PR-RR-017) to determine the MW lost. This procedure follows the formula set out in clause 8.64 of the Code for calculating 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

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

The system operator's SCADA data calculated the value of MW lost as 239.41. However, the system operator's load SCADA data may be a different resolution to the grid owner's HVDC SCADA data and the system operator is comfortable to rely on the grid owner's more accurate data.

Using the event charge formula the calculation is as follows:

Event Charge = $1250 * (256.1MW – 60MW)

Event Charge = $245,125

Appendix 1: CORRESPONDENCE

1.1 CONFIRMATION OF EVENT NOTICE

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TRANSPOWER CAN

Customer Advice Notice **Revision**

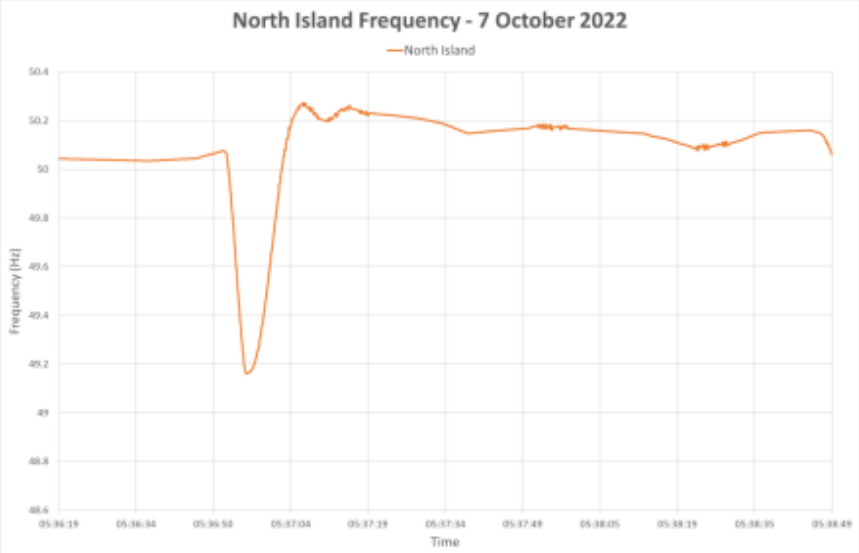
To:	cm@nzx.com, CAN NZ Participants	**From:**	The System Operator
Sent:	11-oct-2022 13:48	**Telephone:**	0800 488 500
Ref:	4504119942	**Email:**	NMData@transpower.co.nz

Revision of: CAN, 4502784391, 10-oct-2022 14:29, Under-Frequency Event Confirmation

Under-Frequency Event Confirmation

The system operator wishes to advise market participants of an under-frequency event which occurred in the North Island on 7 October 2022.

Event ID	4309
Affected Islands:	North Island
North Island Minimum Frequency:	49.16 Hz
Time (start of UFE):	05:36:55
Time (of min. frequency):	05:36:56



Market Operations

Transpower NZ Ltd
P.O. Box 1021,
Wellington 6140,

1.2 SYSTEM OPERATOR REQUEST FROM INFORMATION – GRID OWNER

TRANSPOWER

Waikoukou
22 Boulcott Street
PO Box 1021, Wellington
New Zealand
Telephone +64-4-590 7000
Facsimile: +64-4-495 7100
richard.renouf@transpower.co.nz

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17 November 2022

Mao Reyes
Grid Compliance Manager
Grid Owner
Transpower
Wellington

Dear Mao,

7th October 2022 North Island Under-Frequency Event

At 05:36 on 7th October 2022 an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- Could you provide information regarding the event and what you believe may have caused the under-frequency to occur on 7th October 2022.
- Could you also confirm whether or not you could have been the causer of the under-frequency event as per the Code.

The information you provide will be used by the system operator to recommend to the Electricity Authority who the causer of the event was. The Electricity Authority will make the final determination of causer.

Please contact me if you require any further information.

Yours sincerely,

Richard Renouf
SO Compliance & Impartiality Manager

1.3 GRID OWNER RESPONSE

TRANSPOWER

Keeping the energy flowing

Waikoukou
22 Boulcott Street
PO Box 1021
Wellington 6140
New Zealand
P 64 4 590 7000
F 64 4 590 6968
www.transpower.co.nz

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24 November 2022

Richard Renouf
Compliance and Impartiality Manager
System Operations
Transpower
Wellington

Dear Richard

7th October 2022 North Island Under-Frequency Event

Thank you for your letter dated 17 November 2022 requesting information on the under-frequency event that occurred on 7th October 2022 in the North Island. My understanding of the event is as follows:

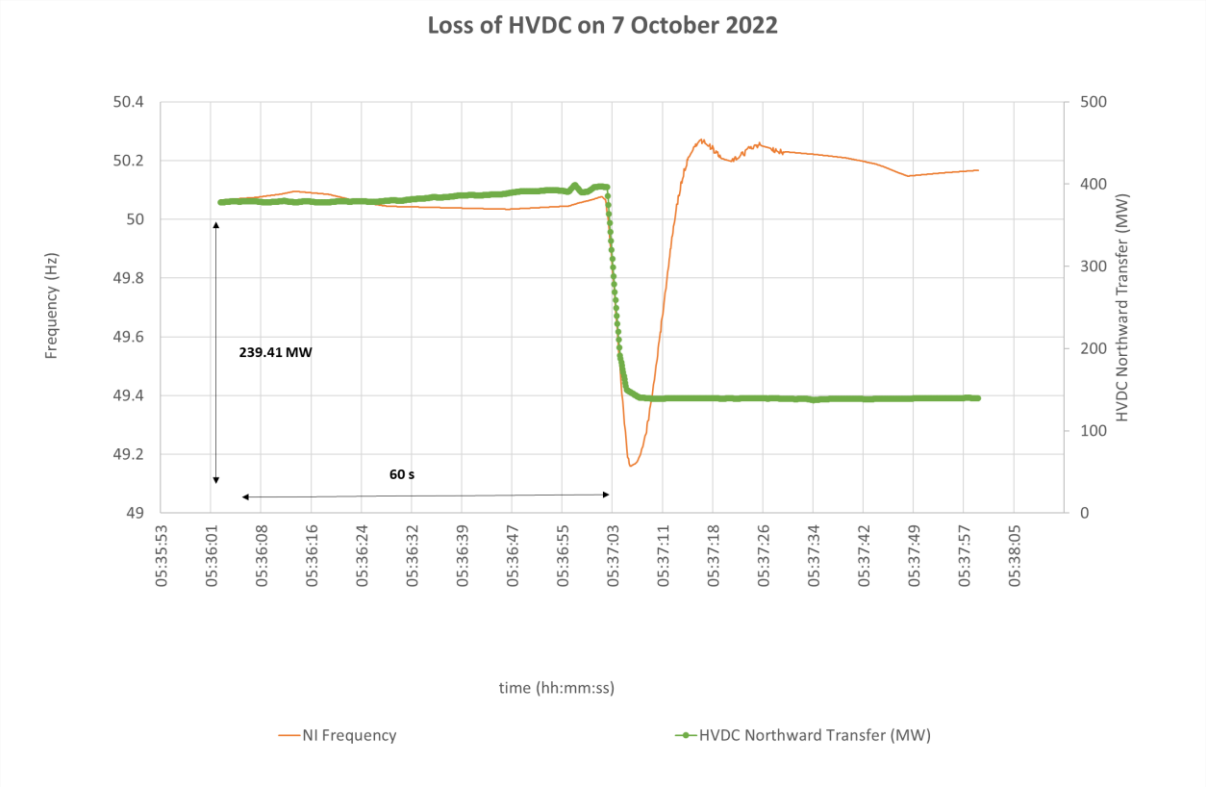
- At 05:36 on 7th October 2022 the HVDC power transfer was reduced by 256MW when the HVDC harmonic filter F4B tripped at Haywards, resulting in an under-frequency event occurring in the North Island.
- A customer advice notice issued on 11th October confirmed that an under-frequency event occurred in the North Island on 7 October 2022 (Event ID 4309).
- Attached as Appendix 1 is the detailed timeline established by Grid Owner's investigation of the HVDC power reduction event. The root causes of the event have been identified and a number of opportunities to improve the reliability of the HVDC link have also been determined. These will be examined further to establish the feasibility of the recommendations in terms of the risks and impact each presents.

Considering the above information, the Grid Owner considers it (HVDC link) was the causer of the under-frequency event that occurred on this day. From our assessment, the MW lost during this event is 256.1 MW using the methodology defined in section 4.2 of PR-RR-017 (Providing Under Frequency Event Causer Recommendations).

Yours sincerely

Mao Reyes
Grid Compliance Manager

Appendix 2: System Frequency and MW Trace



Appendix 3: GRID OWNER HVDC POWER REDUCTION TIMELINE

Pre-Event	
3 October 2022	Start of 2 week scheduled maintenance outage on Haywards Filters F3A and F3B from 3 October – 14 October 2022, with an 8-hour recall time.
5 October 2022	System Operator industry briefing on the tight generation situation to meet demand for the forecast cold snap over the next 2 days, 6-7 October 2022.
14:59 6 October 2022	The System Operator issues a CAN advising that there is a low residual forecast for the Friday morning, and requests increased energy and reserve offers for that period.
17:06 6 October 2022	The System Operator issues a CAN advising that Transpower has cancelled live-line work on HVDC Pole 2, scheduled for Friday. The live-line work did not increase the HVDC contingent risk, but would have required disabling of automatic restart after a line fault. Cancelling the live-line work helped improve HVDC system resiliency.
Friday 7 October 2022	
04:00 – 04:28	HVDC transmitting about 260 - 300 MW North with Roundpower mode enabled. To help reduce the over-night AC voltage : • Pole 3 is run in monopole with the Monopole-Bipole Transition Level set to 350 MW. • Haywards Filters F4A and F5B are the only 220 kV filters connected and the threshold for connecting additional filters has been raised to delay connection of further filters.
04:28:25	The rising morning demand increases reactive consumption on the system, and there is no longer a need to minimize the number of connected filters. The HVDC GAC reduces the filter switching threshold to allow more filters to be connected.
04:28:28	The RPC connects Filter F5A.
04:28:32	The RPC attempts to connect Filter F4B, but CB 762B red phase fails to close and F4B trips. • The 'Pole Block for Multiple AC Filter Outages Logic' activates to hold the HVDC in monopole operation to maximize transfer capability. • As designed, the RPC does not automatically set Filter F4B to manual mode, and the filter remains available to the RPC, but cannot be switched until all protection alarms are cleared. • There is no effect on the HVDC transfer of 300 MW.
04:28:35	The RPC connects Filter F6A .
04:31	The HVDC GAC contacts the on-call Transpower HVDC engineer and requests the HVDC service provider to investigate the fault onsite. The HVDC GAC then resets all Filter F4B protection trip alarms except for

	the POW relay alarm which prevents the RPC from switching F4B. Filter F4B switching is left available to RPC for automatic switching.
04:32 – 05:35	The HVDC bipole transfer rises above the Monopole – Bipole Transition Level of 350 MW up to about 407 MW. The 'Pole Block for Multiple AC Filter Outages Logic' keeps Pole 3 in monopole operation and does not change to bipole operation because the combined outages of F3A, F3B, and F4B would otherwise limit HVDC transfer to 140 MW.
05:23	The System Operator issues a CAN advising there is an unplanned outage of Haywards Filter F4B. The effect of this outage is to increase the HVDC CE risk as the HVDC transfer will be limited to 70 MW as a monopole in the event that Filter F5B trips.
05:37	The System Operator issues a WRN advising there is a risk of insufficient generation and reserve offers to meet demand and provide N-1 security for a contingent event for the morning peak. This results from the limitation on HVDC transfer in the event that Filter F5B trips.
05:36:52	The HVDC service provider has arrived on-site and visually checked that Filter F4B and Circuit Breaker CB 762B are not damaged. The service provider then resets the POW relay alarm for CB 762B. As Filter F4B is still available to the RPC, resetting the POW relay alarm increases the bipole power limit to 1200 MW. The Roundpower Mode control now issues a 10 sec long deblock command to Pole 2 to transition to bipole operation whilst HVDC transfer is maintained at 410 MW.
05:36:54	2 sec after deblocking Pole 2 the RPC attempts to connect Filter F4B, however red phase fails to close a second time. The 'Pole Block for Multiple AC Filter Outages Logic' blocks Pole 2 and HVDC transfer is maintained at 410 MW by Pole 3 in monopole operation. Unbalance protection trips Filter F4B after 1.4 sec.
05:36:56	The HVDC controls unexpectedly deblock Pole 2 again due to the persistence of the 10 sec long deblock command.
05:36:59	The unexpected Pole 2 deblock signifies a failure of the Bipole to Monopole transition. This results in Roundpower mode being automatically disabled and continuation in bipole operation. With three Haywards AC filters now on outage (F3A, F3B for maintenance and F4B tripped) and the HVDC in bipole operation, an HVDC power limit was set by the control system which limited the total transfer capacity to 140MW. This causes a power reduction in HVDC transfer from around 410MW to 140MW within 2 seconds. The rapid HVDC power reduction results in the North Island frequency falling to 49.16 Hz and tripping North Island interruptible load before recovering.
05:46:52	The 'Pole Block for Multiple AC Filter Outages Logic' blocks Pole 2 again and Pole 3 maintains power transfer in monopole operation. This removes the 140 MW bipole limit and allows Pole 3 to operate in monopole up to rated continuous capacity of 840 MW.
05:57	The Transpower HVDC Engineer instructs the HVDC GAC to set Filter F4B in manual mode so it cannot be automatically connected.
07:15	The restriction of the HVDC to Pole 3 monopole operation results in the System Operator issuing a GEN for the North Island advising there are insufficient generation and reserve offers to meet North Island demand and provide N-1 security for a contingent event. North Island distributors respond by shedding controllable load.

07:36	After on-site investigation, the HVDC engineers bypass the Filter F4B POW relay and request the HVDC GAC to attempt a manual close of CB762B. The manual close is successful and Filter F4B is left in service in Manual mode to prevent further automatic switching.
07:41	The HVDC GAC enables Roundpower mode and the HVDC changes from monopole to bipole operation at 411 MW transfer and power limit of 1200 MW.
08:00	The System Operator ends the Grid Emergency.

Glossary of abbreviations and terms

Authority	Electricity Authority
Act	Electricity Industry Act 2010
Code	Electricity Industry Participation Code 2010
Regulations	Electricity Industry (Enforcement) Regulations 2010